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95

Tuula Nousiainen

Children's Involvement in the Design of Game-Based Learning Environments

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ABSTRACT

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This study examines the involvement of children in the development of game-based learning environments. It aims to build a rich picture of the process and the effects of children's participation in technology design projects and to apply, modify, and develop methods and practices to be used in this context. In this study, user involvement is investigated in terms of two dimensions: its process and its goals. The former explores the structure of the process and the methods employed in the involvement of users, as well as the collaboration between developers and users. The latter addresses the role of user expertise and the actual context, the empowerment of the users, and the quality of the outcome. These issues are examined from the points of view of both children and developers, as well as through the observation of participation activities and the analysis of the final products. The research was carried out at the Agora Center, University of Jyväskylä, within the development projects of two game-based learning environments – Talarius and Virtual Peatland. In each project, there was one elementary school class as the principal participant group. The research was conducted using development research as the main approach, and the research process was cyclical, with the results from the first project informing the planning and conducting of the other. Participation in a technology design project provides children with valuable opportunities both for learning and for voicing their opinions. In order to feel ownership over the final product, however, children need to see their contributions in the outcomes very concretely and be able to clearly follow and influence the evolution of their ideas throughout the process. As a response to challenges regarding the feeling of ownership, ways of building a more gradual and transparent process of involvement and the adoption of concrete content creation as a new element of participation are suggested. The results can be applied both in future design projects conducted with children, but also in a broader context, especially in classrooms to support children's technology and new media literacy skills.

Keywords: user involvement, game-based learning environments, children's participation, development research

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Jyväskylä, November 2008

Tuula Nousiainen

FIGURES

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1 INTRODUCTION

A child-centred perspective has arisen as an emerging approach for addressing the relationship between children and technology in the field of human-computer interaction (HCI). Traditionally, much of the research regarding children and technology has focused on the impacts of technology on children and their learning, but in the recent years there has been growing interest in the roles of children in the design of software aimed for them, and a child-centred way of looking at technology design has been brought into discussion in an increasing amount (Bruckman & Bandlow 2003; Druin 2002). A concrete example of this is the Interaction Design and Children (IDC) conference which was held for the first time in the year 2002, as an international workshop, and has since grown into an annual conference addressing a large variety of issues dealing with children and technology design. Hence, in the design of technology, children are no longer seen only as research objects or as a passive target group for the development of new technologies. Instead, the potential of involving children as active participants in the design process is being increasingly acknowledged. There are, however, still great challenges in the development and application of methods, practices and principles for successful child-centred design.

User involvement is seen by many researchers as a successful approach in software design. This can be seen most clearly as increased user satisfaction when users have been engaged in the design process (e.g. Kujala 2003; Maguire 2001). In addition to producing software that meets the users' requirements, a central principle in active user involvement is to support their feeling of having a say in the development. This is emphasized especially in participatory design, a design philosophy based on the ideals of workplace democracy and empowerment (Clement & Van den Besselaar 1993; Kensing & Blomberg 1998).

This study examines issues related to the involvement of (child) users in the design of educational game applications intended for children. The main goal of the study is to build a thorough picture of the process and effects of children's participation, extending the scope of children's involvement into a more multidisciplinary direction. Involvement is examined from the points of view of both the user participants' and the developers' experiences, as well as through the observation of the participation activities and the analysis of the outcomes. The multidisciplinary framework developed in the course of the study encompasses fields which emphasize active participation in other contexts but which have not been taken full advantage of in the context of technology design projects with children. Such fields entail especially sociology, child-centred pedagogy, and the phenomenon of user-created content. Based on these fields, methods and practices to be used for children's involvement at different stages of development projects are analyzed, modified, and developed.

The research was carried out within the Agora Center at the University of Jyväskylä, addressing two development projects of game-based learning environments. In the first project, the pilot version of a board-game-like learning environment called Talarius was developed. The aim of the second project was to develop Virtual Peatland, a web-based learning environment about peatlands. In each project, an elementary school class participated in the process. The research process was cyclical; the results of the first cycle (Talarius) informed the second cycle (Virtual Peatland). The study was carried out using development research (Richey et al. 2004; van den Akker 1999) as the principal research approach due to the research being conducted as a part of the work of a multidisciplinary research group, the principal collective research method of which is development research. Development research is generally used in the study of educational interventions, and bearing also significant resemblance to the design-science approach (e.g. Hevner et al. 2004; van Aken 2004) employed in information systems research, it was seen as a suitable approach for this study.

The study examines the process of user involvement on the one hand and meeting the goals of user involvement on the other – these two dimensions form the basis of the conceptual framework of the study, and the research questions fall within these categories. In terms of the process, the research questions deal with the structure and the methods used in the projects, as well as the collaboration between the developers and the users. The goal-related research questions, on the other hand, address questions dealing with the following themes: the extent to which the goals related to product quality are met, the empowerment of the users, making use of user expertise, and addressing the actual context. Moreover, questions related to design as a learning process are addressed as well.

The study contributes to the research in the field by providing a comprehensive, detailed, and practice-grounded account of the world in which technology designers cooperate with children in the school environment to design new applications. This activity is examined from the perspectives of the children and the developers alike, enhanced by the analysis of how the contributions provided by the children actually manifest in the outcomes. The results provide both new ways of involving children in design projects and new insights into existing ways of doing this. Special attention is paid on the children's feeling of ownership and their experience of contributing to the final outcome. Another essential contribution is that the study extends the scope of children's involvement in technology design towards a more multidisciplinary direction by examining what technology design could learn from approaches such as child-centred pedagogy and childhood sociology – both of which have traditions in addressing questions related to children's active participation in contexts other than technology design –, as well as player-centred gaming cultures and user-created content. In order to respond to needs beyond those of people who develop new technological applications, I will discuss the results of the study also from the perspective of everyday school work with the aim of providing teachers with insights that they can make use of in the classroom on their own.

The thesis consists of six chapters, reflecting the structure of the development research process. The first chapters lay the groundwork for the thesis by, firstly, describing the theoretical background of the study as well as the conceptual framework and the research questions derived from it (Chapter 2) and, secondly, by discussing the research methods and the structure of the research process (Chapter 3). Chapter 4 presents the first cycle of development research in this study. Firstly, earlier research related to the principles and methods of user involvement in technology design is reviewed: general approaches such as user-centred design and participatory design are discussed, as well as approaches that are more specifically focused on children and technology (i.e. learner-centred design and child-computer interaction). The first case project, Talarius, is then presented and the ways in which the involvement of users was put into practice in this project are portrayed. The process and the participation methods employed in the project are described and analyzed, and the implications of the results are presented. Chapter 5 represents the second development research cycle of the study, dealing with the development of the Virtual Peatland learning environment. This chapter follows a similar structure as the previous chapter. First, an extended multidisciplinary framework for user involvement is built based on literature and the experiences obtained from the first research cycle. Then the results from using an approach based on this framework in the Virtual Peatland project are discussed. Comparison of the results of the Virtual Peatland study to those obtained from the Talarius project is emphasized. Finally, in Chapter 6, the results of the study are summarized and discussed, their implications are reflected from several perspectives, and the study is evaluated. Moreover, directions for future research are suggested.

2 THEORETICAL FRAMEWORK AND RESEARCH QUESTIONS

This chapter presents the theoretical framework of the study and the research questions derived from the framework. The framework is based on a review of research literature related to user involvement. The purpose of the literature review was to establish the background for approaching the main goal of the study, namely examining the successfulness of user involvement from the perspectives of the user participants themselves, the developers, and the final product. The review highlighted issues that have been raised in previous literature as essential aspects of user involvement. These issues fell into two categories: those related to the *goals* of user involvement and those that deal with the *process* of user involvement. These two dimensions also formed the basis for the research questions of the study.

One of the characterizations of user involvement and its goals discovered in the literature review is Kujala's (2003) model presented below (Figure 1). She suggests that the main goal of user involvement is enhanced system acceptance, and has found that it can manifest in different ways, as the figure indicates. The figure shows that user involvement in itself may directly promote satisfaction in the users as they have gained an understanding of the system in the course of the development. Additionally, they might consider it important that they have been heard in the development. In other words, participation can be a value in itself. For the most part, however, the increased acceptance is due to enhanced system quality, which in turn is a result of successful implementation of requirements: the system fits the users' actual needs and is perceived both useful and usable. Another factor affecting the system quality is the performance of the development team; fewer iteration cycles may be needed, and user involvement may have other positive effects on the project work; for example, it can lead to more innovations. However, the influence of user involvement on the project process is somewhat ambiguous: despite acknowledging the various benefits, the developers may also consider it difficult to embed active user involvement into the process, and changing – as well as potentially conflicting – requirements may have negative effects on the process. (Kujala 2003)

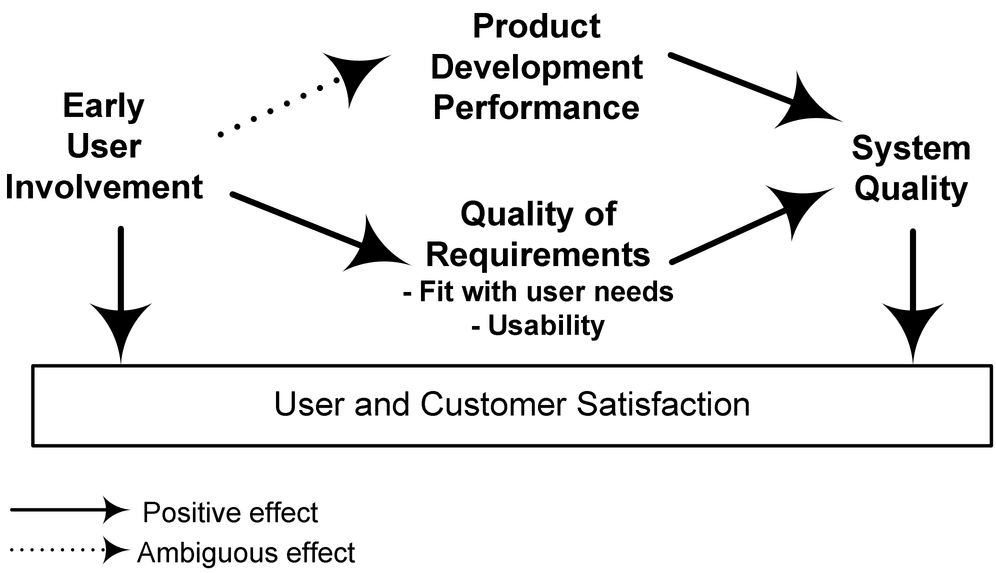

FIGURE 1 Effects of user involvement (Kujala 2003, 12)

A key concept in examining issues related to user involvement in a project is *the relationship between the goals of user involvement and the process through which the goals are approached*. This is a complex relationship – one indication and representation of which is the framework presented in Figure 1 – and entails also ambiguous relationships between the different aspects of user involvement. This relationship is the skeleton of the conceptual framework of the study (Figure 2).

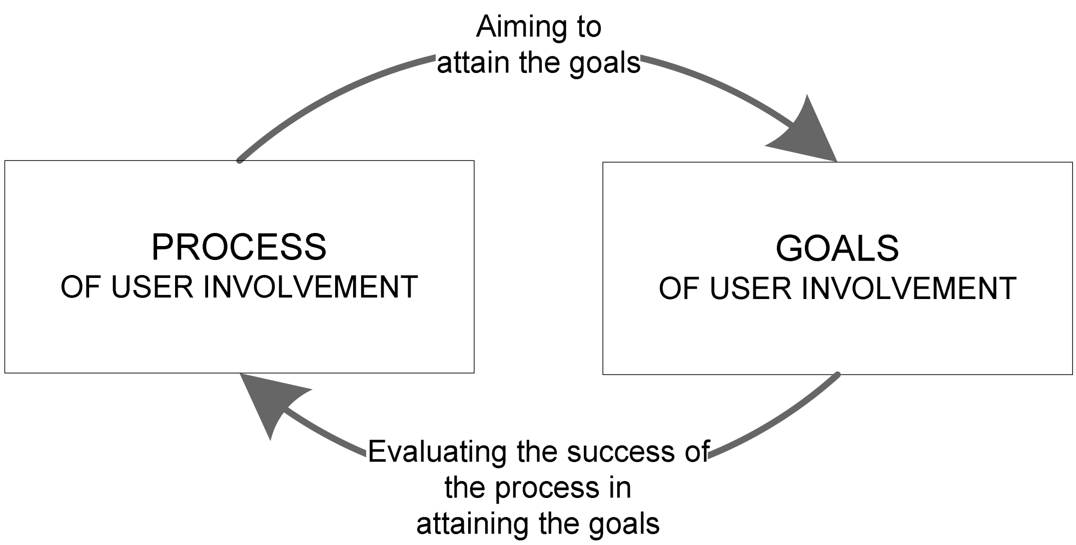

FIGURE 2 Basis of the conceptual framework: the goals and the process of user involvement

Figure 2 represents the two key elements that need to be addressed when studying user involvement: the goals and the process of user involvement, and the relationship between them. In other words, it is necessary to identify the goals of user involvement in general, and the process through which the goals are approached. In this study, both of these elements are in a crucial role: the aim is to look for successful ways (i.e. process) to involve users in the development of digital learning environments, and the most essential criterion in assessing the process is to examine how the general goals of user involvement are attained.

This skeleton of the conceptual framework served as a key starting point for the literature review conducted to form the basis of this study. The aim of the literature review was to discover issues of which the two main elements of the framework consist and, consequently, which comprise the issues that need to be adopted as the principal research themes and questions of the study. The following sections will examine the constituents that surfaced in the literature review, first the goal-related and then the process-related issues.

2.1 Goals of User Involvement

The involvement of users in the design of technology has been considered one of the prerequisites for good design (Kensing & Blomberg 1998). User involvement can be defined as a rather broad concept which, according to e.g. Kujala (2003) and Damodaran (1996), is seen as a general and wide-ranging term covering various levels of direct contact with the users of the technology being developed, from the role of informants to that of full participants. For the purpose of this study, user involvement is broadly defined as a development process incorporating ideas and feedback obtained directly from end users (in this case, children) at various stages of the process, starting from the initial steps of the process extending to the use of the finished product. This, as mentioned, is a broad definition, and in the course of this thesis it will be discussed in more detail how it was put into practice in the two different projects investigated in this study.

User-centred design and participatory design can be identified as the principal approaches of user involvement. The subsections below focus on the goals of user-centred and participatory design as well as on the reasons for involving users that have been emphasized in literature related to user-centred and participatory design. The main issues that were highlighted in the literature in terms of the goals of user involvement and the rationale for involving users entail the following issues: 1) enhancing product quality and user satisfaction, 2) bringing the users' expertise into the development process, 3) taking the actual use context into account better, and 4) empowering the users and giving them a sense of ownership.

2.1.1 Enhancing Product Quality

Previous research has revealed several positive effects of bringing users into the design process (e.g. Cherry & Macredie 1999; Damodaran 1996; Kensing & Blomberg 1998; Kujala 2003; Muller 1992). A positive effect on the quality of the system being developed is considered one of the main reasons for involving users in technology design throughout the development cycle. As Figure 1 illustrated, product quality is affected by user involvement in different ways: firstly, user involvement yields information that leads to better requirements and, secondly, users' active participation can bring about improvements in team performance (Kujala 2003). Improved quality, for its part, fosters user satisfaction and promotes acceptance of the new system. In other words, satisfaction with and commitment to the product are a result of better overall quality that has been achieved through more relevant requirements and through the versatile expertise that has contributed to the design of the product (Cherry & Macredie 1999; Damodaran 1996; Kujala 2003; Muller 1992). The quality of the application entails that it fits the users' ways of working better, thereby increasing productivity, decreasing errors, and reducing the need for training and support (Maguire 2001).

The improved quality is not limited only to the application itself; especially participatory design emphasizes that the goal is to improve the quality of work life as a whole (Blomberg & Henderson 1990; Cherry & Macredie 1999). It has been stated that through participatory design it can be ensured that the solutions suit the users' ways of working and are considered useful (Cherry & Macredie 1999; Kensing & Blomberg 1998). These views can be extended to design projects conducted together with children; the same principles can be seen to apply in the development of learning tools for school use or for informal learning.

2.1.2 User Expertise

As mentioned above, the information obtained from users has a crucial role in terms of the quality of the requirements. One commonly stated principle in user involvement is multidisciplinary expertise ranging from technical experts to content area specialists and from usability experts to visual artists (Gulliksen et al. 2003; ISO 13407, 1999; Knudtzon et al. 2003). Crucially, one of the most important expert groups are the users. Their domain of expertise is the experience they have with their own work and problems related to it (e.g. Schuler & Namioka 1993).

Similarly as adult end users' knowledge about their work practices is valued in participatory design with adults, children's expertise about the issues they are familiar with is also considered valuable. Several researchers (e.g. Bruckman & Bandlow 2003; Read 2005) have emphasized the need to better understand children's needs as technology users, as their ways of interacting with technology often differ fundamentally from those of adults e.g. in terms of curiosity and tendency to explore and their preference of working together.

Moreover, children's wishes especially regarding the fun and motivating aspects of technology may be difficult, or impossible, for adult designers to envision (Read 2005; Scaife & Rogers 1999).

Bringing users' expertise into the design process is demonstrated especially in participatory design approaches. It has even been said that participatory design turns the traditional roles of systems design upside down: users are the experts, and designers are their "technical consultants" (Schuler & Namioka 1993). The core idea of having users as participants is that users themselves know best how their tools and working conditions can be improved (Schuler & Namioka 1993). It has been stated that participatory design allows the users' knowledge and experiences to be genuinely brought into the design process (Cherry & Macredie 1999; Kensing & Blomberg 1998; Wood 1998).

2.1.3 Taking the Actual Context into Account

For a large part, the value of the users' active role in technology design lies in bringing their knowledge of the context into the design process (Maguire 2001). Several sources (e.g. Gould & Lewis 1985; Gould et al. 1997; Gulliksen et al. 2003; ISO 13407, 1999; Karat 1997) emphasize the significance of the real use context in design and evaluation and see user involvement as a key factor in allowing the developers to take the context into account when designing a system. Through the users' involvement, the real context becomes a natural part of the design process. Designs should be matched against the requirements together with the users, in real context, at different stages of the project; at the early phases of the project with the aid of mock-ups and later with functional prototypes (Gulliksen et al. 2003; ISO 13407, 1999). Karat (1997) emphasizes context as well. He points out that user-centred design attempts to take the context into account in a broader sense than traditional approaches, putting emphasis on the real environment into which the application must fit, instead of relying on simplified ideas of the users and their tasks. Another viewpoint is the idea of holistic, or integrated, design: all aspects of the application – user interface, work practices, manuals, etc. – should be developed in parallel, at the same time taking into account the environment into which they will be introduced and the situations and practices they will influence (Gould et al. 1997; Gulliksen et al. 2003).

As stated in the subsection dealing with the quality of the product, in participatory design the focus of development is not solely on the technology but on the work environment as a whole (including the social and organizational aspects), the aim being to improve work practices (Blomberg & Henderson 1990; Cherry & Macredie 1999). Technology is just one part of the working environment. Therefore context and actual use situations are in a significant role. As Kensing and Blomberg (1998, 172) describe the relationship between the users and the designers, "design professionals need knowledge of the actual use context and workers need knowledge of possible technological options". In the case of child participants, their environments at home or in school take the place of the workplace context (e.g. Nesset & Large 2004). The expertise of the children is related to these environments, and the realities of these settings form the basis for design.

2.1.4 Empowerment of Users

The opportunity to participate in decision-making can also be seen as a value per se (Damodaran 1996; Kujala 2003). Several characterizations of user-centred design and participatory design point out the empowerment of users and the promotion of workplace democracy as one cornerstone of the involvement of users: in addition to the effects which user participation has on the outcome, it is also a goal as such to support active and continuous involvement of users (e.g. Gould & Lewis 1985; Gould et al. 1997; Gulliksen et al. 2003; ISO 13407, 1999).

The establishment of a collaborative relationship between the users and the designers is in a key role with regard to the empowerment of the users (Gould & Lewis 1985; Gould et al. 1997; Gulliksen et al. 2003). In participatory design, in particular, an essential principle is that all goals and designs are negotiated together, and not pre-assumed either by users or designers (Blomberg & Henderson 1990). Participatory design promotes collaboration and equal roles of all participants. As in user-centred design, the idea is to involve users in the design process starting from the beginning and continuing throughout the process. Adding to this, participatory design strongly emphasizes the equality of the roles of the designers and the users. The overall goal is to improve the quality of work life, and this goal is accomplished by using a collaborative orientation (Blomberg & Henderson 1990; Cherry & Macredie 1999). Another aim is to promote workplace democracy through the empowerment of users, by allowing them to have an active role in the making of decisions that affect their work (Clement & Van den Besselaar 1993; Kensing & Blomberg 1998). Participation gives the users a sense of ownership; users can recognize their input concretely as the product includes features suggested by them (Cherry & Macredie 1999). Consequently, being involved in the design, feeling ownership of the product, and understanding the development process foster the users' commitment to the product, as discussed above.

2.2 Process of User Involvement

The section above dealt with the goals of user involvement and the motivations for engaging users actively in the design process. As the outline of the conceptual framework (Figure 2) illustrated, the other main component that requires examination is the process with which these goals are approached. Below, I will discuss three distinct yet interrelated issues, each of which represents one aspect of the process of user involvement: the structure of the process (i.e. what kinds of phases or areas the user involvement process entails), methods (i.e. what needs to be considered when planning the activities to be used in involving users in different phases of design), and the design collaboration (i.e. what are the challenges and issues related to the functioning of the team consisting of users and developers).

2.2.1 Structure of the Process

One of the cornerstones of both user-centred and participatory design is an iterative and incremental approach. The focus in the design process is on the users and their tasks starting from the early stages of the design and continuing all through the process. (Bevan & Curson 1999; Blomberg & Henderson 1990; Cherry & Macredie 1999; Gould & Lewis 1985; Gould et al. 1997; Gulliksen et al. 2003; ISO 13407, 1999; Maguire 2001) The ISO 13407 standard (1999) specifies a model of human-centred design cycle which consists of 1) planning the process, 2) specifying the context of use, 3) specifying the user and organizational requirements, 4) producing design solutions, and 5) evaluating the design solutions against user requirements (Figure 3).

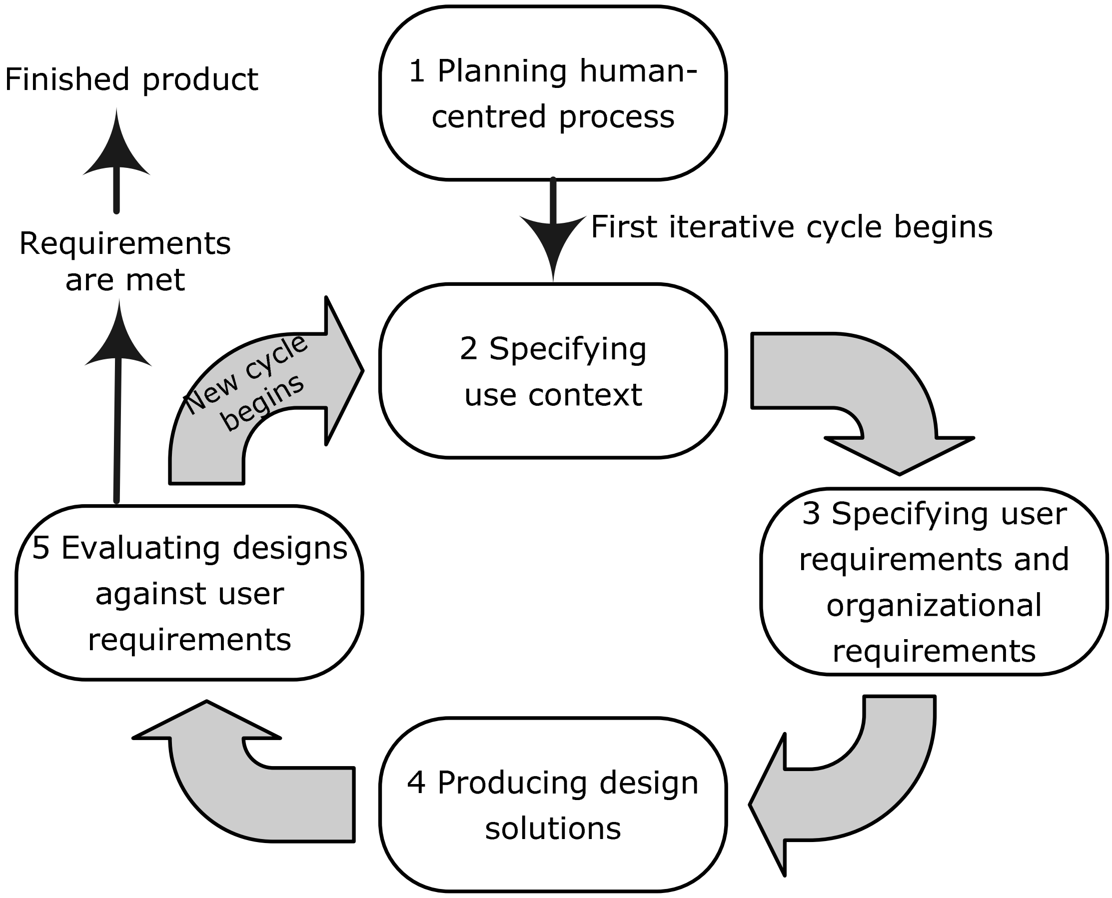

FIGURE 3 Human-centred design cycle (ISO 13407, 1999, 6)

As illustrated in Figure 3, a fundamental idea behind *user-centred design* is the use of an iterative approach. Each iteration consists of specifying the use context and the users' needs, developing a solution to meet these requirements, and an evaluation phase that produces feedback and suggestions for the next iteration (ISO 13407, 1999). According to Bevan and Curson (1999), in the first iteration the goals and designs can be rough – the requirements are on a very general level and the solutions are simple sketches or mock-ups. Iteration by iteration the requirements become more and more refined, and the design solutions are produced as higher-level prototypes (Bevan & Curson 1999). The improvements that are made to the solutions are based on actual user testing conducted with the aid of prototypes of different levels of fidelity (Gould et al. 1997; Gulliksen et al. 2003). The cycle is repeated and the goals are elaborated on each iteration until the product meets the requirements set by the users on the one hand and the organizational goals on the other (Bevan & Curson 1999; ISO 13407, 1999). Moreover, Gulliksen et al. (2003) emphasize that besides being iterative, the design process should also be incremental. By this they mean that the application is divided into deliverables which are then evaluated in real use, and the results inform and guide the development of the following increment (Gulliksen et al. 2003).

The design cycle puts special emphasis on planning and defining the process (Gulliksen et al. 2003; ISO 13407, 1999). Successful user involvement requires that the design process and its different phases and activities be clearly defined. As Figure 3 shows, the planning of the process is included in the user-centred design process as a specific, essential phase. A carefully planned design process ensures that there is a clear understanding of the requirements set for the application – which, according to the ISO 13407 standard (1999), is one key principle of user-centred design. An additional issue related to the planning of the design process is customization (Gulliksen et al. 2003): there is no one right way to carry out user-centred design, and organizations and projects need to adapt the approach in whatever way is suitable in each case.

In sum, the user-centred design cycle implies that users can have an active role in setting the goals (i.e. specifying the context and requirements), refining them (i.e. specifying refined requirements in each iteration), and evaluating the outcomes (both intermediate solutions in each iteration and the final product) – at least in principle. However, in practice user-centred design often places users in a position in which they are merely reactors to suggested solutions, not initiators of ideas (e.g. Scaife et al. 1997; Nesset & Large 2004). In other words, the users' contribution is minimal – or left out altogether – in all other phases except for the testing and evaluation of solutions in different iterations. The input of users, adults and children alike, can be better valued by involving them in more varied ways than merely by placing them in a reactive role towards the end of the design process (e.g. Nesset & Large 2004).

In terms of process structure, participatory design is largely based on the same ideas as user-centred design: user involvement is sought early and continued throughout the process. Also, the main structure of participatory design process is iterative (Blomberg & Henderson 1990; Cherry & Macredie 1999). The objective of the iterations is to put the design solutions under constant review and to give both the users and the designers versatile insights and increasing experiences regarding the application in the course of the process (cf. Cherry & Macredie 1999). Iterations and design representations of different levels work as a continuous and gradual process of developing a common understanding of the product being designed. In the beginning of the process, the designers have their own interpretations of the users' work, and the technological issues (possibilities, limitations, restrictions) are rather unfamiliar to the users. However, with each iteration the developers and the users gain more understanding about each other's perspectives and standpoints, and they start developing a common ground in their work, within which they then define and elaborate the solutions. Emerging ideas are evaluated in actual situations in the real environment (Blomberg & Henderson 1990). This helps build a common understanding when both parties see how the product fits the real context.

Successful establishment of collaboration in participatory design depends on several factors. Firstly, the users must have access to all relevant information they need in their participation. Secondly, they need to have the possibility to independently express their views regarding the problems addressed during the project and to participate in the decision-making process. Thirdly, the use of resources needs to support user participation: the users' time resources, their possibility to use different facilities, and their expertise have to be taken into account. A common challenge is that the users' participation and contribution to the development project is limited by their lack of time as they often have their regular tasks to carry out as well. The fourth point is the flexibility of the organization and the technology; in other words, whether these leave room for new arrangements and solutions or restrict changes. The final requirement is the availability of appropriate methods, such as prototyping, to be used in the participatory project. (Clement & Van den Besselaar 1993; Kensing 1983)

Neither user-centred nor participatory design defines or assigns the methods by which the processes ought to be carried out. The user-centred design cycle presents the framework for the process but leaves rather open the question of how it should actually be realized (Karat 1997; Kirakowski 2002). Similarly, participatory design is a design philosophy rather than a methodology; it does not present prescriptive instructions for carrying out a design process, nor is its goal to develop one single method to be followed. Instead, it gathers diverse methods and techniques for the practitioners to choose from and to arrange a suitable procedure according to the situation. (Cherry & Macredie 1999; Kensing & Blomberg 1998) Hence, as pointed out by Gulliksen et al. (2003), customization of the process is an essential aspect of user involvement; the methods need to be adapted to suit each particular case.

2.2.2 Methods and Practices Used at Different Phases of the Process

As there are no set procedures for carrying out user involvement in development processes, it is a challenge in each project to find the appropriate solutions for doing it. The selection of methods and practices is in a crucial role: how successful the collaboration between the users and the designers is depends to a large extent on the availability of appropriate methods for the participants to represent ideas and design solutions (e.g. Clement & Van den Besselaar 1993). An important point in the successful involvement of users is that the developers use understandable ways of representing design solutions so that all stakeholders understand the terminology and the underlying purposes of the solutions (Kyng 1995, cited by Gulliksen et al. 2003). Using concrete ways of representation, such as low-tech and functional prototypes, is useful in achieving genuine collaboration with a shared understanding of issues. Similarly, the users should be provided with methods which allow them to express their views in an adequately unrestricted way but which also yield outcomes that are not too arduous to apply to the development work in practice. If the methods are too rigorously structured, some useful information may remain undiscovered, while too vaguely defined tasks may frustrate the users or fail to address the most essential questions.

Kensing and Munk-Madsen (1993) suggest that communication in participatory design deals with three domains of discourse – the users' present work, technological options, and the new system – and takes place on two levels, abstract (to provide an overall picture of a domain) and concrete (to understand the abstract knowledge through concrete experience). This illustrates the basic challenge of user involvement: transforming abstract, tacit knowledge (both the users' knowledge about their work and the developers' knowledge about the technological possibilities) into a concrete form understood by all participants during the design process.

In a similar vein, Muller (2003) emphasizes the importance of hybridity in participatory practices: methods that fall between the "home grounds" of the users and the developers are considered fruitful because they allow the different parties to negotiate and collaboratively create new ideas, without relying too heavily on the domain of either group. In order for the participants (users and developers alike) to gain relevant information, the information must be in a commonly understood form, and in order to communicate their opinions, the participants need forms of expression. The availability of appropriate methods is one – but not the only – key to these challenges. Establishing a general attitude that promotes collaboration and working actively to accomplish genuine cooperation are important underlying factors in determining the success of participation (Clement & Van den Besselaar 1993; Gulliksen et al. 2003).

2.2.3 Functioning of the Design Team

In addition to the more procedure-oriented issues such as the process structure and the methods, the functioning of the team is an important aspect in determining the successfulness of user involvement. This entails issues such as communication, the roles of the participants, the effects of the users' participation on the developers' work and vice versa, and the general stance of the participants – developers and users alike – towards the design task.

As pointed out in the subsection dealing with user expertise, multidisciplinary knowledge is essentially a part of a design process involving users. As the ISO 13407 standard (1999) states, user-centred design requires expertise from different fields. The configuration of the design team depends on the context and goal of the application to be developed; in addition to technical experts and HCI specialists (e.g. Gulliksen et al. 2003), there may be a particular need for experts from e.g. education or art (Knudtzon et al. 2003), depending on the type and purpose of the application. Users bring the expertise of their own special area into the process. Damodaran (1996) points out, however, that users may feel inadequate or incompetent to give their opinions regarding design decisions, and this can lead to a fallacious feeling of involvement in which there is mutual respect but no real communication, leaving basically all issues for the developers to decide. Damodaran calls this the "hostage" role of the users, and it is often a result of the lack of familiarizing the users with design work. An equally problematic situation arises when the users who are involved in the project adopt a "propagandist" role: they receive training related to design methods, and as a result their perspective gets closer to that of designers – hence, they gradually lose the genuine user point of view and start seeing issues more as designers (Damodaran 1996).

Many of the issues dealing with user involvement – benefits and challenges alike – boil down to communication. One significant risk associated especially with participatory design is the possibility that despite all good intentions, the empowerment that is being aimed at is not accomplished. It may happen that the developers determine the pace of design sessions, talk about issues with professional vocabulary not understood by users, and direct the design without paying adequate attention to the users' points of view (Olsson 2004). In addition to finding methods that allow the users' expertise to come through, the designers' attitude towards user involvement is in a central role when it comes to successfully activating the users in the project: all participants should attend to the significance of the users' involvement and, in ways defined by their own roles in the project, make an effort to take it into account (Gulliksen et al. 2003).

2.3 Conceptual Framework and Research Questions

The conceptual framework of the study was fleshed out with the aid of the goal- and process-related issues that were discovered. As discussed above, the goals of user involvement entail product quality, user expertise, real context, and user empowerment (the right side of Figure 4). The process-related issues include the phases of the process (the general structure and the methods used in each phase) and the functioning of the design team consisting of developers and users (the left side of Figure 4).

The conceptual framework served as a basis for formulating the research questions for the study (Table 1). The research questions were divided into the two main themes (process and goals), and each main theme was further divided into several sub-themes based on the structure of the conceptual framework (Figure 4). One or more research questions were connected with each sub-theme.

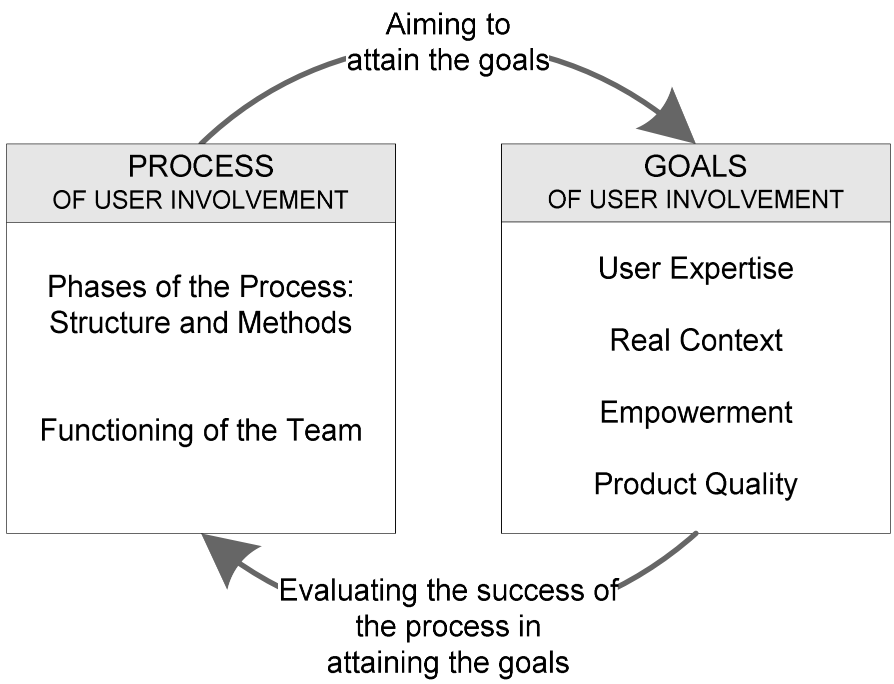

FIGURE 4 The conceptual framework

The first main theme, the process of user involvement, entails two sub-themes. The first deals with the process-related aspects of design projects: the goal is to describe and analyze the structure of the process of user involvement in a particular project and the methods of participation that were used in the project. Two research questions are related to this sub-theme (Table 1). The first question (Q1a) deals with process reconstruction, i.e. the description and analysis of how the process was structured, which methods were used, and what led to these choices. The purpose of the question is to examine what the process of *user involvement* was like, which was not necessarily equivalent to how the phases of the project were officially formulated by the developers. For example, the project phases can be defined e.g. in terms of the waterfall model, but this as such is of little relevance to the users: what shows to them is the way the participation activities are structured. The other question (Q1b) addresses the participants' experiences: how the children and the developers experienced the participation process and methods. The second process-related sub-theme is related to the functioning of the team, the aim being to analyze the different aspects collaboration in the project; i.e. what kinds of collaboration-related issues are brought up either by the children or the developers (Q2).

The other main theme is related to the goals of user involvement, and it consists of several sub-themes, as seen in the conceptual framework. The first issue to be addressed is the users' expertise: firstly, in which aspects of the design the developers especially seek input from the users and how they make use of the users' expertise (Q3a) and, secondly, how the children, for their part, perceive their own expertise in the project (Q3b). Another goal-related sub-theme deals with the real use context and in which ways it is taken into account

TABLE 1 Research questions of the study

PROCESS OF USER INVOLVEMENT

Theme	**Objectives**	**Research Questions**
Structure and methods	Describing and analyzing the structure of user involvement process and the methods used to carry out the process	Q1a Process reconstruction: how was the process of user involvement structured and which methods were used? Q1b How did the participants (children and developers) experience the structure of the process and the methods used at different stages of the project?
Functioning of the team	Analyzing the success of collaboration and its effects on the development work	Q2 What are the key issues regarding the collaboration between the children and the developers?

GOALS OF USER INVOLVEMENT

Theme	**Objectives**	**Research Questions**
Bringing the users' expertise into the process	Examining how the users' expertise is addressed	Q3a In which aspects of the design work do the developers seek user expertise? Q3b How do the children perceive their own expertise in the project?
Taking the actual use context into account	Examining how the real use context is addressed	Q4 How is the actual use context taken into account in the process?
Perceived and actual influence of the users	Analyzing the perceived and authentic effects of user involvement on the design outcomes	Q5a Feeling of empowerment: How do the children experience the extent of their influence on the development of the product? Q5b Actual influences: How do the ideas and the feedback of the children manifest in the prototypes and products?
Product quality and viability	Assessing the quality of the final outcome in terms of actual use	Q6a How well does the final product meet the needs of real use? Q6b How well does the outcome meet the users' expectations?

in the project (Q4). The next sub-theme is user empowerment and influence: the aim is to address both the perceived and authentic effects of the children's involvement. The former refers to the children's own feeling of empowerment and ownership (Q5a), while the latter is concerned with the analysis of the concrete manifestation of their ideas and feedback in the outcomes (Q5b). The final sub-theme deals with the quality and viability of the applications developed in the projects, on two dimensions: firstly, how well the final outcome meets the user participants' expectations (Q6a) and, secondly, how well it meets the needs of real use in the classroom (Q6b).

The following chapter will discuss the research design of the study.

3 RESEARCH DESIGN

The previous chapter laid the groundwork for the study through the construction of the theoretical framework and the research questions derived from it. In this chapter, I will discuss the structure of the research process and the research methods used in the study. The chapter begins with a discussion on how *involvement* has been defined in the context of technology design with children, and what is meant with involvement in this study. Next, I will present the research approach used in the study, both on a more general level and particularly in the context of this study. From the research methods I will move further to issues related to data gathering and analysis. Finally, a look will be taken at ethical considerations, especially from the point of view of conducting research with children.

3.1 Defining Involvement

Current studies describing technology development projects that involve children in the design process typically refer to Druin's (2002) typology of the roles of children in technology design and use it to categorize the approach adopted the study. In this section, I will present this model, as well other views on children's roles in technology design, and discuss the connections between them and this study.

3.1.1 Druin's Model of Children's Roles in Technology Design

In Druin's (2002) much-cited model of the roles of children in the design of new technology, the roles in which children can be involved in the design gradually broaden from users to testers and informants, and finally to the most intensive of the categories, namely design partners. Figure 5 depicts this nested structure of roles.

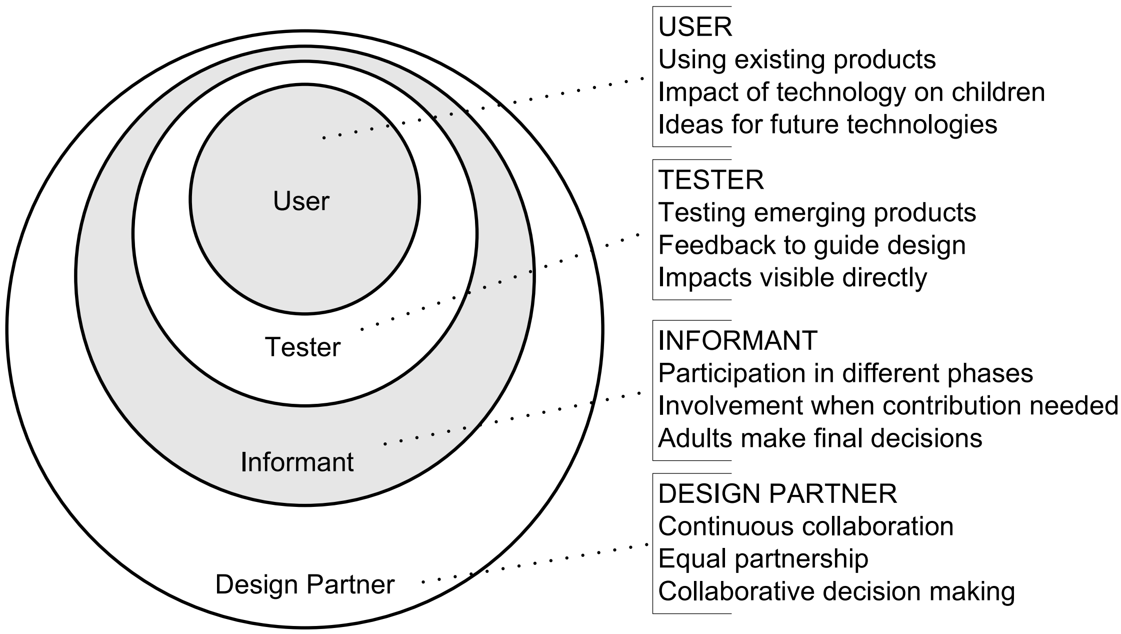

FIGURE 5 Children's roles in technology design (adapted from Druin 2002, 3)

According to Druin (2002), observing children as *users* of existing technologies helps us understand learning processes or form general concepts and principles for technology development in the future, whereas having children take part in the *testing* of emerging technologies provides specific directions for products that are in the making, and the impacts of the children's feedback are more immediate than in the role of a user. In the end, in both of these roles children have little say, and the initial ideas and designs come from adults. The role of an *informant* (Druin 2002; Scaife & Rogers 1999 and 2001; Scaife et al. 1997) broadens the scope by involving children (as well as other focus groups) in different parts of the design process, depending on when and where their contribution is needed. They might be involved as early as in concept design, be prototype testers, or be observed while using existing software. According to Druin (2002), the frequency of children's involvement and the ways in which they participate vary a great deal between projects, but it is still adults who are ultimately in charge and make the final decisions. The problem is that this may make the children feel that their ideas are being ignored or overruled (Williamson 2003).

The role of a *design partner* seeks to take the collaboration yet one step further (Druin 2002). As in the role of informants, children can be involved in the design in various phases of the process, but Druin (2002) describes the difference between the two approaches being in the intensity of the participation: design partners take part in the design regularly throughout the process as equal partners with the other members of the design team, bringing in their domain-specific knowledge and experiences. It is also emphasized that activities be carried out collaboratively, with adults and children together (e.g. Knudtzon et al. 2003; Druin 2002; Druin et al. 1999). In practice, Druin's (2002) view of design partnership entails a specific, permanent design group consisting of children and adults which meets regularly for a long period of time on a weekly or twice-weekly basis to design and evaluate different technological applications (Druin 2002; Knudtzon et al. 2003). This is both the main advantage and the main pitfall of the approach: as Williamson (2003) points out, only a very small number of children can be involved in the group at the same time. Moreover, most projects – let alone commercial development ventures – do not have the time or the financial resources to carry out the design process in such an intensive way (e.g. Williamson 2003).

Druin (2002) summarizes the differences between these roles by examining each role in terms of three dimensions: the children's relationship to adults, their relationship to technology, and the goals of inquiry. This overview is presented in Table 2 and discussed in more detail below, based on Druin's (2002) categorization.

TABLE 2 Comparison of children's roles in technology design (Druin 2002)

Dimensions		**User**	**Tester**	**Informant**	**Design partner**
Relationship to adults	Indirect relationship	x	x	x	x
	Feedback		x	x	x
	Dialogue			x	x
	Collaborative elaboration				x
Relationship to technology	Finished product	x		x	x
	Prototypes		x	x	x
	Ideas			x	x
Goals for inquiry	Developing educational theory	x	x		
	Studying impacts of technology	x	x	x	
	Better usability or design		x	x	x

As Table 2 illustrates, the gradual broadening of the roles along the continuum from users towards design partners is most clearly demonstrated in the relationship to adults. In the role of users, children are merely observed or tested, with little or no direct interaction with the adults conducting the research. As testers they also have a chance to give direct feedback, as informants they can engage in dialogue with adults in several different ways, and as design partners they generate and elaborate ideas in collaboration with the adults as equal partners. When it comes to the relationship to technology, Table 2 shows that the roles of user and tester are limited to phases where there is a concrete product – either finished or prototype – to use. As informants and design partners, on the contrary, children can be involved in the process already in the idea generation when the signposts for the development are being formulated. The difference between the roles of an informant and a design partner, in this case, is that informants participate more sporadically whereas design partners are continually involved in the design. As regards the goals for inquiry, on the other hand, the table implies a shift from general to specific as we move along the continuum from users towards design partners. The role of a user, especially, aims to answer questions of a more general nature, whereas in the case of the design partner role, the answers are basically limited to the particular technology being developed. The tester and informant roles may be able to address both general and specific; they provide answers to direct the design of one particular application but they can also include activities aiming to uncover broader problems, for example with regard to the educational effects of a particular type of application. (Druin 2002)

However, what the role classification does not explicitly reveal is where to draw the line between these different approaches in practice. The table shows the essential differences but when the roles are applied in practice, there seems to be some confusion in the research literature about their definitions. It appears that informant design, for example, can basically range from something near the tester role to something very close to design partnership. For example, Nesset and Large (2004) argue that the approaches used by e.g. Theng et al. (2000) and Bilal (2003) – labelled by the authors as design partnership – do in fact not qualify as design partnership as there is no fixed design group that meets regularly. On the other hand, a school-based design approach (Taxén et al. 2001) – which is based on Druin's design methodology and conducted in child–adult teams but due to resource constraints also relies more on adult-made interpretation and selection of ideas – is recognized as design partnership (Druin 2002).

This classification largely focuses on the roles *appointed to* children in technology design in general. It has also been analyzed how their roles *evolve* during the participation in a design project. Druin and Fast (2002) examined project journals written by children during a three-year technology design project and saw four different roles emerge from them: the authors suggest that the children's roles evolved during the project from *learners* through *critics* and *inventors* to *design partners*. Right from the beginning of the project it could be seen that the participation helped the children learn to understand the process of invention. When they had been participants for some time, their role expanded to that of a critic, meaning that they began to give feedback on the good and bad aspects of different technologies. Furthermore, they began to act as inventors, suggesting new ideas for technology applications in their journals. Finally, the children were seen to have adopted the role of a design partner: they began to understand the meaning of collaboration in the invention process and to build onto other partners' ideas. It was noted, however, that moving along the continuum towards the design partner role was inevitably a slow process that required time for the children to understand that they could indeed work as equal partners with adults. (Druin & Fast 2002)

3.1.2 Defining Children's Roles in this Study

While Druin's user – tester – informant – design partner model provides a good basic framework against which to reflect one's research setting, one problem with the typology is that it leaves quite a few issues open to interpretation, especially when it comes to the differences between the roles of informant and design partner. This manifests as some confusion with using these terms in research literature, as illustrated by the examples mentioned above, such as those pointed out by Nesset and Large (2004). Some researchers seem to view only a permanent, long-term, intergenerational design team as design partnership (e.g. Druin 2002; Druin et al. 1999; Nesset & Large 2004) whereas a couple of sessions during which children design something count as a design partner approach for others (Bilal 2003; Theng et al. 2000) – and between these ends there are numerous intermediate interpretations of the concept.

Strictly in Druin's terms, if the existence of a permanent multidisciplinary design team meeting regularly over a long period of time is seen as the core characteristic for design partnership, the approach used in the projects examined in this study would allegedly not meet the criteria. Consequently, it would fall into the category of informant design. Referring to Table 2, which presents a comparison of the roles, the approach used in this study most closely resembles the criteria of the informant role. When it comes to the children's relationship to adults, the children engage in dialogue with the adults in different ways during the development process. As regards their relationship to technology, their participation deals with ideas, prototypes, and the finished product alike. The goals for inquiry address both the improvement of the specific product being developed and – especially through field experiments of the finished products – questions of a more general nature dealing with the impacts and value of technology on learning.

However, informant design is probably the vaguest term in the taxonomy – it has been used to cover a wide range of approaches which substantially differ from one another. For example, there are examples of informant design that involves different children at different phases of the process (and consequently some of these children are in fact in the role of testers) while, on the other hand, some informant design approaches involving the same children for a longer period are very close to the design partner role, only somewhat less intensive and collaborative. Therefore, when reflecting it in terms of Druin's typology, I situate the approach adopted in this study between the informant and design partner roles, as a mixed approach of these two. I base my view on the following notions: Firstly, in each of the two cases examined in this study, a group of children participated in the development throughout the whole process within that particular project. The time frame varied, depending on the project, from around six months to almost a year and a half. Secondly, there was some variance in the degree of participation. In some instances the design or evaluation sessions were less frequent and the children's input was sought after discovering the need for their feedback or ideas regarding some particular problem, whereas in others there were more regular schedules planned beforehand with the children and their teachers. Thirdly, in addition to the principal participant groups who have been involved throughout the process, some of the projects have had other children as additional informants or testers on a one-time basis, bringing an input with a fresh point of view into the process.

Another issue that is distinctive to the approach of involving children in this study is that it has been influenced by views about participation from several fields. These will be discussed in more detail in Chapter 5, upon presenting the broadened multidisciplinary framework for children's involvement, but I will mention one key perspective already here as it is closely related to the background principles of the study in general. In addition to the perspective represented by Druin's typology, the concept of child-centredness from educational sciences, and its influence on the role of the children in this study, is necessary to address here. The main principles of child-centredness can be summarized into the following points: children as active participants in their (learning) environments, activities derived from the children's own world, and listening to the children's views (cf. e.g. Hujala 2002; Kankaanranta 1998; Kinos 2001, 2002). The research conducted here has aimed to build its approach upon these principles. First, the goal of the idea of participation in the first place is to allow children to be involved in the design of learning tools aimed for them; hence, participate actively to shape their learning environment. Second, the methods used in the development processes throughout the study have evolved with an aim to address the children's needs better. The third principle, listening to and taking into account the ideas and views of the children, is common with the tenets of e.g. user-centred and participatory design. Child-centredness manifests in this study especially as an effort to listen to the children's own views about their participation and the methods used in the process, and consequently to learn from this and attempt to provide them with methods that suit their preferred ways of working.

The approach is also mainly school-based, yet less formally structured than a particular classroom-based approached called curriculum-focused design (see Rode et al. 2003). Most of the design and evaluation sessions take place within the time frame of school lessons; they can be defined as design workshops taking place during the school day. Hence, unlike in curriculum-focused design, they principally have not been strictly adapted to specific lesson plans or to the curriculum context. Significant exceptions to this were field trial periods in which the teachers could integrate the applications to their work in ways they saw as most appropriate. Moreover, due to the collaboration with schools the process needed to be flexible and the ways and the extent of the participation were negotiated together with the participating classes. In one of the projects the sessions were more regular, whereas a less frequent scheduling was adopted in the other one.

Studies describing development efforts conducted in collaboration with adult users rarely make role distinctions equivalent to those proposed by Druin (2002) for children (Figure 5 and Table 2). Instead, user involvement and participation are often used as general terms to describe approaches involving users in the development more broadly than merely as testers of prototypes. As regards this study, I see it as necessary to discuss the roles of children in the case projects of the study in relation to Druin's categorization – which I have done above – but instead of adopting any of the labels as such, I have chosen to use the term "participant" to cover the forms that children's involvement takes in the context of this study.

3.2 Methodological Choices

The principal research approach applied in this study is development research (Richey et al. 2004; van den Akker 1999), the primary employment context of which is the research of educational interventions. Development research shares many essential principles with the design-science research approach (e.g. Hevner et al. 2004; van Aken 2004) used in information systems research. The rationale for mainly referring to development research in this study is the fact that the research was conducted in a multidisciplinary research group which entails researchers whose fields range from educational sciences to mathematical information technology and from game design to natural sciences. A shared research topic for all these different researchers and their respective perspectives is the use and development of educational technologies. Development research has therefore been adopted as the collective research approach in the group and consequently used as the principal approach in this study as well.

This section discusses the methodological choices of the study. The principal focus is on development research, but other relevant methods – case study research and participatory action research – are addressed as well. The methods are presented both on a more general level and in terms of their application in this study.

3.2.1 Design-Based and Development Research

The concept of development plays a significant part in this study on two different levels. Firstly, the context of the study is the process of developing game-based learning environments and, secondly, the goal of the study is to develop methods and practices for involving children in the aforesaid process. This two-level idea of development accounted for a key issue in deciding on a research approach suitable for the study. Due to this emphasis on design and development in two dimensions, turning to a *design-based research* or *design science* approach, more specifically *development research*, seemed an appropriate choice in this study. Below, I will discuss these approaches generally and in the context of this study.

Design-Based Research

Design-based research has been appointed by some researchers as a general term covering the variety of names with which various research approaches with common background principles have been labelled, including e.g. development research (see e.g. Design-Based Research Collective 2003; Wang &

Hannafin 2005). Design-based research stems from the field of educational research, and "blends empirical educational research with the theory-driven design of learning environments" (Design-Based Research Collective 2003, 5). The goal of design-based research is to enhance instructional interventions and produce design principles, using an iterative approach carried out in actual contexts as a collaborative effort between researchers and practitioners (Wang & Hannafin 2005). Multidimensional dialogue between theory, practice, and design outcomes is an essential trait of design-based research (Design-Based Research Collective 2003).

The principal context for design-based research is the design and study of educational interventions such as products, programmes, materials, practices, or policies (Design-Based Research Collective 2003; Richey et al. 2004; Seeto & Herrington 2006; van den Akker 1999; Wang & Hannafin 2005). Design-based research as such would thus be directly applicable to the context of this study – the development of learning game applications. My research goals are, however, related to the *process* along with which this development work takes place and especially the methods and practices used in it, more than the product as such. Therefore I will take the definition of design-based research onto a more general level, in order to move from the development of educational interventions to the development of design methods and practices used in these efforts. Although the products play a significant role as the goals and outcomes of the processes studied, they are not the main object of study here. Instead, the focus is on the development process and development methods. In the contexts where design-based research is usually applied, the setting is generally vice versa: the process provides valuable experiences to inform the results of the research, but the main focus is on the product and its qualities and effectiveness. The role of the observations made about the development process is usually to explicate how the product came to be the way it is, and the process is generally described from the point of view of how different design choices shaped the product. As pointed out, in this study the roles shift. The products (i.e. the learning game applications developed in the case projects) are studied from the perspective of how different forms of user involvement affect their development. In other words, the product informs about the successfulness of the procedures. Analyzing the product is, however, only one angle from which user involvement is studied; equally important perspectives are the experiences of both the designers and the participating users, as well as researcher observations of the design activities throughout the process.

Wang and Hannafin (2005) have identified five key characteristics of design-based research. First, design-based research is *pragmatic*: it deals with practical questions, but the development of theory is a tightly interwoven and integral part of the practical process. Moreover, design-based research goes deeper in analyzing the feasibility of a theory than merely stating whether it does or does not work; it also examines how the theory might be refined based on experiences from studying it in practice. Second, the approach is *grounded*. This means that it is grounded in and driven by relevant theory, research, and practice. Additionally, it also means that design and research are based on actual settings instead of being conducted in isolation from real-world contexts. This entails that research is embedded in the practical development activities, allowing the design process to be studied. Third, design-based research is *interactive, iterative, and flexible*. By interactivity, Wang and Hannafin mean a collaborative design process in which the researchers work together with the designers and other participants. Processes are iterative, forming a cycle of design, implementation, analysis, and redesign. Related to this, processes are also flexible: the initial idea evolves and changes during the process, as needs for alterations are encountered. Fourth, design-based research can be characterized as *integrative*. It employs a variety of different research methods in order to ensure the validity of the research, and the methods may evolve and change in the course of the process, along with the focus of the research. Fifth and finally, design-based research is *contextual* by nature: the results of the research are linked to the setting in which the research is carried out and to the process through which the results have been discovered. The level of the generalizability of the design principles generated as results of design-based research also varies. Thus the context needs to be documented in detail in order for other researchers to evaluate the research as well as to determine appropriate situations for applying the results, and for the same reasons it is useful to provide guidance for adapting the research in other settings and contexts. (Wang & Hannafin 2005)

Based on the above principles, the following table (Table 3) presents design-based research in terms of the focus of this study. It should be noted that there are several characterizations of design-based research, some of which deviate from Wang and Hannafin's (2005) description in terms of some aspects, but in this study I will base my definition of design-based research on this particular classification. Moreover, the research process and the development process are intertwined and it is sometimes difficult to make a distinction between these two dimensions, however the issues presented in the table principally deal with the research dimension.

I will briefly discuss design-based research in the context of this study, based on the table. As the table illustrates, all the main characteristics of design-based research are met. Firstly, the study aims to contribute to the principles and methods to be used in the development of educational applications with children, hence it addresses practical questions. Moreover, its aim is both to address the particular practical problems at hand (i.e. the ongoing development processes) and to add to the research in the field on a more general level. Secondly, theoretical and contextual grounding are both present in the study. The empirical research is based on an extensive, multidisciplinary literature review, and the research activities take place within real development projects. The processes are informed both by theory and by practical experiences acquired in the course of the study. Thirdly, the approach is interactive and the research is collaborative: developers and children play a key part in the research process. The development processes studied are iterative by nature, which is reflected in the structure of the research process as well. The methods

TABLE 3 Employing design-based research in this study (adapted from Wang & Hannafin 2005)

Characteristic	Explanations in the context of this study
1. Pragmatic	Addresses practical issues: practical development methods and principles Theory and practice being refined together: practical experiences from designing + more general contribution to research
2. Grounded	Theoretical grounding: • Literature review on user involvement: Identifying benefits, challenges, and different participation methods • Theory-based rationales for choices of participation methods Contextual grounding: • Real-world development projects as research context • Research carried out throughout the projects
3. Interactive, iterative, flexible	Interactive • Research conducted in collaboration with the developers and user participants Iterative • Iterative development and research process, according to the principles of user-centred design Flexible • Development and research methods refined and varied in the course of the project to meet emerging problems and the potentially changing needs of the product and the participants
4. Integrative	Mixed research methods and data from multiple sources: e.g. questionnaires, interviews, participant observation, video and audio recordings, document analysis Research methods vary and evolve along the process in accordance with the refinement of development methods and research focus
5. Contextual	Careful documentation of research process and results Results discussed in terms of the context and process Applicability of results discussed

used in the development process and the research process alike are modified, replaced, and refined in the course of the projects, based on observations made about their pros and cons. Fourth, the integrative nature of the research is demonstrated in the use of a range of different data sources and research methods which evolve in the course of the process. Finally, the research process and findings are thoroughly documented, the results are presented and discussed contextually, and their applicability and generalizability are discussed.

Design-Science Research

In information systems research, a related approach is referred to as design-science research (e.g. Hevner et al. 2004; van Aken 2004). The emphasis of design-science research is on scientific knowledge used in the design process. In the words of van Aken (2004, 226, italics in original), the goal is to

> develop scientific knowledge to support the design of interventions or artefacts by professionals and to emphasise its knowledge-orientation: a design-science is not concerned with action itself, but with *knowledge to be used in designing solutions, to be followed by design-based action*.

Further, Hevner et al. (2004) emphasize that what essentially differentiates design-science research from routine design, is that contributing to the knowledge base is clearly stated.

According to van Aken (2004), design-related knowledge can be related to three types of designs: object-design, realization-design, and process-design. The first type, object-design, refers to designing the intervention or artefact itself, such as a computer application. The second type, realization-design, means the plan made by the designer in order to implement the intervention or build the object. Finally, the third type, process design, refers to the methods and process of designing the solution.

Design-science studies are often conducted as multiple-case studies, and according to van Aken (2004), there are two kinds of such studies: one type examines design processes afterwards, and the other is conducted in the field in close collaboration with the developers in the course of the process. Van Aken refers to the former as extracting studies and to the latter as developing studies. Developing studies can entail alpha and beta testing of the issues discovered: by alpha testing, van Aken (2004) means evaluating the findings in the original context, whereas in beta testing the findings are put to the test outside the original context.

Development Research

Belonging to the design-based research paradigm, development research (also referred to as developmental research) is employed in studies of educational interventions, addressing either the intervention itself, the process of developing it, or both (e.g. Richey et al. 2004; van den Akker 1999). Van den Akker (1999, 5) defines the goal of development research as "reducing uncertainty of decision making in designing and developing (educational) interventions". He (ibid., 5) clarifies this goal in more detail by further specifying two sub-goals, one being more practice-oriented and the other more academically oriented: Firstly, from a more practical point of view, the aim of development research is to "provide ideas (suggestions, directions) for optimizing the quality of the intervention to be developed". Secondly, it aims to create and test design principles regarding either the characteristics of the intervention itself ("what it should look like") or the procedures used in the development of the intervention ("how it should be developed"). This double-layered approach corresponds well to the needs of this study. As previously stated, the focus of this research is principally not to study the product but instead the process. Therefore, referring to the aforementioned goals, the main focus is on the question "how it should be developed".

Furthermore, the development research process is cyclic by nature. It is not assumed that the optimal intervention is born at once, but instead the goals are approached with the aid of prototypes that meet them increasingly with each iteration. Van den Akker (1999) mentions the following tasks as the phases of development research: 1) the analysis of the task, problems, and context ("preliminary investigation"); 2) the design of solutions with a sound theoretical background ("theoretical embedding"); 3) empirical testing and evaluation regarding the feasibility of the intervention in real context and with real users; and 4) the documentation and reflection of the process and outcomes and generating design principles or guidelines. Moreover, characteristically of iterative processes, revision and refinement are an essential element in the phases. Reeves (2000) has described the process (based on van den Akker 1999) as depicted in Figure 6.

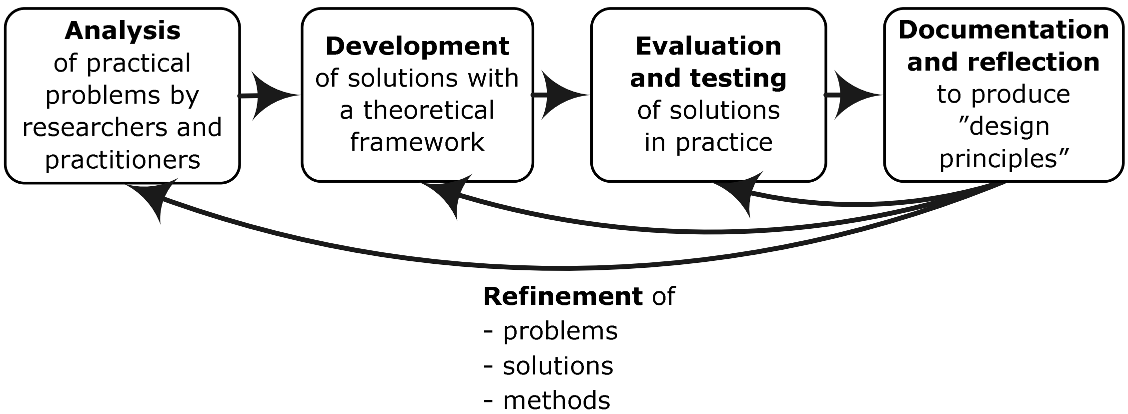

FIGURE 6 Phases of development research (Reeves 2000, 9)

These phases closely resemble the phases of the 'ADDIE' model of instructional systems development: analysis, design, development, implementation, and evaluation (e.g. Clark 1995; see also Seeto & Herrington 2006 for an examination of these two models together). However, according to van den Akker (1999), development research differs from professional development practices in terms of its more rigorous orientation to theoretical groundings and analysis based on empirical evidence. Firstly, the preliminary analysis is more systematic and thorough; secondly, the phases of development research entail a comprehensive and profound theoretical grounding; thirdly, the viability of the intervention is validated with clear empirical evidence; and finally, the documentation, analysis, and reflection of the intervention are conducted very thoroughly in order to produce design principles (van den Akker 1999).

Characteristically, research and development go hand in hand in development research, which manifests clearly in the cyclic structure. Moreover, especially in the case of this particular study I have emphasized the two layers that exist in the approach; the one aiming to develop the product and the other aiming to develop the process. In the following I will discuss these in terms of my research. The same phases apply on both levels: In the analysis phase, the task and context are determined. This can mean both the context and goals of the product, and the context of the whole development process. As an example of the latter, situated in the context of this study, the characteristics of the participants and the setting are taken into account. Issues to be addressed include e.g. the number and age of the participants, their knowledge about the topic at hand, the resources available to carry out the process, and the context of the participatory activities (a specific design team, collaboration with a school class, involvement of different informant groups at different stages, or other). In the second phase, the design is carried out with theoretical embedding. From the product perspective, theories relevant to the design of the product are identified and applied. From the process perspective, methods for involving users in the design process are analyzed and applied. The third phase, testing and evaluating, is also carried out on two levels and assesses both the product and the methods used in its development. The experiences of the participants (users and developers alike) have an essential role in this. The results inform the following cycles both in terms of the qualities of the product and ways of carrying out the design activities. Fourth, both the outcomes and the process are analyzed and reflected upon, the results are fed back into the process, and more general principles are formed based on the analysis of the product and process.

Types of Development Research

Development research can be divided into two types of studies, labelled as *Type I* and *Type II* by Richey et al. (2004), or as *formative research* and *reconstructive studies* by van den Akker (1999). Moreover, *explorative design studies* can be considered related activities but as they have a less scientific and generalization-oriented approach, they are usually distinguished from the other two types (van den Akker 1999). Table 4 summarizes the key characteristics of each of the two principal types of development research.

The first type of development research (Type I or formative research) differs from the second type (Type II or reconstructive studies) in terms of its scope, the ways of conducting the research (e.g. research activities, methods, role of the researcher), and the type of its outcome and the conclusions that can be drawn. Type I focuses on studying and presenting the entire development process of a specific product while Type II examines often somewhat more limited development-related issues from a more general perspective.

The core of Type I research is the development of a particular product, the development process of which is usually documented in its entirety in a very detailed manner, entailing also analysis and evaluation of the final product (Richey et al. 2004). Type II, on the other hand, often focuses on a more specific question but approaches it from a broader perspective – it might, for example, put emphasis on a particular design method or model (Richey et al. 2004). Consequently, the results of the studies are different: Type I produces detailed yet context-specific results, often in the form of "lessons learned" from the

TABLE 4 Characteristics of the different types of development research (DR), drawn from Richey et al. (2004) and van den Akker (1999)

	Type I / Formative Research	Type II / Reconstructive Studies
Scope	Analyzing the development process of one specific product or programme, evaluating the outcome	Development processes, tools or models more generally
Relationship to DR phases	Conducted throughout the process; emphasis on development and evaluation	Usually after the process, sometimes during it; emphasis on documentation and reflection
Research methodologies	Qualitative methods, case studies (mainly descriptive), evaluation methods (surveys, tests, performance measures)	Experimental and quasi-experimental methods, surveys, qualitative methods
Researcher's role	Researcher involved in the development process	Researcher studies processes as practiced by others
Outcome	Product-specific lessons learned	New or enhanced development models and principles
Conclusions	Context-specific	Generalized

process, whereas the results of Type II are of a more general nature and present new or enhanced models, procedures and principles for development (Richey et al. 2004; van den Akker 1999).

Due to the different foci and objectives, ways of carrying out the two types of development research also vary. In Type I studies, the research extends over the entire development process and the researcher is an active participant in the development while Type II studies usually examine the processes after they have been completed, without the researcher as a participant (van den Akker 1999). Although both types often employ qualitative methods, they place different emphases on certain methods. Richey et al. (2004) have analyzed studies employing development research approaches and identified e.g. the following issues regarding the methods used in different types of studies: Firstly, Type I studies covering the whole development process commonly use case study methods, mainly of a descriptive nature. Moreover, as Type I studies often include evaluation and analysis of the final product, different evaluation methods such as user surveys or performance measures and tests are typically also used in these studies. While studies of this type emphasize detailed description, in Type II studies the focus is on experimental or quasi-experimental methods, especially in order to evaluate and verify the viability of a particular method or model being studied. Furthermore, surveys and interviews are often used in Type II studies to gather data either from the users' or from the designers' perspective regarding the development process or methods.

In relation to the phase structure of development research (Figure 6), each type of development research emphasizes the phases differently. Type I, or formative research, entails all of the phases presented in the figure, covering the whole development process with the main emphasis, however, on the phases of design with theoretical embedding and empirical evaluation. Type II (reconstructive studies), on the other hand, emphasizes the documentation and reflection phase, not so extensively addressing the process itself during the development activities. (van den Akker 1999)

There is a great deal of development research that does not directly fall into either category or entails traits of both types. For example, the review of developmental research studies by Richey et al. (2004), despite using this typology as a framework, identifies some characteristics typical of Type I among studies that principally fall into the Type II category and vice versa. The boundaries are not strict and there is a great variety of linkages between the different ways of carrying out development research (van den Akker 1999). The typology is, however, a useful tool in defining one's research approach and in situating it among the body of research.

Structure of the Research: Applying Development Research

Above I have discussed the principles of development and design-based research and also how they manifest in this study. Next I will examine how the structure of the research process of this study has been formulated based on the background principles of development research. I present the structure of this study as consisting of both successive and nested development research cycles (Figure 7).

Firstly, the whole research process constitutes one, all-encompassing cycle starting from a literature review to form the basis for the whole research process, stretching over both of the case projects, and ending up as the final findings of the study. Secondly, this larger cycle comprises two smaller cycles, each corresponding to one case study. The experiences gathered in these cycles are not only fed back to the next iteration of the same cycle but the results of the first cycle also inform the second project. Similarly, the outcomes of the cases are reflected upon against relevant literature in the course of the study and at the end of the whole process.

It is also worth defining the framework of the research in terms of the two principal types of development research, Type I and Type II. As stated above, many development research studies contain qualities of both types. The roles of these types in the context of this study can be elucidated by referring to the above figure. Type I most clearly manifests in the overall structure of the research. Each of the smaller cycles represents one case addressing all the phases of development research, and the phases have been studied throughout the whole development process. During the development process, observations

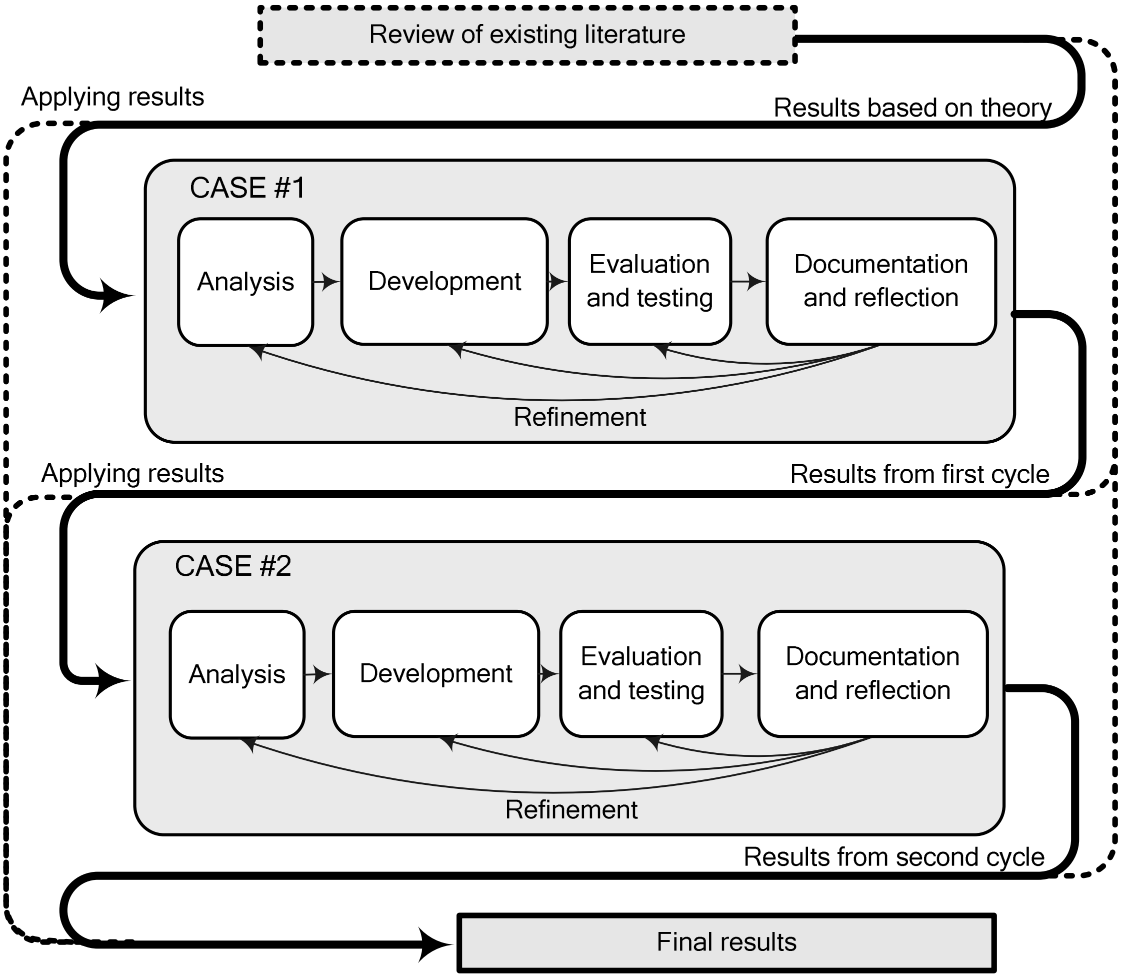

FIGURE 7 Development research applied in the structure of the study

and findings have been collected in the form of lessons learned, and the results of the cycles have been fed back into the development process both within that particular case and on an inter-case level. On the other hand, in order to identify more general patterns, to discover more general findings, and to come to more general conclusions, a more thorough analysis of all the cases has been conducted after the projects.

Development Research and the Role of the Researcher

Finally, I will discuss the researcher's role in development research and describe the role in this study. As defined above, a collaborative orientation – that is, interaction with the developers as well as with the end users – is an essential characteristic of design-based and development research (e.g. Design-Based Research Collective 2003; van den Akker 1999). However, different types of development research represent different views of the nature of the researcher's role. Type I and Type II development research differ from one another in terms of several points, the role of the researcher being one. The most significant disparity is the extent to which the researcher actively influences the development process. To repeat what was stated previously, Type I characteristically has the researcher as an active participant throughout the process while Type II studies address the processes as practiced by others (van den Akker 1999).

Above I came to the conclusion that this study entails characteristics of both types of development research. This is the case also with regard to the researcher's role: the extent of my participation and influence varied between different projects and also between different phases of a particular project. For example, the first case, Talarius, was carried out as project work by students who formed the principal project group. I was involved in the project by providing the developers information on methods of user involvement and by planning the methods and activities together with them. However, I was not as closely involved in the processes as I was in Virtual Peatland. The difference is perhaps best described by labelling my role as that of a "consultant" in Talarius and as a development group member in Virtual Peatland, especially in the early stages of the project.

Data were gathered throughout the process in each of the projects. However, the different roles I had in different projects shaped the collection of data as well. In the project in which I had a consultant role, the emphasis is more heavily on external data sources such as development documents and interviews, whereas in the project in which I was more closely involved, observations and research journals are in a more significant role. Data collection is described in more detail below, in Section 3.3.

3.2.2 Other Relevant Research Approaches

In addition to development research, this study borrows from the principles and methods of some other related research approaches. Some aspects of the study touch on the characteristics of *participatory action research*. Also, most essentially, *case study research* provides tools for conducting the study: designing the study setting as well as collecting and analyzing the results. In this subsection I will present the core points of these approaches and discuss their role in the context of this study.

Action Research

Action research has been defined as "a collaborative approach to *inquiry* or *investigation* that provides people with the means to take systematic *action* to resolve specific problems" (Stringer 1996, 15, italics in original). An essential feature of action research is that it is e.g. terminologically and procedurally close to the practitioners' world, promoting their understanding of the research process (ibid., 15). Kemmis and McTaggart (1988, 10) also emphasize the systematic and collaborative nature of the action research process. Action research is a spiral process consisting of *planning* the actions to be taken to tackle a specified issue, *acting* to implement that plan, *observing* the effects of the action, and *reflecting* these effects to form the basis of a revised plan for the next cycle (Kemmis & McTaggart 1988, 10-15). They highlight also the importance of flexibility in the process: the plan, the action guided by the plan, and the observation of the process must be flexible in order to adapt to unpredicted effects and constraints because their emergence is characteristic of real-life situations (ibid., 11-13). Moreover, they point out that action has its grounding both in former experience and in the present context: it is always based on prior practice to a certain extent but it can have only a speculative understanding of issues in light of the realities of the particular context at hand (ibid., 12). Karlsen (1991) has described the process of action research with the following structure (Figure 8).

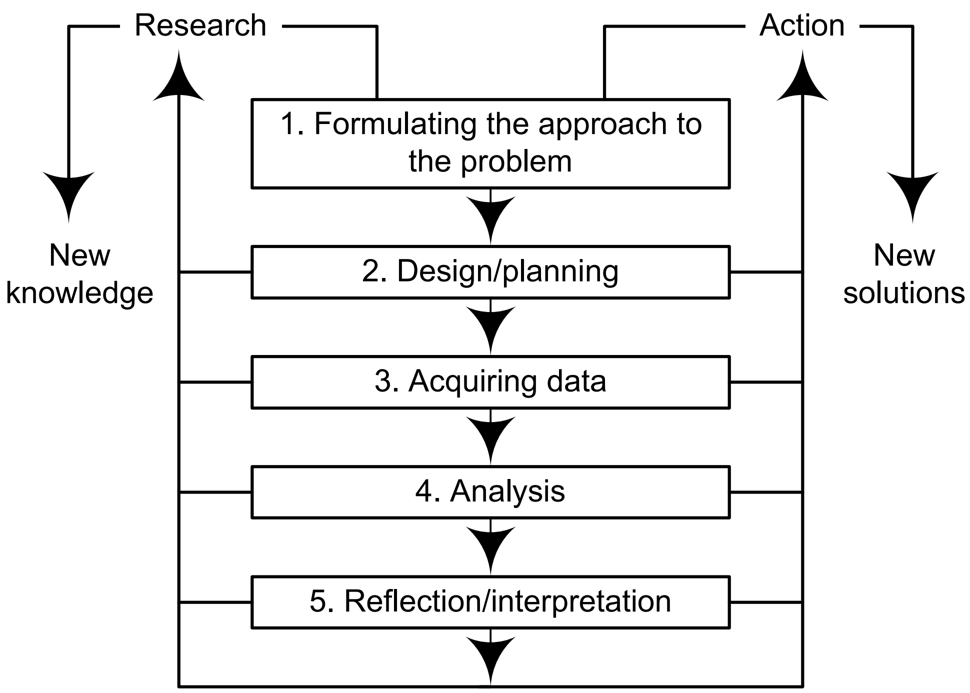

FIGURE 8 Action research (Karlsen 1991, 150)

Figure 8 demonstrates the dual nature of the action research approach: action and research are carried out side by side throughout the process, aiming to create both new knowledge and new practical solutions. However, even if the structure and objectives of action research bear a substantial resemblance to those of development research, action research has not been included in the development research framework. The reason for this, according to van den Akker (1999), is that action research does not have an adequate balance between development and research: action research emphasizes "the 'action' component and lack[s] an explicit scholarly orientation on contributions to knowledge that is accessible to others" (van den Akker 1999, 6). As Reeves (2000) points out, action research will be useful in studying localised, smaller-scale issues but it is not an adequate approach for more complex problems. This is also implied in Stringer's (1996) definition presented above: action research mainly concentrates on solving specific practical problems related to a specific situation, putting less emphasis on the generalizability or the broader application of the results.

Despite these criticisms, there are such elements in action research that are suitable for studies employing development research and therefore worth considering in the context of this study. Whyte (1989), for example, highlights one particular emphasis of participatory action research which relates to a core issue of this research, namely interdisciplinarity. Participatory action research is in opposition to one-angled views on the topics it studies – instead, it emphasizes the need to understand the context more broadly. Whyte (1989, 383, italics in original) writes:

> In organizational research, the research literature in any single discipline provides a very inadequate base for solving important practical and theoretical problems. To gain a firmer base, we need to be able to integrate information and ideas in our own discipline with *technical* information and ideas relevant to the organization studied.

As the description shows, action research aims to discover and address the actual problems in the context at hand by looking at the environment from different perspectives. It is not enough to directly apply theories and methods from the researcher's own discipline; the field being studied presents its own characteristic questions that require the researcher to look into the context from more angles, both with the aid of literature and through practice. I will briefly discuss the issue in light of this study.

The context of this study is the development of educational game-based applications, conducted in collaboration with groups of children principally in school environments. When we examine this setting and extract the perspectives of different scientific disciplines from it, we find at least information systems (it deals with the development of software) and human-computer interaction (it employs a user-centred approach), pedagogy (the applications are learning tools), childhood studies or early childhood education (the aim is to allow children to have a voice), sociology (issues of roles and participation play a central part), and game studies (the applications studied are each more or less game-based). This requires that the framework of the study, and the literature reviewed in order to set this framework, not be limited to one discipline: even though the principal focus, due to my own background, is on the issues of human-computer interaction, the focus would have remained overly narrow without touching on the other relevant fields. Moreover, in addition to this wide variety of research disciplines, several practical issues stemming from the concrete context come into play as well, such as the age and number of the participants or the embedding of the activities into the everyday schedules of their school work. An action-oriented approach used in the research ensures that not only the theoretical background but also the practical considerations – which only emerge when they are observed in reality – are covered.

Another key principle of action research that is especially essential in the context of this study is the requirement of flexibility. As stated above, Kemmis and McTaggart (1988) have emphasized flexibility in all phases of the action research cycle. The plan of action must be able to adapt to unexpected changes and limitations that are often bound to appear in design and research activities conducted in real-life settings. The action itself has the same requirement: it must be dynamic enough to be able to instantly respond to observations and needs arising from the practice in the course of the development cycle. To make this possible, flexibility is required also of the observation of the process. Observation needs to address the activities from a forward-looking point of view (i.e. how they will inform the next development cycle) but it also has to be able to identify issues that need to be reacted to immediately in the same cycle. Predefined observation categories are not adequate as they are unable to deal with unexpected issues. Finally, the requirement for flexibility extends to the reflection phase as well. Reflection is both evaluative and descriptive, portraying the process and summing up the observations documented during it but also actively constructing meanings and taking contextual issues into account. (Kemmis & McTaggart 1988, 11–15)

Case Study Research

In studies of e.g. usability research methods, approaches that evaluate the methods in isolation from their actual context have been common. For example, the debate surrounding the usefulness of different usability evaluation methods has been focusing on issues such as the optimal number of test participants or the effectiveness of the methods in terms of the number of usability problems detected, often in artificial test settings (Hornbæk & Frøkjær 2005; Wixon 2003). While these are important questions, they often fail, however, to address the vast range of issues that developers come across in actual projects. Therefore, according to Wixon (2003), an approach based on case studies conducted in real development projects is what is needed to bring the evaluation of methods closer to real-life contexts. He supports his position with two main arguments: Firstly, there is development and usability work being conducted all the time, which provides a natural context for researching and learning about the practices being used. Secondly, "the development of real products is the only context sufficiently rich to produce the kind of nuanced examples that are needed to develop a differentiated and contextualized understanding of methods needed by practitioners" (ibid., 32). This study aims, for its part, to respond to this need and thereby add to the body of knowledge and experiences cumulated from case studies conducted in real contexts. After all, in the case of participation methods and practices, it is virtually impossible to study them in isolation from practice and real-life situations.

A case study, according to Yin (1994, 13), is "an empirical inquiry that investigates a contemporary phenomenon within its real-life context, especially when the boundaries between phenomenon and context are not clearly evident", hence when the researcher intentionally wants to address contextual issues as well. Case studies can be studies of naturally occurring events, or they can, as in this study, be conducted in action research form when cases are created or modified by the researcher's actions (Hammersley & Gomm 2000).

The case study approach is most suitable for studies of descriptive and/or explanatory nature; in other words, in research that addresses questions of "why" or "how" (Yin 1994, 4-9). One main advantage of the case study approach, especially from the point of view of applying it in development research, lies in its ability to provide and manage many different types of data, ranging from various documents to interview and observational data (Hammersley & Gomm 2000; Yin 1994, 8). The use of various sources of evidence also enables the verification of the findings through triangulation (e.g. Huberman & Miles 1994; Patton 2002, 247-248; Yin 1994, 90-93).

Issues related to data collection and analysis will be discussed in more detail in the following section.

3.3 Data Collection and Analysis

The development research approach, as well as the case study strategy, can entail both qualitative and quantitative data (e.g. Richey et al. 2004; Yin 1994, 14). However, development research studies largely build on qualitative research methods, albeit e.g. surveys are commonly used (Richey et al. 2004). In development research aiming to provide a rich depiction of the process being studied, qualitative evidence is in the main role in conveying the essence of the development process.

In this section, I will discuss the collection and analysis of the data used in this study. I will first look at qualitative data in general: the types of such data and analysis methods relevant for this study. Then I will proceed to describe the data collection methods of this study and to explain the analysis procedures of the different types of data utilized in the study. Finally, I will discuss the relationship between the data collected and the research questions to which they aim to provide answers.

3.3.1 Gathering and Analyzing Qualitative Data

Miles and Huberman (1994) provide a summary of the strengths of qualitative data. Consistently with the tenets of development research, qualitative data are gathered within an actual context, and hence the data excel in providing rich and extensive depictions of naturally occurring events. Moreover, as the data are often gathered over a prolonged period of time and there is a great deal of flexibility as regards how they are collected, qualitative studies are able to address, describe and explain issues related to processes. Finally, Miles and Huberman point out a context in which qualitative data are especially appropriate: when the aim is to identify the "meanings people place on the events, processes, and structures of their lives and [to connect] these meanings to the social world around them". (Ibid., 10)

Qualitative data are obtained from three main types of sources: interviews, observations, and documents (Miles & Huberman 1994, 9; Patton 2002, 4; Wolcott 1992). These three main types, the forms their data take, and the questions they address are summarized in Table 5.

TABLE 5 Types of qualitative data, based on Patton (2002) and Wolcott (1992)

	Form of data	**Issues addressed**
Interviews (‘enquiring’)	Verbatim quotations (in context)	Subjective experiences, opinions, feelings, knowledge
Observations (‘experiencing’)	Field notes (detailed descriptions)	Activities, behaviour, conversations, interpersonal interactions, observable organizational processes
Documents (‘examining’)	Excerpts of documents (written or other type)	Document-dependent: subjective accounts (e.g. diaries, open-ended written responses), factual data (e.g. clinical records), interpretive data (e.g. photographs)

Interviews take the form of verbatim quotations and are able to address questions related to subjective perspectives, such as experiences, opinions, feelings, and knowledge. Observations, on the other hand, provide information on what is happening: the activities, behaviours, and interactions that are taking place in the environment being studied, and observable organizational processes. Observations are typically recorded in the form of field notes. Finally, documents can provide different types of knowledge depending on the focus and format of a particular document. Some documents, such as diaries and written accounts provided as answers to open-ended questions, deal with subjective perspectives while others can yield very detailed factual data (e.g. clinical records or statistical documents), and yet others can be highly interpretive by nature (e.g. photographs or drawings).

However, as the richness of the data is one of the main strengths of qualitative research, its greatest challenge lies in the same issue: making sense of vast amounts of data in the analysis process (cf. Patton 2002, 432). As Miles and Huberman (1994, 10) put it, “[t]he strengths of qualitative data rest very centrally on the competence with which their analysis is carried out”. As the data are plentiful and rich, the account of the analysis process needs to be that as well. Patton (2002, 438) stresses the importance of clearly distinguishing between description and interpretation. The data must be presented fairly and with “thick descriptions” to support the readers’ understanding of the issue and to allow them to make their own interpretations (ibid., 433-438). In order to accomplish this, the researcher needs to examine and report the analytical process accurately and in enough detail (Miles & Huberman 1994, 12; Patton 2002, 434).

The analysis of qualitative data is constant dialogue between the data and theory, between different sources of data, and between the data and the researcher’s interpretations or expectations. This interactive nature of different phases of analysis is represented in the following figure (Figure 9) by Miles and Huberman (1994, 12).

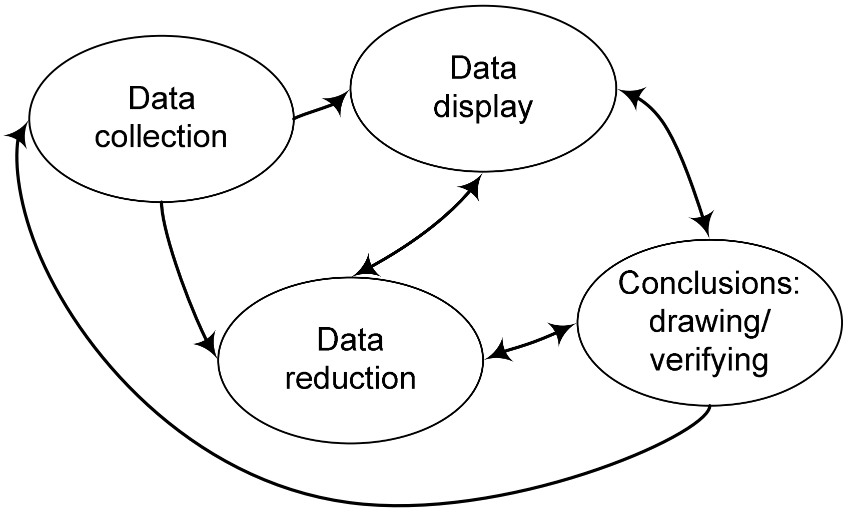

FIGURE 9 Components of data analysis (Miles & Huberman 1994, 12)

The interactive model of the relationships between different components of data analysis presented above illustrates well the interactive nature of the analytical process. The three main components of analysis pointed out by Miles and Huberman (1994, 10-12) – data reduction, data display, and conclusion drawing and verification – are in constant dialogue both with one another and with data collection. None of the components is a specific and isolated phase having a fixed place at a certain point of the process; instead, all of them inform each other throughout the process, even before the actual data gathering.

Data reduction entails "selecting, focusing, simplifying, abstracting, and transforming the data that appear in written-up field notes or transcriptions". In other words, data reduction refers to coding, clustering, summarizing, writing memos, identifying themes, and other analytical activities performed to the data, aiming to arrange and focus them, and make them more manageable and organized. Also the decisions made before the actual collection of data to focus the study (e.g. conceptual frameworks, research questions, selection of cases, data gathering methods) are data reduction. Data display has the same general goal as data reduction; to organize and make sense of the bulk of data. Ways of displaying data range from mere extended text to various techniques based on visualization, such as matrices, charts, graphs, and networks. The drawing and verification of conclusions also extends over the whole process of analysis: patterns and themes start to emerge, guiding the data collection and leading to next steps of analysis. Data reduction and display facilitate this process and, with each step, make the conclusions increasingly grounded to the data. (Miles & Huberman 1994, 10-12)

A cyclical process of data collection and analysis is especially relevant in development research efforts. Even if the more scrupulous analysis of the whole development process and the drawing of final conclusions are left to be conducted after the studied development projects, preliminary analysis and conclusions need to take place already during the development processes in order to inform and improve them.

3.3.2 Data Gathering and Analysis in this Study

Previously I have discussed the general methodological framings of the study. The main research strategy applied in the study is the development research approach which emphasizes careful documentation of the development process and, being based on case studies, multiple sources of data. This subsection describes the data collected from the different case studies, explicates the process of analysis for each type of data, and discusses the roles of the different types of data in this study – in other words, how the data aim to shed light on the research questions from different perspectives.

Table 6 provides an overview of the types of data gathered in the study (more detailed description of the data collected from each of the case projects can be found in Appendices 1 and 2, respectively).

TABLE 6 Summary of the data related to each case

		PROJECTS	
Type of data	**Data**	**Talarius**	**Virtual Peatland**
Interviews (‘enquiring’)	Children’s questionnaires and/or discussions	x	x
	Developers’ questionnaires and/or discussions	x	-
Observations (‘experiencing’)	Research journals[1] and field notes	x	x
	Design session video material	(x)	(x)
	Field trial data and/or results	x	x
Documents (‘examining’)	Developers’ documentation[1]	x	x
	Design session outcomes and final product	x	x

As presented in Wang and Hannafin’s (2005) summary of the main characteristics of design-based research approaches, the use of mixed research methods and the evolution of the methods in the course of the process are among the critical issues in design-based research, ensuring adequate documentation of the development process. By having multiple different sources of data in each case project I have aimed to achieve this goal in this study. Multiple types of data were gathered, each aiming to uncover the research problems from a specific angle. They represent each of the three main strategies of qualitative data gathering: enquiring, experiencing, and examining

1 Research journals were used in two roles: as researcher notes (observations) and as a part of development documents.

(Patton 2002, 4; Wolcott 1992). The principal difference between the projects in terms of data gathering was that in the Talarius project (in which my role was mainly that of a consultant outside the development group) interview and questionnaire data were gathered from the developers, while in the Virtual Peatland project, the field journals which were written by different members of the group served as a data source representing the researcher and developer perspectives alike.

As regards the analysis of the data, I touched on issues related to qualitative data analysis on a more general level in subsection 3.3.1. Here I will proceed to describe the analysis of the different types of data described above. As pointed out several times, continuous data collection and analysis as well as conclusion-drawing and implementation are typical of development research. Therefore more limited analyses were performed to different types of data (especially interview or questionnaire data and field notes) throughout the whole process, firstly, in order to feed results and conclusions back to the process and, secondly, to guide further data collection. More extensive analytical work incorporating all the data collected from the projects, aiming to address issues of more general nature, was carried out after each project.

In the following I will discuss the different data gathering methods I have used and their roles in the entire study, as well as the analytical approaches employed in the process of data analysis.

Gathering and Analyzing Interview and Questionnaire Data

Children's experiences and opinions were explicitly inquired through interviews and questionnaires. Each case project included either interviews, questionnaires, or both. Depending on the duration and intensiveness of the project, these inquiries took place either only at the end of the project or also in different occasions in the course of the project. Data gathering was modified in the course of the projects, and from the first project to the other. After the Talarius project, it was noted that it was inadequate to collect questionnaire data about the children's experiences only at the end of the project, and therefore in the Virtual Peatland project, the gathering of questionnaire data took place more intensively throughout the project. In addition to the children, the developers were interviewed and/or inquired with questionnaires about their experiences as well. Developer interviews and questionnaires play an especially big role in the Talarius project, in which the development work was carried out by a specific project group in which I was personally not a member.

As stated above, initial analysis of the interviews and questionnaires was conducted already during the development process, immediately after the data collection. These analyses were carried out from the point of view of instant improvements to the development processes. The questionnaires and interviews were examined in order to quickly identify problematic issues and other significant findings that would be necessary to be aware of in the immediately upcoming phases of the development process. In this quick analysis, questionnaire responses were digitalized and analyzed question by question by grouping the respondents' answers into categories based on the contents. Interview data were examined through the interviewer's notes; full transcriptions of the interviews were not yet made. This analysis was, as pointed out, practically oriented, aiming for rapid application of the findings, and questions were not yet addressed on a broader, conceptual level. In the Virtual Peatland project, for example, the children's opinions on each evaluation session were analyzed in this manner in order for the successes and problems encountered in each session to inform the planning of the subsequent sessions. To illustrate this with one instance, the answers to the question *"What was it like to plan and create ideas for the Virtual Peatland website?"* were categorized into positive, negative, and neutral/ambiguous experiences. Within these categories, the most frequently appearing contents of both the positive and the negative statements were searched in order to extract the most important issues brought up by the children regarding what made the participation methods pleasant or unpleasant, with the aim of using this information in carrying out future sessions.

The process of the more extensive processing of the interview and questionnaire data, conducted after each project, was as follows. Interviews were transcribed verbatim (omitting filler words) and arranged into text files, each of which consisted of one interview. Questionnaire responses were arranged in the same way. The analysis of the responses was conducted with the aid of the Atlas.ti scientific software. The responses were coded on two levels. The higher level represented more general themes derived from the research questions. In the children's interview and questionnaire data, the themes were related to 1) their experiences of the process and the methods employed in involving them in the process, 2) their thoughts on the functioning of the team, 3) their conceptions of their own expertise in the development, 4) their views regarding their empowerment and influence in the process, and 5) how the final outcome met their expectations. In the developers' data, the themes were largely equivalent to those of the children, only from a different point of view: 1) the developers' views regarding the process of user involvement and the methods used in it, 2) their conceptions of the issues related to the functioning of the team, 3) the issues in which they sought children's expertise, and 4) how they addressed context in the process. The lower level of coding was more detailed and based directly on the literal content of the utterances coded. By so doing, these more detailed codes could be mapped to the general themes and, subsequently, grouped to form categories under these main themes. For example, a child's comment about his participation "I have played and given feedback" was coded on a more specific level as belonging to the category of the participants' *roles* in the process, which was an issue related to the *functioning of the team,* on a more general level.

Documents, Research Journals, and Field Notes

Another valuable source of information about the developers' point of view is the documentation produced by the developers during the process. Such documentation can include more formal files such as different types of project plans and reports as well as more informal documents such as project journals. Characteristically of development research, my role was that of both a researcher and a developer. Therefore the research journals written either only by me or together with other researchers/developers in the group have also a double role in the data. I have analyzed them from two points of view, in other words by using them both in the role of researcher notes and as one part of development documentation. In the first case the emphasis of the analysis is on the observations and reflections on the process as a researcher, while in the latter case it is on the aspects related to the children's participation from the point of view of the development of the application. I will illustrate this with the following data excerpts.

> We obtained contents to the idea map very well, although there were some starting problems at first. Telling their opinions seemed to feel a bit difficult to the children at the beginning, but once they got the hang of it, they started to come up with a lot of ideas. Collecting the ideas in several phases (first the sheets the children filled in individually, then the list into which all the things mentioned [by the children] were written, and after that the idea map based on the most central things) was a good way to gather ideas at least in the sense that in addition to the final idea map we also got some "uncensored" versions of the ideas to examine and analyze.

This quotation represents the researcher perspective: the session is described, and the pros and cons of the activity carried out in the session are reflected upon. The following quote, on the other hand, represents the developer perspective, as it focuses on the implications of the results of the session on the application to be developed.

> In the children's ideas, wishes related to game-likeness and interactivity (building one's own park, taking the role of an animal of the park, making one's own animations etc.) were clearly emphasized.

The documents were organized into text files, each file representing one document, e.g. a meeting memo, a weekly report by a project group, a risk analysis report, or a research or development journal (see Appendices 1 and 2 for complete listings of all documents used as data). No text was cut out at this point, and in case the document included graphic presentations not supported by the analysis software within textual documents, the image was saved separately and a reference (name of the figure) was placed in its place within the text document.

The analysis was carried out in an equivalent way as the analysis of the interview and questionnaire data. The documents were analyzed on two levels, the more general themes being the same as in the analysis of the questionnaire and interview responses. The codes of the more detailed level, again similarly as above, were based directly on the literal utterances. As I had at this point, based on the interview and questionnaire data (which I analyzed first), come up with initial structures for the categories, I could use this structure as a basis for the coding of the documents: I assigned new data into the already established categories as well as created new ones. I could also use the new data to challenge and alter the categories I had established in the analysis of the interviews and questionnaires.

To illustrate these coding levels, the following quotation taken from the developers' phase report of the take-into-use and closing phases of the Talarius project was coded on the more general level as being related to the research question dealing with *the functioning of the team*. On the more specific coding level it was coded as having to do with teamwork-related *motivation*.

> In both phases, [our] work motivation has been excellent […]. The good motivation is possibly partially explained by the fact that [we] considered it an important task to make this application for the pupils of the partner class, and we did not want to disappoint them. All the members of the group have been very committed to the project work in both phases.

Video Recordings

Most of the design and evaluation sessions were videotaped in order to support the observations made during the process. The video recordings were not transcribed into textual format or analyzed in detail; instead, their role was to be a supporting resource which could be turned to for reference if there was a need e.g. to confirm an event described in the field notes and research journals. Thus the aim of the video recordings was to illustrate, verify and exemplify observations and interpretations made by the developers or researchers about the children's activities in the design and evaluation sessions.

Design Session Outcomes and Final Products

In interviews and questionnaires, and to some extent also in documents and observations, the emphasis is on the personal views and subjective experiences of the different participants. Therefore it felt necessary to examine the research problems also from such a point of view that is more distanced from subjective views of any group of people involved in the development process. I sought to obtain this perspective through the content analyses of 1) design session outcomes, 2) prototypes of different levels, and 3) the final products, as well as the comparison of these items in relation to each other.

The design session outcomes (drawings, idea maps, and other artefacts created by the children; children's verbal comments about their wishes regarding the application; evaluation session feedback) of each case project were analyzed in order to identify all the elements appearing in them, especially the most frequently appearing ones. User interface (UI) drawings were analyzed by classifying all different UI elements that were present in the drawings, counting their frequencies, and identifying their locations. Similarly, mind maps were analyzed by identifying, categorizing, and counting the frequencies of content items showing in them. Ideas given by the children verbally have also been content analyzed in a similar manner. The realization of these ideas was examined by comparing, item by item, the results of the analysis to the different prototypes and final products created in the case projects. Moreover, the effects of the feedback given by the children in the prototype evaluation sessions were analyzed by comparing their feedback and suggestions to the elements of the subsequent prototypes.

The purpose of this analysis was to study the actual effects of the children's involvement from the product perspective. The examination of this perspective together with those of the developers and the children aims to provide an alternative viewpoint to the influence of the children's ideas and feedback on the development of the products.

Evaluation of the Product in Use: Field Trial Data

Another strategy to examine the success of the design processes is to turn to the data gathered from the field trials of the different applications in order to evaluate the final products in use. As discussed in subsection 2.1.1, one of the main benefits of user-centred design has been said to be its positive effect on the quality of the product being developed, which manifests especially in the usability of the product and its suitability for the users' actual needs and tasks (e.g. Kujala 2003). The realization of this goal has been addressed in this study by examining the results of the field studies of the applications developed. In other words, the quality of the product in real use is used as one indicator of the success of the development process.

Summary: Research Questions and Data

With the descriptions of the different data types used in the study, I wish to illustrate, among other things, the integration of the variety of perspectives from which the issues of children's participation can be looked at. On one dimension, the data address three points of view: the developers, the children, and the product. The views of the developers are sought through interview and questionnaire data and documents, the children's experiences are gathered in the form of interviews and questionnaires as well as observational data, and the product point of view is examined with the aid of the analysis of design session outcomes, different prototypes of the product, and field trial results. On another dimension, the points of view of the process and the product can be differentiated: the data aim to shed light on how the children's participation is reflected in the development process on the one hand and in the final product on the other. A summary of the relationships between the data and the research questions is presented in Table 7.

Within the first main theme (the process of user involvement), the data related to the research question dealing with process reconstruction (Q1a) is based on the developers' documentation and observations recorded in research journals; these data provide accounts of the structure of the process and the reasons leading to a certain way of conducting the process of user involvement. The principal data used to examine the experiences related to the process and methods (Q1b) include interview and questionnaire data from the children and

TABLE 7 Research questions and types of data used to answer them

PROCESS OF USER INVOLVEMENT		
Theme	**Research Questions**	**Data**
Structure and methods	Q1a Process reconstruction: how was the process of user involvement structured and which methods were used?	Development documents Field notes / Research journal
	Q1b How did the participants (children and developers) experience the structure of the process and the methods used at different stages of the project?	Interviews/questionnaires Development documents Field notes / Research journal
Functioning of the team	Q2 What are the key issues regarding the collaboration between the children and the developers?	Interviews/questionnaires Field notes / Research journal Development documents
GOALS OF USER INVOLVEMENT		
Theme	**Research Questions**	**Data**
Bringing the users' expertise into the process	Q3a In which aspects of the design work do the developers seek user expertise?	Interviews/questionnaires Development documents
	Q3b How do the children perceive their own expertise in the project?	Interviews/questionnaires
Taking the actual use context into account	Q4 How is the actual use context taken into account in the process?	Interviews/questionnaires Development documents Field notes / Research journal
Perceived and actual influence of the users	Q5a Feeling of empowerment: How do the children experience the extent of their influence on the development of the product?	Interviews/questionnaires
	Q5b Actual influences: How do the ideas and the feedback of the children manifest in the prototypes and products?	Design session outcomes Prototypes Final products
Product quality and viability	Q6a How well does the final product meet the needs of real use?	Field trial data
	Q6b How well does the outcome meet the users' expectations?	Interviews / questionnaires Field trial data

the developers, observational data (i.e. field notes, supported by video recordings of the design sessions if necessary), and the developers' documents. The same data are used to address the second sub-theme, namely collaboration and team functioning (Q2).

The second main theme examines how the goals of user involvement were met. The sub-theme related to user expertise is approached from different perspectives: the data related to the developers' point of view (Q3a) include developers' interviews and questionnaires as well as development documents, whereas the children's perspective (Q3b) is approached by analyzing their interviews and questionnaires. The next sub-theme is concerned with how the context is taken into account in the development process. In the context-related research question (Q4), the developer's inquiry data, development documents, and research journals are used as the principal data.

In the empowerment-related sub-theme, the answer to the research question related to the children's feeling of empowerment (Q5a) is based on the analysis of inquiry data from the children's perspective. The question dealing with the manifestation of ideas (Q5b), on the other hand, examines the effects of the children's involvement neither from the perspective of the developers nor of the children themselves, but from that of the product. It employs the concrete artefacts created during the development processes as data: various design session outcomes ranging from verbal comments to drawings, prototypes produced at different stages of the projects, and the applications produced as the final versions of the products.

The sub-theme dealing with product quality relies for a large part on field trial data. The question related to the feasibility of the application in real use (Q6a)is solely based on the data collected in field trials (interviews, questionnaires, field notes, and supporting video recordings), while the one related to whether the application meets the user participants' expectations (Q6b) relies more on the interview and questionnaire data collected from the children.

3.4 Ethical Considerations

I will finish this chapter by discussing the ethical considerations related to conducting qualitative research with people, especially with children. Research entailing direct involvement with the people being studied, in an actual context, brings about specific ethical issues to address (e.g. Punch 1994). Moreover, these questions have their own specific nature when this direct contact involves children (e.g. Morrow & Richards 1996; Thomas & O'Kane 1998). I will first more generally touch on ethical questions in qualitative research and special considerations associated with the involvement of children in research, and then I will proceed to have a look at these issues from the point of view of this particular study.

3.4.1 Ethical Issues: Qualitative Research with Children

The need to address ethical dilemmas in qualitative research is crucial especially because qualitative methods can be seen "as having the potential for most intrusion and hence being the most ethically precarious" (Morrow & Richards 1996, 102). This is emphasized in research examining very sensitive topics, but even when dealing with less delicate issues, questions of ethics play an important part. Issues that are necessary to address in order to conduct ethical research with people include e.g. consent, deception, privacy, and confidentiality (see e.g. Christians 2000; Sieber 1992). In research conducted with children, there are certain special dimensions in these issues, as well as some additional questions to be dealt with.

Consent refers to agreement to participate in research, and it should be both informed and voluntary. Informed consent denotes that the subject has all the information needed to make a decision about participation: the purpose and the setting of the study are described to the participants in an understandable way (e.g. in terms of language and terminology), with all necessary information included (Sieber 1992, 26-37). As a rule, deception of participants or omission of crucial information from their awareness is not ethically acceptable in research (Christians 2000). However, sometimes the nature of the research requires that some aspects not be disclosed to the participants beforehand; in these cases the participants are asked for consent to concealment, and they are carefully debriefed afterwards (Sieber 1992, 66-67). Voluntariness, on the other hand, entails that consent is obtained without coercion or excessive persuasion (ibid., 26). Voluntariness requires especially close attention in research conducted with children in school settings, where peer pressure and the impact of authority figures (teachers and other adults) play a significant role (ibid., 122).

Two perceptions about children, namely vulnerability and incompetence, are frequently referred to in discussions of research ethics involving children and typically also reflected in legal conceptions about children (Morrow & Richards 1996). Thompson (1992) specifies several vulnerabilities and restrictions that apply to research conducted with children: limited cognitive competencies manifesting as difficulty to understand the research process and thereby to give consent of participation, limited social power (e.g. decisions of participation made for them by parents, school, or other adults and institutions), and their legal status as minors which simultaneously both protects and restricts their rights. With children as research participants, it is usually necessary to have both the parents' permission and the child's assent, with the children having veto power over the parents' consent (e.g. Sieber 1992, 32; Tymchuk 1992).

When the research subjects are members of a specific community, or a group with limited social power, there are often also "gatekeepers" involved in the consent process. Gatekeepers are representatives of the community who let the researchers enter the setting, help them establish an understanding with the participants, and negotiate acceptable conditions for conducting the research

(Sieber 1992, 29, 85). For example, in research with children, representatives of schools and kindergartens (e.g. principals or teachers) often act as gatekeepers.

Questions of *privacy*, *confidentiality*, and *anonymity* are particularly salient in qualitative research where the number of participants is relatively small, research is case-based, and the data are rich and illustrative. In the case of research conducted with children, the effects that feelings of intrusion of privacy may have on the development of the children's self-esteem create additional issues for the researcher to take into account (Melton 1992). The three terms are interrelated, all referring to personal information with slightly different foci. Sieber (1992, 44-45, italics in original) describes the differences in the following way: the concept of privacy is related to "*persons* and their interest in controlling the access of others to themselves", confidentiality "refers to *data* (some record about the person, such as notes or a videotape of the person)", and anonymity deals with the handling of "the names and other unique identifiers […] of subjects".

Questions of privacy, confidentiality, and anonymity are of importance also from the point of view of the success of the research in terms of the correctness of results. This is because the subjects' feeling of control of the information about themselves and their trust regarding the use of the data about themselves affect their willingness to participate and to respond accurately (Sieber 1992, 45, 53). When working with child participants, respecting their privacy also shows that they are treated as independent and trustworthy individuals (Melton 1992).

Many of the issues that are specific to research with children boil down, to a large extent, to power structures between children and adults. Morrow and Richards (1996) point out that while the view of children as a vulnerable group aims to protect them, it also places them as objects rather than subjects – a stance from which the researcher should in fact move away in order to acquire an authentic understanding of children's experiences as social actors. They also criticize the view of children's incompetence – which refers to children's limited ability to decide on their participation in research and provide valid data – by arguing that it "reflects a cultural reluctance to take children's ideas seriously" (ibid., 98). As Morrow and Richards point out, differences between children and adults as research subjects can and should be acknowledged, but they need not be seen as deficiencies.

Next, this study will be discussed in light of the aforementioned issues.

3.4.2 Addressing Ethical Issues in this Study

The development research approach employed in this study forms an interesting and challenging context to explore the issues related to the ethics of the research. A distinctive feature is that due to the nature of the approach it is difficult, or even impossible, to distinguish between the children's involvement in the *development* of the applications and their involvement in the *research* of the development process. Research activities are simultaneously development activities, and vice versa. Similarly as this setting poses challenges to the research on a practical level, it does that also to the ethical considerations – both when addressing them during the research process and when evaluating them in retrospect.

Thomas and O'Kane (1998) suggest participatory research methods as a way of overcoming ethical challenges in research with children. In this sense, the intertwined relationship between the development activities and the research activities was rather an advantage than a disadvantage. In accordance with development research principles, a key characteristic of the participation was listening to the children's feedback and adapting the sessions accordingly. Furthermore, research was an inherent part of the participation in the development project: the children worked with the same researchers throughout the course of the project, and sharing their ideas and opinions on the product or the process with them, either through the design activities as such or through specific interviews or questionnaires, was the "name of the game".

Moreover, one main goal of this study was to examine how the children experienced the participation in the development process: hence, as the research and development are intertwined, the results of the study (i.e. the children's opinions about their roles and their feeling of control in the development process) are an indicator of the children's perceptions of their role in the research process as well. Therefore, the extent of how successfully ethical considerations have been addressed can be evaluated on the basis of the results of the study.

This nearly inseparably intertwined relationship between the development of the applications and the research of the development process is also one crucial dimension of challenges related to *consent*. It is difficult to determine to what extent it is possible to differentiate between consent to participate in a *development* project and in the *research* related to this project. I attempted to address these challenges by bringing up the research perspective during each design session or other activity carried out with the children. The children were explained that besides their contribution to the development of the application, we were also interested in their experiences about the participation in general and about the different methods through which they participated in the course of the project, in order to find out how to improve the methods so that they would be better suited both for the children and the developers. To illustrate this with one specific example, these issues came up particularly naturally in relation to the video recordings of the sessions. The children took interest in the cameras and were curious to know in more detail about the reasons why the sessions were videotaped. This genuine interest was a good basis not only for explaining the role of the video recordings in the research but also for talking about the purpose of the research more generally.

The gatekeeper position of school teachers and kindergarten staff was a key factor in each case project. Firstly, the basic structure of the participation was negotiated with them. In the case of the projects or field trials carried out in collaboration with school classes, the activities were regarded as part of school work, with the whole class participating. A key challenge in this approach, from the consent point of view, was dealing with peer pressure: in such a setting – when everyone else participates – the threshold to decline is likely to be very big. It is possible that a child would rather not have participated in a particular activity but felt that as it belonged to the school day, it was required. In the field trial sessions carried out in kindergartens, the challenge with peer pressure was not as salient. In these environments there is characteristically a variety of activities going on at the same time, and therefore participation – or non-participation – does not gather as much attention among the other children.

Secondly, the gatekeepers had a significant role in informing – and suggesting suitable ways of informing – the children's parents about the projects. In the school-based projects, communication to the parents took place via the teachers in a more informal fashion, whereas in the field trials carried out in kindergarten environments, the parents were given a more formal letter explaining the study and a written consent form to be signed and returned. In addition to general consent for the child to participate in the project, permission for videotaping was explicitly asked in the consent form. Most parents consented both to the participation in general and to the video recording of activities. In a couple of cases a child was allowed to participate in the activities otherwise but not to be videotaped. Some consent forms were never returned; this was taken as dissent unless a parent gave verbal consent, having forgotten to return the written form.

As regards *privacy* and *confidentiality*, Sieber (1992, 44-45) states that issues of confidentiality are preferably addressed already in the consent agreement, stating what may be done with the information. In this study, it was made clear to the participants that the research data were to be used only for research purposes and viewed only by the research group. Due to the generally sensitive nature of video material about children, this was especially strongly emphasized in the case of the video recordings. The use of video recording appeared to be, for both the parents and the children, the most prominent question in terms of both privacy and confidentiality. As mentioned above, some parents consented to the participation otherwise but did not allow the participation activities to be videotaped despite being aware that the video material would not be viewed by anybody outside the research group. Also among the children, being videotaped appeared to raise the most questions. The purpose of videotaping was explained to the children by telling them that we wished to tape the design and evaluation sessions in order to document them more precisely and to be able to return to them later. Like the parents, the children were also given assurance that nobody else than the researchers would see the video recordings. Even after being explained this, they often wanted to ask and confirm it several times during the design sessions ("So it's *absolutely* sure that no one else will see the video?").

The children often had a twofold stance towards the presence of the video equipment. On the one hand some children were, especially at first, somewhat apprehensive of the cameras, while on the other hand they were very interested in them (there is discussion on the effects of video cameras also e.g. in Druin 1999; Druin et al. 1999; Nielsen 1998). I noticed that allowing the children to examine the camera and play with it a bit (e.g. to go and have a look at the other children via the camera display and to play in front of the camera) before or in between the design sessions made the setting more relaxed and comfortable. I believe that to some extent this also helped the children understand that the presence of the video camera did not require them to act more formally or to be cautious about what they say or do.

In development research, aiming for *anonymity* during the data gathering process is often unfeasible; the research is conducted in close collaboration with the participants, and data collection is continual. Also when the children's experiences of the participation were gathered with questionnaires, they were asked to write their names on the papers in order to respond to the potential need for linking different items of data about the same person. Therefore, questions of anonymity step into the picture more strongly in the reporting phase, when making decisions regarding the presentation of the data.

In qualitative research, dealing with anonymity in the reporting of the results can be problematic. Sieber (1992, 54) suggests that "[w]hen reporting case studies, the names of persons, places, special events, occupations, ethnic background, and so on should be changed" and "[a]ny special characteristics of subjects should be changed slightly so that individuals cannot be identified". Accomplishing this adequately is a challenging endeavour in the reporting of development research efforts; the whole research process is very contextual, and it is necessary to describe e.g. settings and situations in a rather detailed way in order to provide the reader with enough of context. In this study, I have made the decision to refer to the case projects with their actual names and describe the applications developed in these projects with identifiable details, but not to disclose the names of the participating individuals (children, developers, etc.) and communities (schools, kindergartens etc.). I am aware that in most cases it is possible, for example, to associate a comment with a specific *group* of people but I have done my best to ensure that no recognition can occur on the level of individuals.

One viewpoint introduced by Morrow and Richards (1996) regarding ethical issues in research with children is the use of methods "which encourage children to interpret their own data" (ibid., 100). In this study, the children's interpretations have had a crucial role throughout the development research process: in the course of the projects, the children have had a chance to clarify and contradict observations I have made and initial conclusions drawn on the basis of these observations. However, similarly as Kiili (2006, 73) critically notes about her study which also deals with children's participation, I have not reviewed the final results and conclusions with the participants, which constitutes a risk of misconception. Further in the vein of Kiili's (ibid., 73) discussion about the risks of misinterpretation, I regard detailed description of the situations and contexts of the research as crucial, in order for the reader to be able to follow the data collection and analysis process and to evaluate the soundness of the conclusions and interpretations.

4 THE FIRST CYCLE: CASE TALARIUS

This chapter deals with the first cycle of the study, namely the development project of an educational game creation application called Talarius, as well as the background principles of the project. The chapter consists of two main sections. In Section 4.1, the background of the approach used in the Talarius project is discussed, first from the points of view of general principles of children's involvement in the development of technology and then by reviewing existing methods of involvement. In Section 4.2, the focus shifts onto the Talarius case, describing the project and presenting the results of the analysis.

4.1 Software Design, User Involvement, and Children

The aim of this section is to examine the principles and the existing methods and practices that have been used in order to involve users in technology design projects. First, the general principles of user involvement in user-centred and participatory design as well as in the more child-focused approaches (learner-centred design and child-computer interaction) are discussed. Then, a review of methods used in the aforementioned approaches is conducted. The purpose of this chapter is to lay the groundwork for applying user-centred methods in the first case project, Talarius.

4.1.1 Children in Software Design: From Human-Computer Interaction to Child-Computer Interaction

The principles and methods for bringing users into the design process of technological solutions have mainly been derived from the human-computer interaction (HCI) perspective on user involvement, encompassing user-centred and participatory design as well as usability research. These approaches have, however, been used mostly in the development of productivity tools. When it comes to designing educational or entertainment applications for children, a recently emerged perspective is child-computer interaction (CCI) (e.g. Read 2005), and another, more pedagogically oriented view to looking at the design of technology for children is an approach referred to as learner-centred design (LCD) (Good & Robertson 2006; Rode et al. 2003; Soloway et al. 1994; Soloway et al. 1996). Figure 10 illustrates the components of the basic HCI view as well as the broadened child-focused view consisting of CCI and LCD.

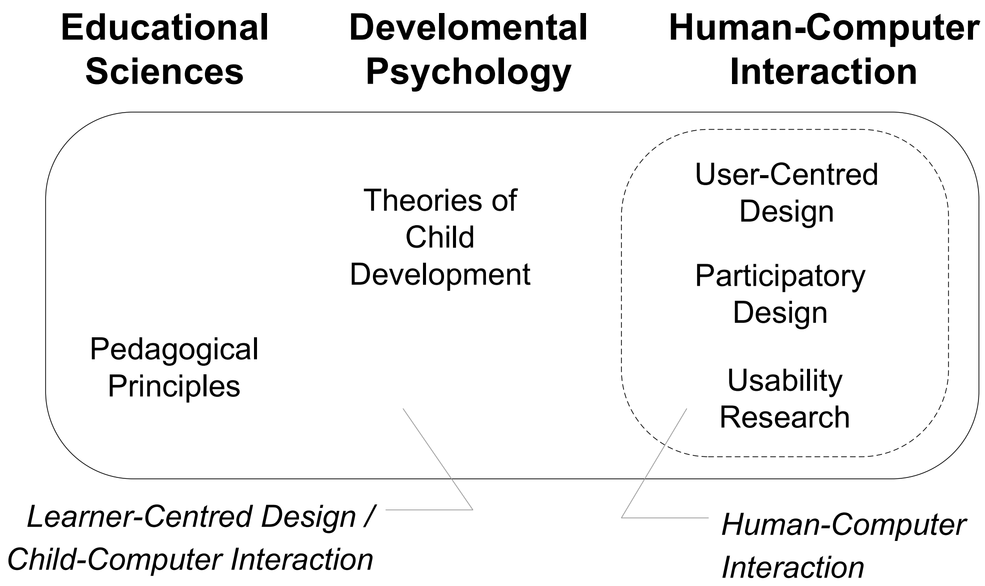

FIGURE 10 User involvement: human-computer interaction view and the view expanded to child-computer interaction and learner-centred design

In the design of children's technology, CCI applies methods from user-centred and participatory approaches and usability research to this particular context, taking into account issues specifically related to children (e.g. Read 2005). Moreover, the design of educational software has broadened the mere HCI perspective towards the principles of pedagogical design: LCD has been introduced as a way of bringing together the HCI point of view on the one hand and the principles and theories of education and developmental psychology on the other (Good & Robertson 2006; Rode et al. 2003; Soloway et al. 1994; Soloway et al. 1996).

User Involvement

The notion of user involvement can be seen as encompassing the approaches of user-centred design and participatory design. Key aspects related to these approaches were discussed in Chapter 2 in which I set the background for the conceptual framework of the study. Here I will briefly summarize the main principles of user-centred and participatory design as a bridge to the discussion of the approaches of learner-centred design and child-computer interaction.

User-centred design (UCD) is based on the idea of engaging users in the design starting from the early stages of the process and continuing to have the focus on users throughout the process, with the aid of iterations (Gould & Lewis 1985; Gulliksen et al. 2003; ISO 13407, 1999; Maguire 2001). The international standard ISO 13407 (1999) describes the human-centred design process as consisting of 1) specifying the context of use, 2) specifying the (user and organizational) requirements, 3) producing design solutions, and 4) evaluating the design solutions against user requirements (see subsection 2.2.1). The cycle is repeated until the goals are met (Bevan & Curson 1999; ISO 13407, 1999).

The basic principles of *participatory design* (PD) are for a large part similar as those of UCD, but it attempts to respond to some shortcomings that have been pointed out in the use of the UCD approach. UCD has been criticized for being indirect in that it heavily relies on the interpretations of user advocates and designers, and for taking users into the design process mainly as testers or evaluators, thereby placing them in a reacting rather than initiating role despite the UCD cycle implying active participation in all phases (e.g. Nesset & Large 2004; Sanders 2002; Scaife et al. 1997). Scaife et al. (1997), for example, describe PD as a more equal form of user involvement. The key principles of PD have been characterized as follows: 1) the goal is to improve the quality of work life, 2) this goal is accomplished by using a collaborative orientation, and 3) the development process is iterative (Blomberg & Henderson 1990; Cherry & Macredie 1999). Hence, on a level of principles PD does not considerably differ from UCD. However, as Scaife et al. (1997, 343) point out, in UCD there is often "too little [user involvement], too late". Consequently, PD emphasizes the active involvement of users starting from the earliest stages of the process. When developers in traditional methods transform user requirements into a specification, they add their own experiences and assumptions into them, and in this process the original meaning of the requirements can become distorted. In PD, on the other hand, requirements are the result of social interaction between the users and the developers. (Cherry & Macredie 1999)

Learner-Centred Design and Child-Computer Interaction

The principles and methods of user involvement have usually been applied mainly in design projects carried out with adult users. As there is a growing interest in designing technology for and with children, *child-computer interaction* (CCI) has emerged as a specific field of HCI that addresses technology design issues from the perspective of children.

The issues related to children and technology have for a large part focused on developing suitable technologies for children on different developmental levels. Bruckman and Bandlow (2003), for example, have discussed the implications of Piaget's (1970) theory of cognitive development for technology design issues, while Markopoulos and Bekker (2003) have looked at the developmental stages introduced by Acuff and Reiher (1997) for marketing research purposes, and applied them to the context of technology design.

According to Bruckman and Bandlow (2003), designers should pay attention to children's motor skills, consider the possibilities and challenges of using speech recognition, take the level of children's reading skills into account, think about the influences of their background knowledge (for example when choosing user interface metaphors), and ponder how to deal with children's interaction styles that differ from those of adults (e.g. in terms of curiosity, tendency to be easily distracted, and preference of working in pairs or in groups). Also Mukti and Hwa (2003) emphasize the need to think about children's interaction styles and mental models when designing applications for them. Acuff and Reiher (1997, cited by Markopoulos & Bekker 2003) have divided children's development into four stages: dependency/exploratory, emerging autonomy, rule/role, and early and late adolescence. Based on these stages that are derived from the development of children's cognitive, social, emotional, moral, and language skills, Markopoulos and Bekker (2003) have presented suggestions of the types of technology suitable for each of the groups. Furthermore, with regard to user interface design, Hanna et al. (1999) have formulated practically oriented guidelines addressing the design of activities, instructions, and screen design of children's applications.

An essential point of view related to the design of technology for children are also the differences between girls' and boys' technology preferences in terms of e.g. the types of games they prefer, the aspects of games they consider important, and the ways in which they interact with technology (e.g. Inkpen 1997; Joiner 1998; Passig & Levin 1999). However, Inkpen (1997) points out that these differences are very complex and multifaceted, and thus gender stereotypes in technology design should be taken with caution. Skills and preferences can vary a great deal between individual children depending on their previous experience (e.g. Markopoulos & Bekker 2003). Therefore, the creation of all-encompassing rules is difficult. Even though guidelines and instructions have their place as starting points of design and providers of general ideas, designers cannot completely rely upon them. Even at their best, they are apt yet rough representations of reality and the actual context is completely outside their focus (cf. Karat 1997).

Read (2005) elaborates the idea of CCI beyond merely "HCI for children" and distinguishes some specific aspects in which CCI differs from traditional HCI. Firstly, children's activities differ from those of adults in that children usually are more explorative and playful than strictly task-oriented, and even when using the same applications as adults do, they often use them differently. Moreover, children's wishes especially regarding the fun aspects of the applications may be difficult for the designers to envision. For these reasons many traditional, mainly task-based, HCI models are not well suitable for designing children's technologies. (Read 2005) Therefore CCI requires existing methods to be modified and new ways of working to be developed. CCI addresses questions related to designing technology with and for children, and adapting design or testing methods to be suitable for working with children.

Conventionally, UCD and PD have mainly been used in the development of applications intended as working tools in the office or production plants.

While many issues and goals of these approaches are directly or almost directly applicable to other development contexts as well, the different types of the applications to be developed (such as educational tools or game applications for children) present some distinctive issues that require closer examination. Norman and Spohrer (1996) define three dimensions that are essential in instruction, and consequently in educational applications; engagement, effectiveness, and viability. Engagement, according to Norman and Spohrer (1996), is a crucial source for motivation and a vital determining factor for the success or failure in accomplishing the desired learning outcomes. Effectiveness is one of the traditional usability components (e.g. ISO 9241-11, 1998; Nielsen, 1993), indicating to what extent the software enables the user to successfully complete the tasks it is intended for. In the context of educational applications, the question is how much the user learns by using the application (Norman & Spohrer 1996). Finally, educational applications need to be viable in terms of use in real situations; even if an application is engaging and effective but fails to accommodate actual contexts of use, to be feasible in terms of different kinds of conditions and boundaries set by the real world, or to be suitable for general use, it cannot be deemed successful (Norman & Spohrer 1996).

As this characterization shows, the design of educational applications requires more perspectives to be taken into account than the design of merely productivity-oriented applications. As e.g. Mukti and Hwa (2003) state, technology design for children should be based both on HCI principles and educational theories. The concept of *learner-centred design* (LCD) has been brought up as an educationally focused equivalent to UCD, combining HCI tenets and methods with educational and developmental principles (Good & Robertson 2006; Rode et al. 2003; Soloway et al. 1994; Soloway et al. 1996).

Soloway (1996; Soloway et al. 1994) has proposed a learner-centred design approach which is based on the principles of scaffolding. Soloway et al. (1994; 1996) have distinguished the growth of the learner, the diversity of learners, and the motivation of learners as the three core issues requiring attention in the development of educational applications, and they have discussed the realization of these learners' needs in the development of the tasks, tools, and interfaces of learning applications.

Rode et al. (2003) have built their curriculum-focused design approach on the principles of learner-centred design. Testing sessions are arranged in the form of structured school lessons and deal with curriculum topics; one half of the group is led by the class teacher who teaches the topic without technology, and the other half is instructed – with the aid of the technological application under development – by an educational specialist from the development group (Rode et al. 2003). When the applications being developed are meant for classroom use, it can be useful to carry out the design process in the actual school setting and with a more school-like structure, as conducting the design activities in actual conditions can produce more realistic feedback in terms of future use contexts (Rode et al. 2003). Just as working-tool-oriented participatory design needs to survive within actual organizational settings and their limitations (Kensing and Blomberg 1998), learning-tool-oriented design with children must cater for the constraints and circumstances set by the school context. Some flexibility is needed from the school's part in every case, but it is often not possible to embed very intensive design efforts into the schedules of the school. Furthermore, the interactions and collaboration patterns between classmates are more genuine than they would be between children who have not interacted with each other before (Rode et al. 2003).

Good and Robertson (2006) have proposed a framework aiming to bring the rather vague concept of LCD onto a more concrete and better-defined level. Their CARSS framework contains five main components that should be addressed in planning and evaluating learner-centred design projects: context, activities, roles, stakeholders, and skills. Different physical and virtual constraints and limitations are described in the *context* component; issues related to the people who either directly participate in the project or to whom the project otherwise holds relevance are addressed in the components dealing with *roles*, *stakeholders*, and *skills*; and the methods and techniques used in different phases of the process (requirements gathering, design, evaluation) are described in the *activities* component (Good & Robertson 2006).

4.1.2 Methods of User Involvement

The methods of user involvement in technology design processes are usually categorized in terms of three main phases: gathering initial requirements, developing and elaborating the design solution, and evaluating prototypes and the final outcome (e.g. Good & Robertson 2006; ISO 13407, 1999). In other words, in the earliest stages of design projects, user involvement methods are used in order to obtain an understanding of the use contexts and the environment in which the product would be used, as well as to learn about the users' current ways of working. In the design stage, the methods aim at inventing and elaborating ideas regarding the product. Finally, after the initial idea creation and negotiation, user involvement focuses on evaluating and giving feedback on the new technological solutions developed in the course of the project – often in the form of prototypes. Evaluation is carried out continuously, in accordance with the iterative nature of the process (e.g. ISO 13407, 1999). All these phases are tightly intertwined, and it is often not possible – nor necessary – to make a clear distinction between the different types of methods. Evaluation methods, for example, can be needed already in the very beginning of the project if users evaluate existing software in order to gather information on their pros and cons to help in the development of the new application. Similarly, a particular method can often both provide insights into the current situation and help create ideas and solutions for improving them.

The field of human-computer interaction (HCI) offers methods for the different phases of the process. Various methods for gathering initial requirements and generating ideas for the application are found especially from participatory approaches, whereas usability research has offered methods for the evaluation phases, in the form of different usability evaluation methods. In this subsection, the aim is to give an overview of general user-centred methods as well as those applied to the design of children's software according to the principles of learner-centred design and child-computer interaction. In the following overview, I have divided the methods into two categories: requirements gathering and idea generation methods are viewed as one group, and evaluation methods as the other.

Requirements Gathering and Idea Generation

Requirements gathering and idea generation methods can be grouped according to their type in the following way: 1) ethnographical and observation-based methods, 2) verbal, narrative, and drama-based methods, 3) documentation with photographs or in writing, 4) drawing, low-tech prototype creation, and other hands-on or art-based methods, and 5) task modelling and game-like methods. The overview includes both more general methods and those specifically designed to be used with children.

Firstly, methods based on **ethnography and observation** have been used in the initial stages of participatory projects. The aim of using ethnographic or ethnography-derived methods in participatory design is for the designers to learn about the users' actual work environment by participating in their everyday activities and by studying them through observation and interviews (e.g. Blomberg et al. 1993; Crabtree 1998). Ethnography-influenced methods such as *Contextual Inquiry* (Holtzblatt & Jones 1993) and the *workplace visits* included in the Cooperative Design methodology (Bødker et al. 1993) have largely the same aims and utilise ethnographical data gathering methods. With the workplace visits, researchers aim to develop an understanding of the users' work conditions by interviewing and observing them (Bødker et al. 1993). Contextual Inquiry, in which users are interviewed while they are performing their typical tasks, is founded on the assumption that the underlying meanings of the things users talk about are not necessarily fully communicated to the researchers without concrete examples (Holtzblatt & Jones 1993).

Druin et al. (1999) have applied Contextual Inquiry with children: in their method, children use existing software while they are being observed and asked clarifying questions. This differs from the original Contextual Inquiry in that there are separate interactors (who ask questions and discuss with the users) and note-takers (who observe and record the sessions) in order to make the children who are observed feel more comfortable. Both adults and other children may be in the role of interactors and note-takers, which has been seen as successful because notes taken by children may reveal things that have remained unnoticed by the adult note-takers. (Druin 1999; Druin et al. 1999) Also according to Jones et al. (2003), *observing children as users of existing technology* has provided a great deal of valuable information to guide the initial stages of design and the production of the first prototypes. It has helped the designers understand children's ways of interacting with the technologies, uncover problems, and start developing solutions based on observations of the children's preferences (Jones et al. 2003).

The second category entails **verbal, narrative, and drama-based** methods. When there is a wish to uncover the users' views and ideas, methods to encourage them to express and verbalize their thoughts are needed. The use of *interviews* is one of the most commonly used research strategies for collecting information about a certain area of interest; semi- and unstructured interviews are a useful method when issues need to be explored and new ideas generated (see Fielding 1995). However, interviewing has some significant drawbacks. Firstly, people might have trouble putting their thoughts into words (Fielding 1995). This is an important consideration especially when the interviewees are children and the topics deal with abstract concepts (Druin 2002; Hanna et al. 1997). Secondly, people might try to rationalize their actions and opinions, or to be over-polite to the interviewer and provide answers they think (s)he wants to hear (Fielding 1995). Again, it is particularly true with child interviewees; the age, gender, or other attributes of the interviewer potentially have an effect on the children's answers (e.g. Read & MacFarlane 2006). *Group settings* are one way of making the interview situation more comfortable for children. Group interviews are also quicker and less costly, and an additional advantage is that group discussions can help participants build on each others' comments and ideas (e.g. Fielding 1995). This is an especially beneficial aspect of group discussions regarding the creation of ideas for new technology. According to Druin et al. (1999) collaboration is beneficial in terms of creativity as the children have a chance to share their experiences and skills with other children.

Specific methods have been developed for children, in order to ease their verbalization and to support the description of current situations and new design ideas. One example of these is a requirements gathering method especially aimed for children, called *Mission from Mars* (developed by Dindler et al. (2005) and further elaborated by Verhaegh et al. (2006)). The idea is to encourage children to verbally express how they see their current practices and what kind of preferences they have by having them tell their views regarding the contexts in question to a "Martian" who does not know much about life on Earth (they have e.g. described the contents of their school bags and explained why playing and games are fun). The fundamental idea of the method is to get the children to express things they would not tell in ordinary interviews because they would feel that these issues are too self-evident. (Dindler et al. 2005; Verhaegh et al. 2006) Children themselves have also acted as *interviewers, both for other children and for adults*. In KidReporter (Bekker et al. 2003), children have interviewed one another, both by using ready-made questions given to them and by asking their own questions. According to Bekker et al. (2003), the goal of this approach is to make the interview questions understandable to the children.

Another verbalizing method to support the exploring of requirements, possible use situations, and design ideas is the use of *storytelling methods*. Muller (2003) lists three ways in which stories have been used in the context of participatory design: prompting and triggering conversation and feedback, exploring the users' views about what the product should do, and presenting design concepts and solutions. Moreover, *drama-based methods* have been used to act out current work or to envision future possibilities in different contexts (e.g. Brandt & Grunnet 2000; Brandt & Messeter 2004; Ehn & Kyng 1991; Iacucci et al. 2000; Svanæs & Seland 2004). According to Brandt and Grunnet (2000), although engaging in a drama-based activity requires some courage from the participants, the use of drama appears to create a common ground for the users and designers, and to make it easier for the developers to understand and relate to the users' environment. There are also examples of having professional actors present scenarios to users (Salvador & Howells 1998; Sato & Salvador 1999). This is said to enable the users to comment on products that do not actually exist yet, by presenting them with live examples and situations (Salvador & Howells 1998).

To conclude, storytelling and role play are particularly useful in technology design either in order to explore current and future tasks and work practices, or to flesh out content ideas e.g. for a game or a game-like environment. The narrative nature of these methods promotes content-related idea generation, such as coming up with or refining a game idea, plot, or characters.

Thirdly, in addition to the different variants of observational and verbal methods, successful efforts have been made to explore requirements and ideas by **documentation techniques**, based on pictures or writing. These have been used especially in projects carried out with children. In KidReporter (Bekker et al. 2003), for instance, children have *taken photographs, interviewed each other, and written "newspaper articles"*. This method focuses on the contents rather than on the functions or the layout of the application; it aims at discovering which aspects of the topic area arouse interest in the children and in what kinds of ways they want to explore the topics. (Bekker et al. 2003)

In a similar manner, Oosterholt et al. (1996) have collected information about possible use contexts for a new product through *photo diaries*. In this method, children are asked to take photographs of the environment in which they would use the new product and to write scenarios of situations involving the product. Photographing has been used also in an adaptation of the aforementioned Mission from Mars method: children took pictures of their favourite games and created *photo collages* of them (Verhaegh et al. 2006). Verhaegh et al. (2006) point out that making a collage is a useful addition to interviews related to a rather abstract topic. The use of documentation with photographs is still a rather new method in the field of PD (Muller 2003). However, Muller (2003, 1058, italics in original) describes it as a "*[r]icher, contextualized communication medium* between end-users and designers" and sees it as having potential in design contexts.

The fourth category entails hands-on activities for generating ideas, such as **drawing, low-tech prototype creation, and other art-based methods**. An essential part of the UCD process are prototypes – both low-tech and functional. The creation of *mock-ups and low-tech prototypes* using ordinary office supplies and other simple objects aims at providing all participants, regardless of their technological skills, equal possibilities to communicate their ideas and discuss different solutions (e.g. Muller 1992; Beyer & Holtzblatt 1999; Spinuzzi 2002).

Furthermore, when working with children, creating mock-ups using low-tech materials gives the children and adults equal possibilities to express themselves (Druin 1999, 2002; Druin et al. 1999). Mock-ups concretize ideas and give the users a hands-on experience of the solution (Bødker et al. 1993). However, one major challenge of low-tech prototyping – observed e.g. in the use of the PICTIVE technique (Tudor et al. 1993) but applicable to the approach in general – is that design sessions sometimes tend to go too quickly onto a detailed level while more general questions are paid less attention.

When working with children, ideas have been gathered with the aid of individual drawings (Bilal 2003; Scaife & Rogers 1999) or by collaborative low-tech prototype creation (Druin 1999, 2002; Druin et al. 1999). The rationale for having children *create drawings* is a wish to allow children to design something new instead of just reacting to existing suggestions (Bilal 2003). However, there are challenges related to the use of individual drawings. Firstly, as Scaife and Rogers (1999) point out, children often tend to pay a great deal of attention to details of their drawings while overlooking the bigger picture, i.e. what the objects in their drawings do and how they behave. Secondly, despite the assumption that expression by drawing or with the aid of low-tech prototyping tools is easy and natural for the children, they might have problems with designing. The more abstract the goal of the design project is, the more difficult it may be for the children to make a connection between their low-tech creations and the final product. For example, in the study of Jones et al. (2003), children had difficulties understanding the idea of drawing things that would be seen on the screen. When they were given hints and suggestions about specific screens, they drew them, but otherwise they only drew random pictures that were in some way related to the topic area (Jones et al. 2003).

One possible method for aiding users and designers to arrive at creative solutions at various stages of the development process are scenarios, which can be used from the very first field visits to prototype testing. In the idea generation phase, scenarios can serve as a starting point for design workshop activities, allowing the participants to express their ideas and relate them to real work situations (Bødker 2000). When working with children, picture-based *storyboards* can be used instead of or in addition to text-based scenarios. With storyboards, ideas for use situations or content-related attributes can be expressed in a style that resembles comic strips (e.g. Hall et al. 2004). The comic-strip-like structure allows for the expression of both temporal and spatial relations (Hall et al. 2004), and can thus be seen as especially well suitable e.g. for creating ideas for game storylines. Jones et al. (2003), however, point out that storyboarding the use of a technological application may be difficult for children as they might not understand the idea of linking different screens together.

Finally, requirements have been gathered through different **task modelling methods and game-like design methods**. One means of idea generation that frequently appears especially in work tool oriented participatory projects is the use of various methods of modelling the users' tasks and work flow. For example, in Cooperative Design, observations made during workplace visits can be addressed in more detail in collaborative *"future workshops"*. These workshops aim at bringing out the problems of current work and generating solutions to them (Bødker et al. 1993). Another approach with similar objectives is the use of *game-like methods*. In organizational games, users and designers describe different ways of organizing tasks and create solutions to problems related to these work practices in a fun and interesting way (Bødker et al. 1993). Ehn and Sjögren (1991), for example, have developed game-like methods for modelling both the physical working environment and the work flow. Brandt and Messeter (2004) have applied different game-like design methods in several projects. They describe a set of four different design games to be used at different phases of the design process to create potential user stories and situations, explore possibilities for technologies for different situations, and to combine these (Brandt & Messeter 2004).

The paragraphs dealing with art-based methods discussed methods utilizing basic materials used in arts and crafts. Another perspective to low-tech prototyping is the use specific, ready-made objects specifically developed for the purposes of modelling the behaviour of different objects and the flow of tasks. An example of this approach is *PICTIVE*, a low-tech prototyping method developed by Muller (1991, 1992). In addition to regular office supplies, there is a set of plastic objects representing icons, windows, and other user interface elements – these can be either generic or specifically prepared for the design of the particular application at hand (Muller 1991). A supplementary method to PICTIVE is *CARD*, in which the flow of the user's task is modelled with playing cards, each depicting a work-related activity, object, person, interaction situation, or mental operation (Tudor et al. 1993; Muller 2001). Using modelling methods is one way of keeping the design from going onto too specific a level too early (Tudor et al. 1993). With children, Scaife and Rogers (1999) have used a method with an equivalent idea as in PICTIVE. Children were provided with laminated pictures of the items that would be included in the application being developed, and they could manipulate their behaviour by moving them against a background (Scaife & Rogers 1999). According to Scaife and Rogers (1999), this was a successful way to direct the children's attention to the behaviour of the objects instead of their appearance, and thereby avoid problems related to children's tendency to concentrate on details when asked to depict their ideas by drawing.

Evaluation

In addition to requirements gathering and design, evaluation of the outcomes plays a considerable role in user involvement. When evaluation is conducted with children, in general the same principles apply as with adults but the methods need to be adapted to correspond to the children's developmental level (e.g. Hanna et al. 1997). According to the general principles presented by Hanna et al. (1997), this can be done e.g. by simplifying instructions, pacing the sessions to suit different attention spans, and paying attention to making the situations comfortable.

Gediga et al. (2002) have classified evaluation methods as either descriptive or predictive. Evaluation taking place in the course of user-centred development projects can be classified as descriptive. Descriptive evaluation involves users in the evaluation, aiming to uncover actual problems in the application to be developed, while predictive evaluation is usually performed as expert evaluation and aims to create more general guidelines and recommendations for future applications (Gediga et al. 2002). Descriptive evaluation can be further classified into behaviour-based (or behavioural) and opinion-based (or attitudinal) evaluation, and it also entails usability testing – which usually combines both behaviour- and opinion-based methods (Gediga et al. 2002; Pagulayan et al. 2003). Issues related to behaviour- and opinion-based evaluation will be discussed below. Additionally, I want to emphasize another particular perspective to evaluation, namely field trials of the application conducted in natural settings.

Behaviour-based evaluation methods are based on recording and analyzing the users' behaviour when (s)he is performing a task with the aid of the technology under evaluation (Gediga et al. 2002; Pagulayan et al. 2003). According to Holzinger (2005), *think-aloud* methods are probably the most important ones in this category because they enable the researchers to understand how the users see the system. However, Wildman (1995), for example, points out problems related to individual think-aloud methods and suggests *paired-user techniques* as an alternative to them. Thinking aloud combined with *observation* has been found useful also in usability tests in the field (Nielsen 1998).

With children, thinking aloud and other methods that require much verbalization have been found to be the most successful methods (Baauw & Markopoulos 2004; Donker & Markopoulos 2001). A study by van Kesteren et al. (2003) discovered that the *active intervention* method, in which children are asked questions while using the software, elicited the most verbal comments. Interestingly, it was also found that the co-discovery method, in which children work in pairs and talk about their actions together, does not automatically work as well as assumed because the children do not necessarily communicate with each other very well (van Kesteren et al. 2003).

In some methods the users are in the role of passive objects of observation, whereas other methods emphasize their active participation. When the aim of the design process is to reach genuine user involvement, the collaborative nature of the interaction between the users and the developers ought not to be discarded at this point of the process either. Buur and Bagger (1999) talk about *user dialogue* instead of usability testing and suggest some procedures that promote more informal and interactive ways of conducting usability evaluations with users. For instance, they promote a more active role of the test facilitator instead of being purely an observer, which is in accordance with the success of the active intervention technique with children (Buur & Bagger 1999; Van Kesteren et al. 2003). Buur and Bagger (1999) also point out that test sessions should become more workshop-like. Collaborative workshop approaches (e.g. Oosterholt et al. 1996) are likely to be successful also in projects carried out in collaboration with children, allowing them to cooperatively assess the outcomes.

As regards the importance of acknowledging the context and actual tasks, *scenarios* have been used as an aid also in usability testing. Users are given scenarios of typical tasks, and they perform their actions in response to the tasks presented in the scenarios (Bødker 2000). According to Bødker (2000), this gives the researchers information about e.g. how the new solution and the users' normal ways of working fit together.

Researchers have also developed usability evaluation methods especially for children. One such method, adapted from educational sciences, is *peer tutoring* in which one child teaches another how to use a product. Peer tutoring (Goodlad & Hirst 1989; Greenwood et al. 1989; Topping 1988) has been applied to usability testing context by Höysniemi et al. (2003). They have discovered that the method promotes children's communication with each other during the task.

Another group of evaluation methods is the category of **opinion-based methods**, including e.g. questionnaires and interviews (Gediga et al. 2002; Pagulayan et al. 2003). Opinion-based methods allow the developers to gain insight on the users' subjective opinions, something which is not in a considerable role in the behaviour-based methods (Gediga et al. 2002). Verbal comments can bring out explanations and rationales for issues that behaviour-based methods may reveal but not fully explain.

Issues dealing with *interviews* have already been discussed above. Some additional issues, related to interviewing children in technology design projects, have been pointed out e.g. by Hanna et al. (2004) who have found that talking informally about children's opinions and reasons for their preferences is a more effective method of evaluation than presenting specific questions (Hanna et al. 2004). Some tradeoffs between *interviews and questionnaires* are mentioned by Gediga et al. (2002). For instance, interviews and questionnaires require different amounts of time and effort at different stages of their use: developing a questionnaire is more time-consuming than planning an interview, but on the other hand, in the carrying-out and analysis phases the situation is the opposite (Gediga et al. 2002). Rode et al. (2003) suggest that it is useful to gather opinions from children both in the form of written and oral feedback. According to them, the use of written questionnaires can help avoid the social pressure making children inclined to conform to the group opinion. On the other hand, having an oral feedback session afterwards acknowledges the fact that children may prefer to say rather than write their opinions, while also giving them a chance to talk about the issues with each other and to build on each others' comments. (Rode et al. 2003)

For the evaluation of children's applications, Read and her research group (see Read et al. 2002; Read & MacFarlane 2006) have developed a specific *fun-measuring method* which is partly based on the use of smiley faces. The method has helped children express their opinions on different aspects of fun in the software under evaluation (Read et al. 2002). It has also appeared more successful to ask children to compare different alternatives than to rate each of them individually on a scale (Hanna et al. 2004; Read & MacFarlane 2006).

Drawing has been used as an aid also in evaluation. Andersen (2002) employed a drawing-based method to study how children understood the idea of an educational application: children used a prototype and, after the use, drew pictures of the elements they considered important in the software and explained their drawings in words. According to Andersen (2002), the drawings act as representations of the digital material, as reflected-upon and verbalized expressions of the playing experience, and as focus objects for communication. Analyzing the drawings reveals how children understand the application and how it could be improved.

Finally, it is worth raising **field trials** as a category of their own. Though user-centred design and participatory design emphasize the importance of understanding the context, there are clear shortcomings in how the real context and the actual use situations are addressed in the evaluation phase. Ethnography-based methods are often suggested to be used in the gathering of requirements *before* starting the actual design process, whereas the evaluation and usability testing carried out *during* the process usually take place more formally, in laboratory settings (Dray et al. 2002). Carrying out the evaluation in the users' own environment and matching test tasks with the users' real goals affects significantly how they experience the situation and the application under evaluation (Kantner et al. 2003). Nielsen (1998) points out that field usability testing enables more realistic tests in terms of understanding the use context. In other words, the value of field trials lies in their ability to reveal how the users really use the product. Potential ways of using the application can be explored already early in the project through e.g. ethnography-based methods, but the accuracy of the implementation of these observations cannot be verified if the real environment is then disregarded at later stages of the process. For these reasons, it is essential to bring the evaluation of the designs into the actual context where the final product is ultimately going to be used.

Due to its qualitative nature, this type of evaluation is best suited for identifying problems instead of measuring performance (Kantner et al. 2003; Rode et al. 2003). However, when the applications in question are learning tools, they also need to be more formally evaluated from the educational point of view; in other words, their effect on the users' learning needs to be studied (cf. Rode et al. 2003). This highlights the need for another type of field trials: the effectiveness of the learning application is assessed and measured in actual classroom use. As Rode et al. (2003) point out, it is essential to verify the usefulness of the application in terms of the requirements set by the curriculum.

To conclude, field trials have two key goals. Firstly, throughout the design process, evaluating design ideas and prototypes in the actual use context can provide more realistic responses and richer feedback and development ideas. Secondly, in the final stages of development, field trials are necessary in order to assess the actual effectiveness of the application in terms of learning outcomes.

4.1.3 A Summary of the Principles and Methods

This section has dealt with different approaches to user involvement and the methods used to involve users – adults and children alike – in technology design. The aim has been to lay the basis for applying user-centred methods and practices in the Talarius project. As a conclusion, I summarize the main points brought up in this section and briefly discuss their implications to the Talarius project.

User-centred and participatory design originate from workplace contexts and from projects conducted with adults in the design of productivity applications. In order to accommodate these approaches to the needs of child participants, principles from educational sciences and psychology have been referred to, broadening the scope into such approaches as child-computer interaction and learner-centred design. The goal of these approaches has been principally to address the developmental level of the children and their needs related to learning.

While the involvement of users is often limited to the later stages of the design process in the form of testing prototypes and final products, especially participatory design has been calling for earlier and more diverse user involvement. In this chapter, I grouped the methods and practices used in the involvement of users into those aiming to 1) gather requirements and generate ideas and 2) provide feedback on prototypes and final products. Especially in the former category, the methods are quite varied, including methods based on observation, verbalization of ideas (ranging from basic interviews to narrative and drama-based methods), documentation of everyday life, task modelling, and creative art-and-crafts-based methods. As a general conclusion, based on the experiences documented in research literature, methods entailing concrete activities and encouraging the use of fantasy have been emphasized in projects conducted with children.

In terms of the evaluation of technology, on the other hand, the variety of methods is not quite as wide-ranging as in idea generation. Using the terms of Gediga et al. (2002) and Pagulayan et al. (2003), these methods can be divided into behaviour-based and opinion-based. In the former category, the focus is on gaining information on the users' performance when interacting with the application, while the latter is interested in their subjective opinions. To summarize the experiences related to different behaviour-based methods with children as participants, active interaction between the user and the facilitator – or, on the other hand, between the user and other users – is in a crucial role. Also in terms of the opinion-based methods, informal communication has been emphasized. Moreover, as regards evaluation, I have raised field trials as one additional category although they can include both behaviour- and opinion-based methods. However, as acknowledging real context is one of the cornerstones of user participation, field trials play a central role in it.

The process of user involvement in the Talarius project will be addressed in more detail in the following section, but based on the issues pointed out above I will conclude with some of the key implications of the issues discussed in this section on the process of the Talarius project on a general level. Firstly, it is essential to involve the children from the beginning of the project, and creative methods entailing concrete activities should be used in the idea generation phase. Second, it is worth carrying out the activities in as natural settings as possible. Especially as the application to be developed is intended for school use, design and evaluation sessions carried out in the actual classroom context (both in terms of the physical space and the structure of the use situations) have a potential for informing the developers about important issues related to the use of technology in classrooms, as a part of normal school work. Finally, despite being school-based, the collaborative approach should be adequately informal in order to encourage the children to voice their opinions and to participate actively in the different phases of the process.

The following section presents the results of the Talarius study.

4.2 The Perspectives Put into Practice: Case Talarius

Above, I have discussed the background principles of user involvement from the points of view of both HCI and its expanded, more child-focused variations (CCI and LCD) as well as reviewed methods that have been employed in projects aiming to involve users (adults or children) actively in the design process. In this section, I present a case study in which these views are applied in practice in the development of a game-based educational application. This first development research cycle of this study was carried out in the development of Talarius 1.0, a pilot version of an educational board game design environment for children.

After a general introduction of the project (Subsection 4.2.1), the results of the study are presented. Subsections 4.2.2 and 4.2.3 deal with the process-related research questions: the former describes the participation methods used in the project and the results related to them, and the latter presents the results related to the collaboration and the functioning of the team. The following sections focus mainly on the research questions related to the realization of the goals of user involvement. In Subsection 4.2.4, the focus is on how user expertise was sought in and brought into the process and how the actual use context was addressed. Subsection 4.2.5 discusses empowerment and influence from the children's point of view, while Subsection 4.2.6 presents the results of the analysis of how the users' ideas manifest in the outcomes as well as the children's experiences on whether the application met their expectations. Finally, in Subsection 4.2.7, the results are summarized and their inferences for the second development research cycle, namely the Virtual Peatland project, are brought forward.

4.2.1 The Talarius Project

The aim of the Talarius project was to build a software application with which children could create and play their own educational computer-based board games. The goal was that Talarius would allow the children to create questions and a game board, and to play these games. The application would not be content-specific, hence the topics of the games made with it can be related to any school subject or topic area. In the Talarius 1.0 project, the goal was to develop a pilot version of the application which would explore the necessary functionality and enable early evaluations and field trials, thereby serving as a basis for the development of the actual application. The development was need-driven in the sense that the project idea originated from a need observed in real school work. The idea for the application to be developed came from an elementary school teacher who had had her class design "traditional" board games out of paper, cardboard, and other art supplies. These creations formed the basis of the project and initiated the idea for developing a computer-based board game design tool. The pilot project took place in the academic year 2003-2004.

Participants

The Talarius project was carried out as a collaborative effort between the Agora Game Lab (Agora Center, University of Jyväskylä) and a group of students of information systems sciences (Department of Computer Science and Information Systems, University of Jyväskylä) who implemented the pilot application as course work for a project work course. There were five members in the developer group. Moreover, the development project involved a computer science student who designed sound effects and music for the application, and teacher students who provided insights about the educational goals of the application.

As user participants in the project were the children and the teacher of a fifth-grade school class, the children being approximately 11 years of age at the time of the project. When it comes to the selection of the participants, the class that was already familiar with the topic of the project was asked to participate. In other words, the class that had designed the paper board games that formed the basis of the whole project was a natural choice to be asked to be involved in the project. There were 23 children altogether in the partner class, 12 boys and 11 girls. Except for one new student, the class consisted of the same children who had created the paper board games in the previous school year.

In addition to the principal partner class, other children were involved on a one-time basis at different stages of the process. During the active development process, a parallel class of the partner class participated by testing a prototype and providing feedback. In the parallel class, there were 25 students. After the pilot version of the application was finished, another school class (fourth-graders) and two kindergarten groups participated in field trials. In the school class participating in the field trials, there were 21 students altogether, while in the kindergarten field trials, 8 children and 4 kindergarten teachers from two kindergartens participated.

Data Collection

In the course of the Talarius project, both the children's and the developers' experiences on user participation were collected, and it was also documented how the activities proceeded from the researcher's point of view. Data were gathered with the aid of questionnaires, interviews, and documents, as well as research journals describing the design and evaluation sessions and discussing the proceedings of the project in general (see a table listing all the data in Appendix 1).

Children's experiences were gathered by two questionnaires: one halfway through the project (Appendix 3) and another after the project (Appendix 4). In addition to these, the children's comments and statements during the participation activities were noted down in the field journal. The role of the first, less extensive questionnaire was to bring forth the most important issues about participation and thereby give directions for composing the second, broader questionnaire. The first questionnaire entailed four open-ended questions addressing both the children's opinions on the application and their experiences related to the participation in the process.

The final questionnaire was composed based on the conceptual framework of the study and the research questions derived from it, on the one hand, and on the need to clarify some observations made during the process, on the other hand. The questionnaire consisted of two parts. The first of them included 20 agree/disagree statements (on a scale from 1 to 5) about design participation, and each of the statements was followed by an open-ended question prompting the children to explain their answer in more detail. Ten of the questions dealt with the participation methods used in the project, and ten were related to the children's more general experiences from the project. The method-related questions addressed 1) interviews about the board games made by the children, 2) drawing of user interface (UI) models and interviews accompanying the drawing session, as well as 3) evaluating the prototypes. As the emphasis in the project was to a rather large extent on the evaluation of prototypes, most (7 out of 10) of the method-related questions dealt with the testing sessions – the nature of the sessions in general (fun, boring, easy, difficult), the clarity of the tasks and instructions, working in pairs, and being able to concentrate on the evaluation tasks. Several of these questions were formed based on observations made during the evaluation sessions, with the aim of shedding more light on the issues observed. The other ten questions were related to the experience of participation more generally, especially on the motivation of the children to be actively involved in the project and their feeling of being able to have a say in the process.

The second part of the final questionnaire consisted of six additional open-ended questions related to the same themes as the statements in the first part. The children were asked about the interesting as well as difficult aspects of the participation process, and about the ideas they had suggested in the course of the project and whether they felt that these ideas had been taken into account. Moreover, they were asked about the use and further development of the application: whether they had ideas for the further development, how they would like the application to be used in class, and what kinds of games they would like to create with the application.

The developers were interviewed twice in the course of the project (Appendix 5). At the beginning of the project they talked about their expectations. They were asked about their general thoughts regarding having children as participants in the project and how familiar they were with the concepts of user involvement or participatory design. Moreover, they were asked about the starting points of the project and how they began to plan the project process. This interview took place right after the session where the children drew the UI pictures, and therefore another crucial theme addressed in the interview were the ideas obtained by the developers from this session.

Later, in the second interview (conducted as an e-mail interview) the developers discussed the issues they had found most useful or most challenging about the children's participation. They were asked about the most successful aspects of the project thus far, as well as the most problematic ones. Furthermore, they were asked about their experiences about the evaluation sessions conducted with the children, how the outcomes of the sessions had influenced the design of the prototypes, and whether the children's feedback had revealed any surprising or unexpected issues.

Establishing Children's Involvement: Background Principles and Practical Considerations

The project was built upon the notion of having the actual users as participants. This approach was adopted for several reasons. Firstly, the participation of children was anticipated to bring useful insights. Children are the experts of their own life; they are the ones who know best what interests them, what they find uninspiring, and how they learn new things (Druin 2002; Scaife & Rogers 1999). Hence, similarly as any other domain expert participating in a design process, children bring experience from their own areas of life into the process. Moreover, as seen in the literature review, user involvement in general has been seen to bring significant benefits to the development of new applications, especially with regard to satisfaction with the product (e.g. Kujala 2003).

Secondly, it was considered important to conduct the project in collaboration with schools. User-centred and participatory design heavily emphasize the importance of taking the context into account in order to ensure that the application fits the actual use situations and tasks (e.g. Karat 1997; Kensing & Blomberg 1998). As pointed out in the literature review, carrying out design and evaluation sessions in the actual context enhances the realism and accuracy of design suggestions and evaluation feedback, as the real environment makes it more natural to think about the application in terms of actual use situations. Except for two special occasions, the design and evaluation sessions took place in the school, either in the children's own classroom (in the case of the drawings and interviews) or in the computer lab (in the evaluation sessions), within the time frames of school lessons. The two sessions not taking place in the school were the first prototype evaluation session and the final feedback session (see Figure 11) which took place at the university. These events were organized at the university, firstly, in order to give the children a chance to see where the developers worked and provide them with slightly different evaluation sessions from those conducted at school, and secondly, to have more computers available than there were in the school computer lab.

Some practical issues presented their constraints to the process and to the methods used. As the activities with children took place for the most part in school, this had to be taken into account when planning the structure of the sessions. For example, the schedules and lesson schemes of a basic school day determined the length of the sessions. In practice, a session could last either 45 or 90 minutes. Moreover, all the children in the class needed to be able to participate in the activities at the same time. Most often this meant that the whole class did the activity at the same time for 45 or 90 minutes or, alternatively, one half of the class first participated for 45 minutes and the other half for the next 45 minutes. This was the case especially in evaluations that were conducted in the school computer lab. On the other hand, this constraint was a contextual trait inherently related to the school-based approach chosen to be adopted in the project.

Another issue setting limitations for the process was the structure of the project work course within which the development of the pilot application was conducted. For educational reasons, the project emphasized project documentation rather heavily, and documentation-related tasks were a significant consumer of the developers' time resources. Therefore, the time required for planning, performing and analyzing the outcomes of the activities carried out with users needed to be minimized.

4.2.2 Participation Methods and Activities

This subsection presents the structure of the process and the methods that were chosen to be used during the Talarius 1.0 project to involve children in the process, and the results related to the different methods. When and how the children participated is illustrated in Figure 11.

As the figure shows, during the active development phase – shown in the upper part of the figure – the development team worked principally with the partner class, augmented with one additional evaluation session with their parallel class (marked with a grey box in the figure). At the beginning of the project, the children of the partner class were interviewed about their previously created board games. They also made user interface drawings and were informally interviewed while drawing. The drawings and interviews were used as a basis for different user interface alternatives which the children then evaluated and critiqued. This was followed by the evaluation of two different

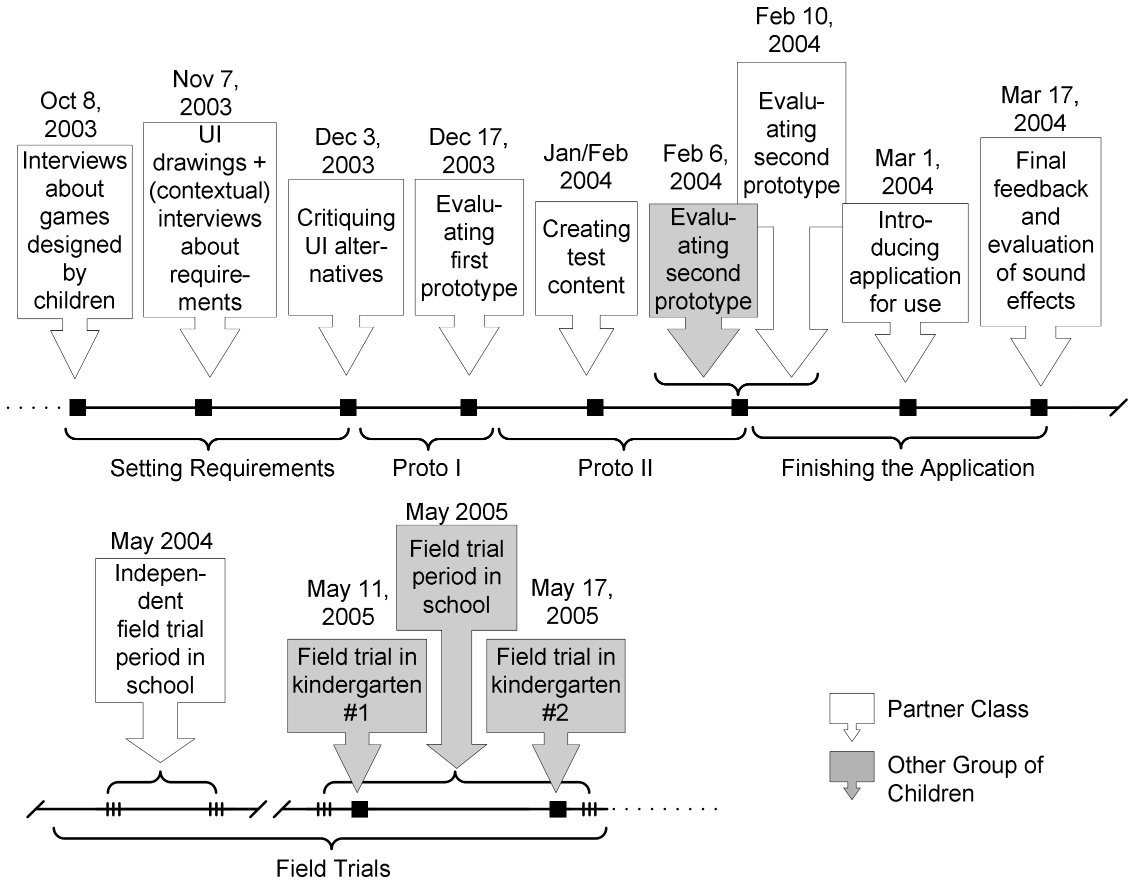

FIGURE 11 Children's involvement in the Talarius project

prototypes, the latter of which was evaluated with their parallel class as well. The partner class also created contents (a series of questions) to be used in the latter testing. At the end of the active development phase, there was an informal "launch session" in which the children used the finished pilot version. Finally, there was one more session, in which the children gave feedback for future development and evaluated the sounds of the application. After the pilot version of the application was finished, the partner class continued to participate in the form of a classroom field trial period later in the spring (lower part of the figure). Besides them, additional groups were brought in as participants of field trials in the following year: a class of fourth-graders from the same school conducted a field trial period with the application in actual classroom use, and the application was also evaluated by children and teachers in two kindergartens.

We can roughly categorize the methods and activities of user involvement that were employed in the project into 1) requirements gathering and idea generation, 2) evaluation sessions during the active development phase, and 3) field trials with the finished application. Below, the structure of this subsection follows this categorization.

Requirements gathering and idea generation

Here, the methods used for gathering requirements and creating ideas for the Talarius application with the children are described and the results related to these activities are discussed. Two methods are addressed: firstly, the interviews about the board games the children had made in class in the previous school year, and secondly, the user interface drawings and the interviews related to them.

At the very beginning of the process, the children of the partner class were **interviewed about the traditional board games** they had created in class. In the interviews, the children presented their games to a researcher. They briefly explained the rules of their games, how they had come up with the ideas for their games, and what the games aimed to teach the players. They were also asked to describe what had been the most fun in the making of the game or, on the other hand, what had been difficult. Finally, they were asked whether they would do something differently if they now had a chance to redesign their game. The aim of these interviews was to gather background information about the children's views regarding the topic and to get early signposts as to what the application ought to include. Most of the games were board games but there were some memory games as well. Some examples of the games are shown in Figure 12.

FIGURE 12 Examples of the children's games

The games as such were seen as a potentially very useful source of ideas to guide the early phases of development, but it was also considered important to have the children themselves present their games. In this case, asking the children to present their games was seen as necessary for several reasons. First of all, analyzing the games alone would not have been able to convey all the relevant issues (e.g. the rules were not explicitly explained in writing in all the games). Secondly, analysis of the games without the additional information provided by the children in the interviews would have been very time-consuming and amenable to misinterpretations. Moreover, it was felt that this would be a good way to introduce the project to the children and make them part of it by providing them with a chance to be experts right away, talking about their own creations that were the basis of the whole project.

The interviews about the games were conducted by me, before the actual developer group was formed, but the interview transcripts were given to the developers to serve as background information. The interviews gave especially an overview of what the children had been thinking while designing the games and what kinds of challenges they had encountered in the game design process. To summarize the outcomes of the interviews, the children had generally enjoyed the making of the games, and especially the hands-on activities entailed in the game creation process (such as drawing, colouring, cutting cards or game pieces, and writing). Other enjoyable aspects of the task included the planning of the rules or the idea of the game, and thinking up questions or tasks for the players. Moreover, one child especially emphasized that it was important to be able to make the game exactly the way she wanted.

On the other hand, while the concrete activities, such as drawing, were liked by the majority of the children, for some of the children the same methods were the most difficult part of the game-making process. This may boil down to the laboriousness of the tasks, similarly as with another aspect considered difficult by the children, namely having to make a big selection of questions for their games. An interesting issue surfacing in the interviews was that it appeared to have been difficult for the children to assess the appropriate level of difficulty. Some children brought up that they had been required to add some additional elements in the last minute to their otherwise finished games to make them more challenging, while some children had noticed that their games were too difficult when others had tried to play them. A potential reason for this is that the learning goals were not necessarily very clear to the children; it was difficult for them to estimate what kind of a game would be useful in terms of learning. However, when the children were asked whether they would have wanted to change something about their games, most stated that they would not change the basic idea of their games, but would adjust aspects such as the level of difficulty or the length of the game.

During the children's interviews, it was observed that the children seemed to consider it somewhat difficult to describe their games. To address this observation more closely, the children were asked in the final questionnaire at the end of the project whether it had been difficult to describe the games in the interviews. A graphic presentation of the answers is presented in Figure 13.

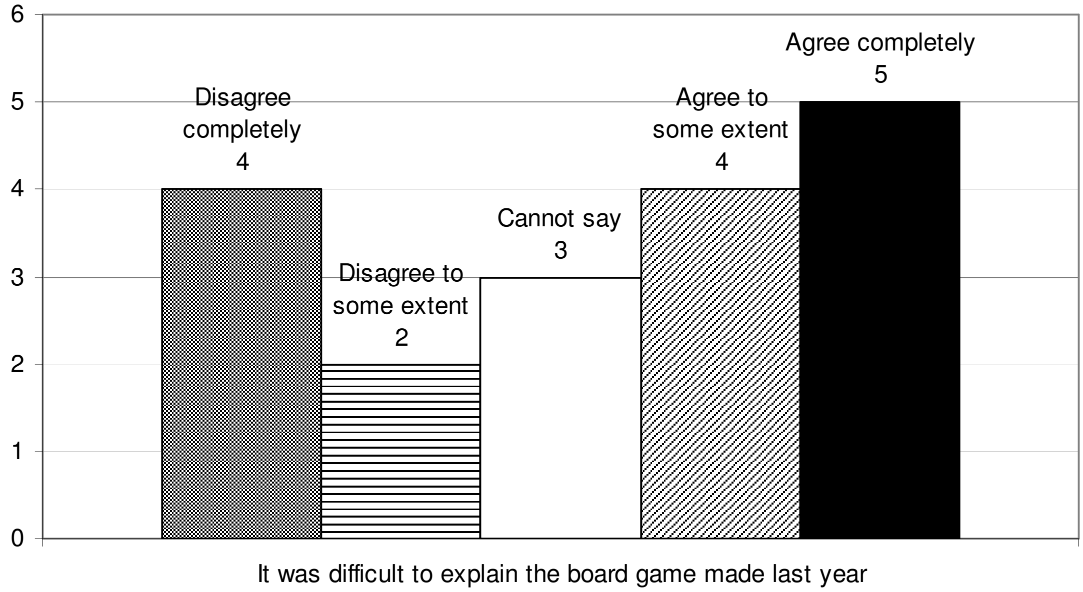

FIGURE 13 Thoughts about the board games and related interviews

As the figure illustrates, the distribution of children's opinions regarding the interviews was considerable. Some children stated that it had been very hard to talk about their games – the board-game related interviews were conducted several months after the time when the children made the games, due to which it was difficult to remember the ideas of the games and the thoughts they had had while designing them, and to explain these issues. On the other hand, others could not even think of what might possibly have been difficult about the interviews: "you just told about [the game] and that's it".

> It was a bit hard, yeah. I couldn't really come up with anything to say [about my game].
>
> It was difficult to explain because I didn't remember it.
>
> It was easy because you had made [the game] yourself so it was easy to tell how you had made it.
>
> Wasn't difficult, you just told about it, and that's it.

Several of the children (5 out of 23) skipped this question altogether because they did not remember the interviews anymore, or had not participated in them in the first place e.g. due to having been in a different class the year before and thereby not having created a board game to be interviewed about.

As regards the role of the board games and the related interviews for the developers, they described the games and the interviews as a basis for their work – a "starting point", as they put it. They pointed out that the material served as a source of inspiration for them in the planning of the application. They did not, however, mention any concrete implications of the games or the interview transcripts on their design choices.

The games created by the children were, however, traditional board games with no indications as to how they could be presented on the computer screen. Therefore the children were also asked to make **user interface drawings** to illustrate how they imagined board games would look like on a computer screen. The children created user interface drawings during their art class. They were asked to draw their ideas regarding what the board game application could look like. They could choose whether they wanted to draw the game-playing mode or the game editor; most found it easier to picture the playing mode and thus ended up drawing it, but some chose to draw the editor mode as well. Each child created an individual drawing. One picture of the playing mode and one of the game creation mode are displayed in Figure 14. The picture of the playing mode (above) depicts the game board in the centre and several elements representing the game settings and player standings at the bottom and top of the screen. The drawing of the game creation mode (below) includes a place for a preview of the board in the centre, and several elements for adjusting the properties of the game around it.

Creating designs with low-technology materials does not require technological skills, and therefore it gives an equal footing to all participants (Bødker et al. 1993). Using low-tech methods in projects is based on the notion that the use of art supplies and materials such as colour pens, cardboard, and clay provide children with a familiar way of expressing themselves, without having to formulate their ideas verbally (e.g. Druin 1999, 2002; Druin et al. 1999). Despite the fact that children are often inclined to draw very detailed pictures and overlook the functionality in their drawings (e.g. Scaife and Rogers 1999) and that this may be a significant drawback for the use of drawing as a method in technology design contexts, it was decided that user interface drawings be used in the project. This was done for several reasons. Firstly, for the reasons stated earlier, there was a desire to use a method that would enable the children to do and not just say. As discussed above regarding the making of the board games that served as the starting point of the project, the favourite aspect of that task for most of the children had been the concrete activities, such as drawing and making game pieces. Therefore drawing UI sketches was seen as a potentially motivating method for the children to engage in. Secondly, there already were "hands-on" low-tech prototypes (in the form the board games) to inform the developers about the children's ideas regarding the functionality of the games as such, so there was no need to "reinvent the wheel" with the same children. However, as mentioned, they were traditional board games with no computer-game functions, and in this respect they did not completely serve the purpose of a low-tech prototype.

While the children were drawing their ideas, they were **interviewed informally**. The discussions had two goals; firstly, the children were prompted to tell about their drawings, in order to shed more light on their design choices. Secondly, they were inquired about some more general issues: they were asked to describe what they thought a good game was like, and to tell what attributes of the games ought to be modifiable in the board game design application. For those children who had chosen to draw the editor mode, the question about the

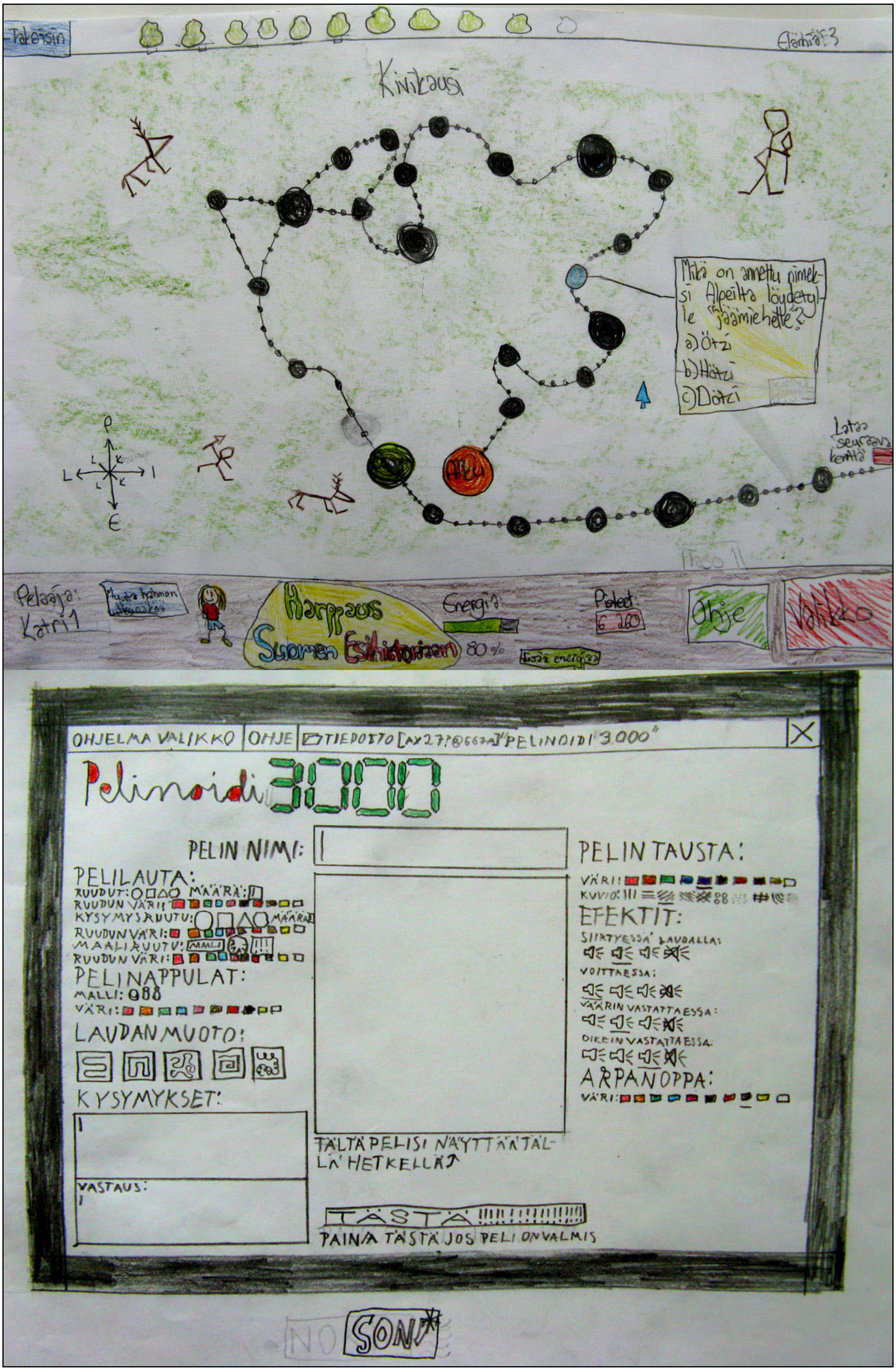

FIGURE 14 Two UI drawings; game playing mode (above) and game creation mode (below)

modifiable features was part of the description of their drawings, while for those who drew the playing mode, it was an additional question. The children were also encouraged to ask if there was something they wanted to know about the project, their participation in it, or the application in general. Some children inquired, for example, about the current phase of the project and its overall schedule, and about the type of the application to be developed. The interviews were not taped; the children's comments were written down as they spoke. The goal of the interviewing was to help the children get their message through more reliably by aiding the developers to interpret the drawings in the way the children had meant them to be understood. On the other hand, because additional questions not directly related to the drawings were also asked, there was a risk that these might interfere with the children's drawing process. These questions were, however, seen as essential because they shed light on the same issues as the drawings, only on a more general level.

The developers' expectations set for the UI drawings to serve as a good idea source were met. The UI drawings were seen by the developers as an especially fruitful and valuable source of information, and they stated that decisions related to the layout, colours, and features of the application were guided by the drawings. According to the developers, the drawings revealed the importance of certain specific features or functions, but they also gave an impression of the children's views regarding more general layout structures and element positions. The developer group digitalized the drawings and analyzed their main attributes, but they also placed them all on display on the walls of their office in order to be able to continually draw upon them for guidance in design decisions – in problematic situations related to e.g. the choice of colours or layout, it was easy to turn to the drawings for clues and inspiration. The following excerpts illustrate the role of the drawings.

> The partner class students drew 20 user interface models altogether, some of which were related to making a board game and some to playing the game. The user interface models were photographed with a digital camera, so that the drawings could be examined also in digital form. The drawings were numbered and they were put on display in [our] project room. This was, in [our] opinion, the best way to make use of the drawings. On the walls of the project room they are visible all the time, thus they can be actively utilized in the design of user interfaces and when considering which features it would be good to realize in the program. (Usability analysis report)

> An especially good method for obtaining information, in [our] experience, were the user interface models drawn by the students of the partner class, from which [we] got a great deal of assistance throughout the rest of the project when designing and implementing the user interfaces of the application. (Final report)

The drawings yielded a great deal of information, as the developers reported, but they also made the group face several questions. The developers discussed, for example, what they should make of the observation that the children's drawings were very colourful: should the colours of the application itself be neutral if the children will make very colourful games, so that the different colours would not clash? Moreover, despite the fruitful outcome, the developers considered it a challenge and even a risk to use such applied data gathering methods as the UI drawings and the accompanying casual interviews. They pointed out that if the developers are inexperienced in using such methods, there is a risk that they do not manage to acquire relevant and appropriate information.

The developers stated having discovered that the navigational elements (e.g. menus and buttons) included in the drawings and their locations reflected the children's familiarity with common Windows software. This suggested to them that they could adhere to familiar conventions in order to enhance the learnability and usability of the application, yet without making it too much of a tool and too little of a game. The importance of quick learning is highlighted especially in children's software, as children are often prone to lose their interest unless they get in control of the software rapidly (e.g. Druin et al. 1999). Another navigation-related issue evident in the pictures was that many tasks were performed using buttons (instead of menus), which suggested that the children wanted all the most essential options to be visible on the screen at all times in order to find them quickly.

> Common elements in the drawings included, according to the [developer] group, e.g. that the menus were in rather traditional places and that many pictures had the Help function clearly visible. Function buttons were, in general, very clearly presented, and the project group concluded that the children wish all functions to be visible at all times. The drawings yielded also many other functional ideas, which the group aimed to utilize during the project while designing user interfaces and creating ideas for features. (Research journals)

In my own analysis of the drawings that depicted the playing mode, I observed that it was very important for the children to see quickly what the status of the game and standings of the players were at a given time. The children had very different ways of representing the standings in their pictures (e.g. points, amount of energy, lives, collected items, money, level of knowledge) but the common element was that this status was clearly visible. Figure 15 shows a drawing which alone entails several ways of presenting game standings: energy, points, and lives.

In the game editor mode, the children's desire for as much freedom of choice as possible became apparent, which is in line with observations made by Druin et al. (1999) about children wanting a large variety of functions and something to explore. According to the drawings, the children wanted the software to enable them e.g. to create backgrounds and characters, to choose freely the game path and the shape and colour of the squares on it, to adjust the level of difficulty, and to add animations to the game. Similar issues came up in the interviews; the children emphasized e.g. colourfulness, having a great variety of options and functions to choose from, and the possibility to collect objects or points and make use of them in the game. (My analysis of the drawings and their manifestation in the outcomes is presented in more detail in Subsection 4.2.6.)

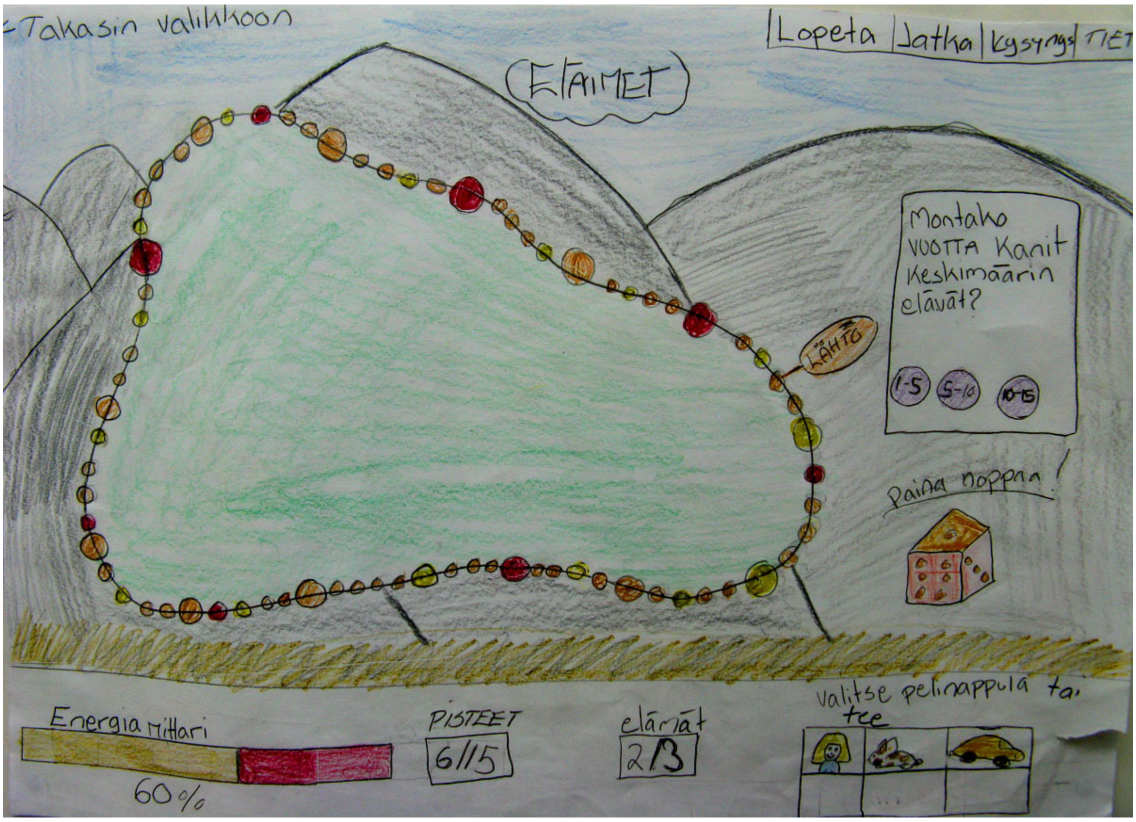

FIGURE 15 A user interface drawing in which the player's status is displayed with the aid of energy, points, and lives

Also from the point of view of the children themselves the drawings were a relatively successful method, and the children in general did not report having had much difficulty with carrying out the drawing task. As Figure 16 shows, thirteen children out of 21 agreed completely or to some extent with the statement "*It was easy to draw the picture of what the application could look like*" in the final questionnaire.

According to the children's accounts, it was the free-formed nature of the drawing task that made it easy: they stated that drawing the pictures gave them a chance to use their creativity and imagination. Especially children who liked designing and constructing things in general liked also the UI drawing task. For some children, the whole task was easy – from the conception of an idea to realizing it – whereas some stated that starting the task from scratch had been difficult for them: they said they had had problems with coming up with ideas for the drawing at first, but once they got an idea, it was then easy to put it on paper. Furthermore, some children felt that they were not very good at drawing in general, and that made them slightly apprehensive about the task. On the other hand, being allowed to draw the pictures exactly the way they wanted made the task fun for many children; it was the drawing task where the children were able to express themselves most freely.

> Once you got an idea, it was really easy because you had a vision of what it would look like.

[It was easy to draw the UI picture b]ecause I like designing things!

It was awfully difficult because I didn't know what kind of a game I could make (drawing was difficult).

It was really difficult, but only the drawing part.

Yes, [it was easy] because you could draw it any way you wanted.

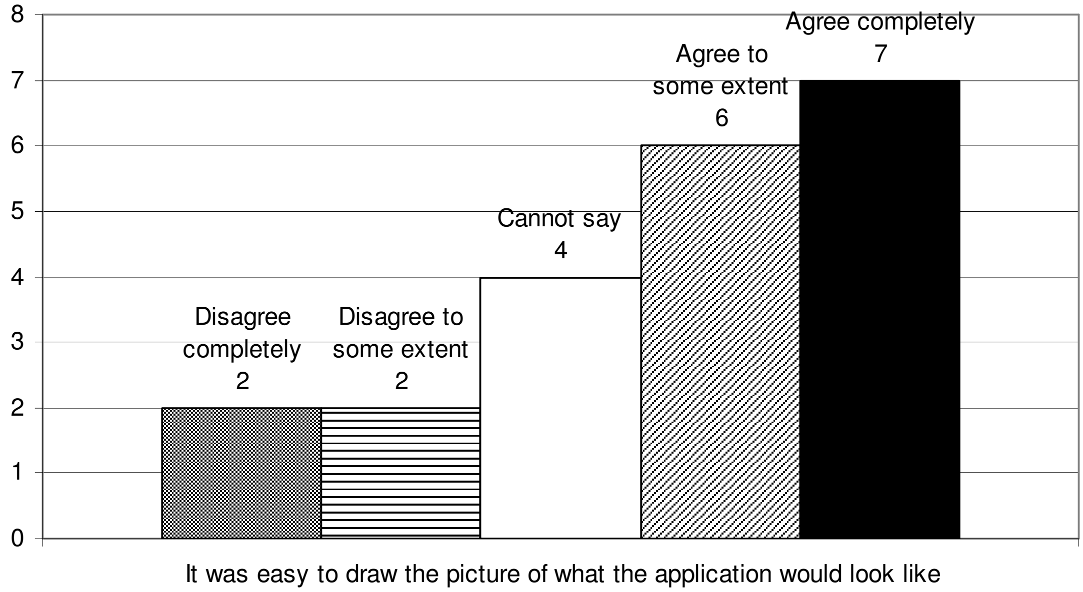

FIGURE 16 Children's thoughts about making the UI drawings

After the session, I pondered in the research journal that engaging the children in a concrete activity (in this case, the drawing task) from the beginning was potentially more likely to arouse their interest in the project and motivate them to be actively involved than e.g. mere interviewing would have been. This notion was supported by some cues from the children, such as one boy specifically asking the developers in a later session whether the drawings had been helpful to them.

Concerning the casual interviews that accompanied the drawing process, the children's opinions were more divided (Figure 17). In the interviews, the children were asked what kinds of features a good game entails, and what they would like to be able to do with game-creation software. Nine out of the 23 children found it difficult to say whether it was easy or difficult to come up with ideas for the functions of the application, while eight were strongly of the opinion that it was easy and four strongly felt that it was difficult. Inventing game features was difficult for the children who had little or no previous experience to refer to. On the other hand, some children took advantage of their experience with computer games and other similar contexts, and thus for them it was easy to express their ideas.

It was easy [to suggest features] if you'd seen other games.

You learn from other games.

It was pretty hard, because I haven't tried or thought about [those things] before.

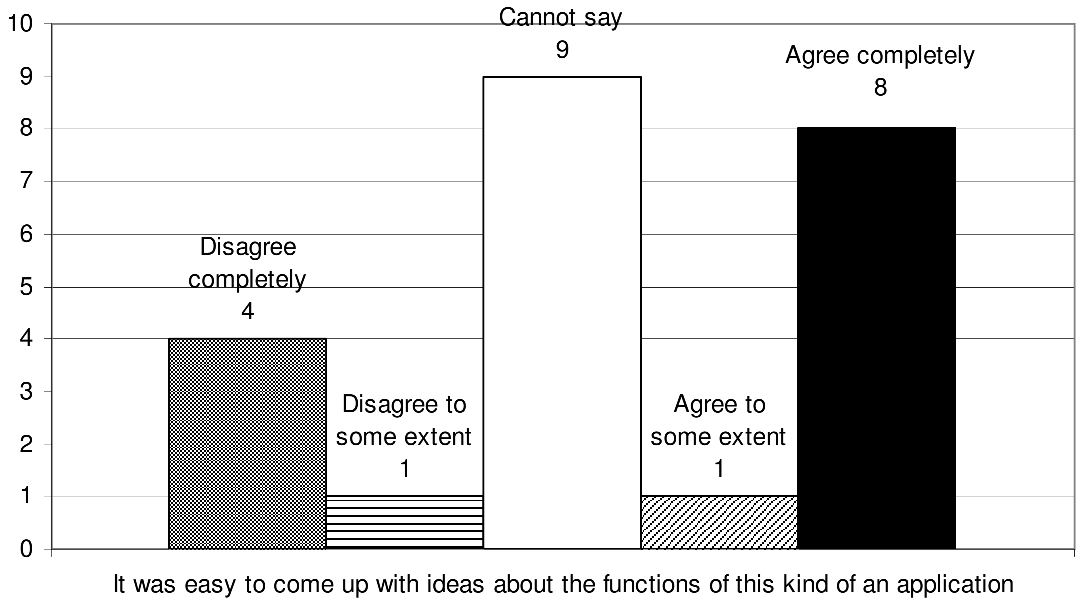

FIGURE 17 Children's thoughts about the interviews related to the UI drawings

Interestingly, however, the children seemed not to consider the drawings to be in as essential a role in the project as the prototype evaluation sessions. A concrete example of this was the questionnaire they answered halfway through the project; the children were asked which methods they had preferred in the project so far and which, on the other hand, had been most boring or difficult. All the answers – positive and negative – were related to some aspect of the evaluation sessions, none of the children mentioned the drawings, not even alongside with the prototype evaluations. One factor was, of course, that the questionnaire was administered after an evaluation session, due to which the prototypes and the evaluation activities were fresh in the children's memory.

Despite this, it was rather surprising that not one student referred to the drawings in this open-ended question dealing with the different activities. It is possible that being integrated in their art class, the drawing task did not particularly stand out, unlike the prototype testing sessions which were clearly different from what they usually did at school. On the other hand, as the children also had a difficult time identifying links between the final outcome and the ideas they had expressed in the drawings (this is discussed in Subsection 4.2.5), it is possible that they therefore did not see the drawings as a crucial step in the design process. On a related note, because such low-tech tasks are rather different by nature from evaluation sessions which deal with already implemented prototypes, they are likely to be considered more remote from the final outcome.

Evaluation

In the following, I will discuss the experiences obtained from the evaluation activities. As Figure 11 showed, first the partner class critiqued UI mock-ups created by the developers and then evaluated two different prototypes in the course of the project. In the evaluation of the second prototype, another school class participated as well. Moreover, there was a launch session for the finished application and a final get-together aiming to gather the children's general comments on the application and especially on the sound effects that were added to the application after the launch session. The structure of the text below is the following. The developers' experiences on the UI mock-up critiquing are discussed first, after which the focus turns to the evaluation sessions. Finally, issues related to evaluation are examined from the children's point of view.

The developers made different **user interface alternatives** based on the ideas obtained from the children's drawings as well as the verbal suggestions they had given. The UI alternatives were computer mock-ups that demonstrated different layouts and different interaction styles (buttons, menus, wizards, mouse clicking and dragging, etc.) for performing the most essential actions but included only little actual functionality. For each mode of the application (i.e. creating questions, constructing a game board, and playing the game), there were three alternative mock-ups. To exemplify, Figure 18 portrays one mock-up for each mode.

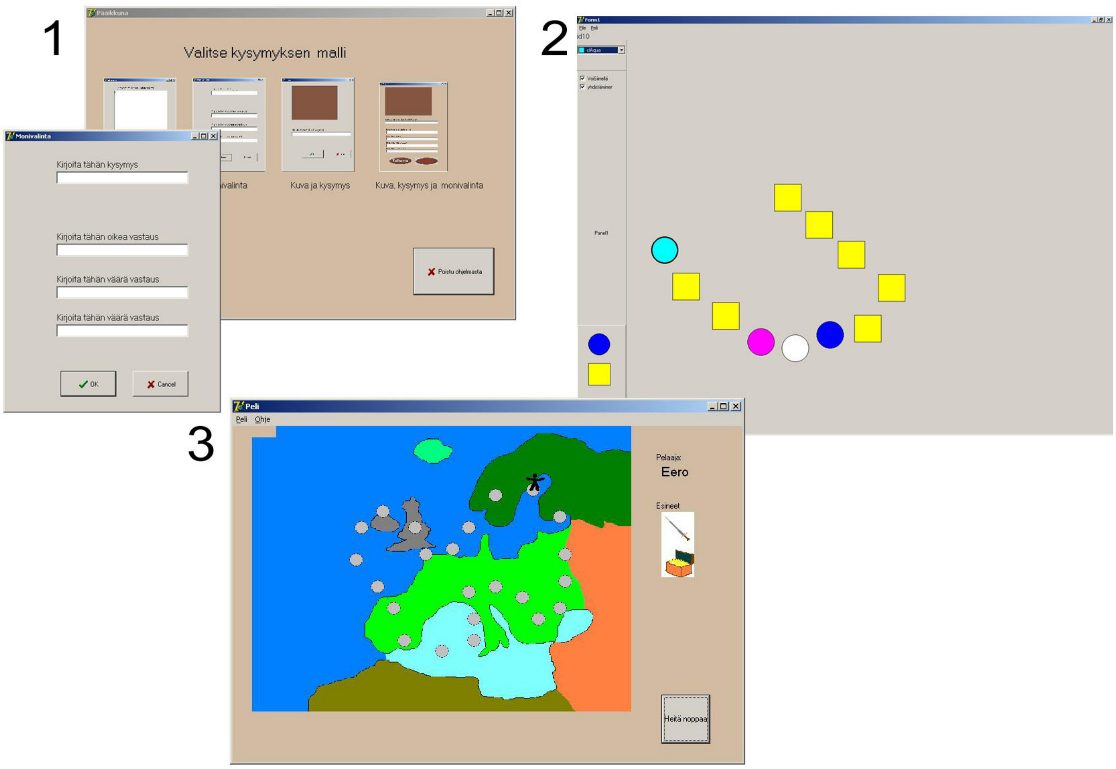

FIGURE 18 Examples of the UI mock-ups: question making (1), game board making (2), and game playing (3)

As the goal was to evaluate different interaction styles, the use of computer mock-ups was seen as more feasible than low-fidelity prototypes because this enabled a more realistic feel of the functions. As Bødker et al. (1993) and Rudd et al. (1996) point out, low-tech mock-ups do not allow as accurate presentation of the behaviour of the application or enable the user to interact with it as realistically as computer prototypes. Creating simple computer mock-ups which differed in terms of interaction styles was considered the best way to receive feedback and suggestions from the children to guide the selection of appropriate interaction styles for the development of the actual application. In order to make the comparison of different solutions as clear as possible, the developers created alternative versions that the children could weigh against each other (see Hanna et al. 2004).

The critiquing session with the children took place in the school computer lab. Half of the class at a time came to evaluate the mock-ups: each session lasted approximately 45 minutes. The children worked in pairs, and they were allowed to choose who they wanted to work with. The activities and comments of each pair were documented in the style of participant observation, active intervention and contextual interviewing (see e.g. Baauw & Markopoulos 2004; Donker & Markopoulos 2001; van Kesteren et al. 2003). As the children were trying the different versions, they were inquired about their preferences and the reasons for them. Additionally, the actions of one pair in each session were videotaped. After they finished trying the mock-ups, they were asked to name the best version in each set of alternatives and to point out pros and cons about each version. Moreover, they were asked to suggest what kinds of features from their favourite games they would like to be included in the Talarius application. These questions were intended to provide more in-depth views into the children's opinions.

The mock-ups were a valuable tool for the developers: when asked how the results of the evaluation sessions demonstrated in the development of the application, the developers stated that the appearance and functionality of each module of the application were designed according to the feedback obtained from the children. Especially mouse functions, menu structures, and the forms used in creating a game were issues strongly directed by the results of the user interface mock-up evaluation, according to the developers. This indicates that the children's UI drawings and the evaluation of the mock-ups supplemented each other; with the mock-ups the developers were able to concretize the impressions they had obtained based on the outcomes yielded by the first requirements gathering methods and to try out solutions that had been inspired by the drawings.

> The appearance and functions of each module have been realized based on the feedback obtained from the children. (E-mail interview at the end of the project)

> With the aid of the user interface prototypes we managed to clarify some user requirements for the application being developed and choose the user interface models for the application […]. (Phase report: Design phase)

The mock-up evaluations informed the development of **functional prototypes**, which again were evaluated with the children at several different points during the process. Based on the signposts provided by the results of the critiquing of the mock-ups, the developers created a functional prototype which was then evaluated and commented by the children. The results of the evaluation guided the developers to make a further prototype, and an evaluation session with the children followed again. The use of computer mock-ups and functional prototypes is an essential part of the user-centred design cycle, providing the users with a chance to evaluate the outcomes of each iteration (see Section 2.2). It has also been pointed out that the use of prototypes brings users into a more contributing role in the process, as prototypes make it possible to incorporate their feedback quickly into the application (Rudd et al. 1996).

The two prototype evaluation sessions were conducted in a largely similar fashion. The children used the prototypes in pairs or small groups, commented on the use of the prototypes, and were asked some clarifying questions if necessary. In these sessions, the children also had paper questionnaires, devised by the developers, in which they were asked about the pros and cons of the prototypes and prompted to give suggestions for further development. Similarly as in the mock-up critiquing sessions, the interactions of one or two pairs per session were videotaped. In each evaluation session, the developers also asked the children to fill in a questionnaire which they called a "motivation-meter". The motivation-meter included questions which asked the children to compare the Talarius application with different other types of applications or activities (e.g. homework, entertainment games, group work at school) in terms of different aspects, such as whether using Talarius was more fun or more boring, or easier or more difficult, than a certain other activity. According to the developers, the goal of the questionnaire was to examine how motivated the children were to use Talarius, and also to monitor whether and how their motivation altered in the course of the project.

The first evaluation session took place in a computer lab at the university. The partner class was invited to the university for an informal "Christmas get-together" (December 17th; see Figure 11), in order to provide them with a special occasion at the end of the autumn term and to give them a chance to see the developers' premises. This was intended as something that would emphasize to the children how important their role and involvement in the project were considered. They first had some snacks and were given a small present to thank them for their participation. There was also informal discussion about the favourite games of both the children and the adults who were present. After the snacks, the children proceeded to a computer lab to see and try the first functional prototype, to give their feedback on it, and to play some web games.

At the beginning of the spring term, before the evaluation of the next prototype, the children prepared in class a set of questions to be used as an example set in the application. The reason for this was to ensure, first of all, that the questions used as pilot content in the evaluation sessions would be suitable for the class level and, secondly, that they would be relevant regarding the topics the children were currently studying at school. This was done in order for the evaluation sessions to support rather than disrupt their school work (cf. Rode et al. 2003).

The evaluation of the second prototype with the partner class was conducted in their own school. The value of evaluating prototypes in the real context lies in the potentially more realistic feedback: the real use situations are understood better by the designers (Nielsen 1998), and the environment and realistic tasks influence how the users perceive the situation (Kantner et al. 2003). In this project, conducting the evaluation in the school computer lab within the time frame of school lessons was expected to shed light on how the application worked in the real school context, both from the technical perspective and from the point of view of its usefulness and usability in school use.

Moreover, as the developers wished to get information from novice user perspective as well, another class from the same school also participated in the evaluation. According to the idea of informant design (Druin 2002; Scaife & Rogers 1999), children are included in the design process in different phases according to when their input is especially needed. In this project, when the developers had developed a second prototype, they felt that in addition to evaluating it with the children of the partner class who now – having been involved in the design process from the beginning – could be described as experts, they also needed to be informed about how the application was perceived by someone who had not seen it before. Another class of the same grade level was asked to participate in an evaluation session, firstly, in order for the other group to be as similar to the partner class as possible in terms of age and knowledge and, secondly, because the pilot contents were particularly related to fifth-graders' current study topics.

Video recording was used both in these evaluations and in the critiquing of the user interface mock-ups. The role of the video recordings was to act as supporting material that could be referred to in order to enrich and explain issues observed in the evaluation sessions. The use of video was qualitative by nature, aiming to identify particularly interesting issues rather than to examine the frequency of problems or to look for general patterns of activity.[2] A quick way to make use of the video material was needed also because, as stated earlier, the time resources of the developers were rather limited. Moreover, as all members of the developer group were not always able to attend the evaluation sessions personally, the use of video could potentially enliven the outcomes of the sessions for those not present (cf. e.g. Muller 1991).

As regards the challenges of videotaping, since video recording was not the primary data collection method, there was no danger of relying too much on the tape and neglecting note-taking during the session. Instead, the main

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2 See e.g. Wixon (2003) for further discussion on the relevance of qualitative vs. quantitative approaches in the evaluation of products under development.

challenges in this case were related to how the children would react to being videotaped. The setting that the interactions of only one pair at a time were being taped was expected to potentially bring both benefits and disadvantages. Firstly, if the camera should have an effect on the behaviour, it would be likely to affect only a few children. The rest of the class could be observed without the distraction potentially caused by the camera. On the other hand, there is a risk that such a setting might make the situation feel unfair to the children in one way or another; the children who are being videotaped do not feel comfortable with the idea that no other pair is videotaped at the same time, or the children who are not videotaped might feel that their participation in the session is less important than that of those who are. To avoid this, it was deemed important to alternate who were being videotaped from one session to another.

Another means of gathering feedback in the evaluation sessions, along with verbally asking questions and videotaping, was the use of questionnaires. Questionnaires were used to complement the comments given by the children and the observations made by the developers during the evaluation sessions. As there were more than ten children present in the sessions at a time, a paper questionnaire was seen as a suitable way to make sure that all of the children had equal opportunities to get their opinions out into the open. As it has been previously pointed out, questionnaires are usually quicker to carry out and analyze than interviews (Gediga et al. 2002), which was seen as an essential benefit in this project where time constraints played a significant role both from the developers' and the school's part.

When the developers finished the pilot version, one more use session was carried out in the school of the partner class. Its purpose was to act as an **"introduction-to–use" session**, in which the children were able to use the application in any way they wanted and also to give suggestions for the further development if they came up with some ideas. From a development point of view, observing the children was also seen as a chance to observe their areas of interest and their ways of using the application – and possibly later use these observations to inform the future development of the application or, for example, the development of tips for using the application.

Druin (1999) has drawn attention to the importance of creating situations where children can direct their activities themselves instead of merely carrying out tasks specified by adults. Nesset and Large (2004, 145) refer to Druin (1999) as they point out that "children are more exploratory than task-oriented – they do what they want to do instead of what adults expect of them". In the previous evaluations of the Talarius pilot application, although not following a strict sequence, the children's tasks had nonetheless been somewhat limited. An opportunity to explore the application more openly was therefore seen as a valuable learning situation for both the developers and the children; the children would have a possibility to come up with their own ways of using it, and the developers would gain insight into the preferences of the children regarding the use of the application.

Figure 19 shows the final pilot version of the Talarius application in each of its main modes (game board making, question making, and game playing).

The first picture (1) presents the game-making view. In this mode, the users can make a game path by adding game squares onto the game board by clicking with the mouse. They can construct the path using standard game squares, question squares, and extra-throw squares. They can also add a background picture to their game board. The picture can be imported from any folder on the computer. In the next picture (2), the question-making mode of the application is depicted; the player can create multiple-choice questions, open-ended questions, as well as “info boxes” which do not contain a question but instead give a piece of information on a topic relevant to the theme of the game. To each type of question, the user can attach a picture, a sound file, or a video clip. Finally, the picture at the bottom (3) depicts the playing mode. The children have made a game related to Estonia with a map as the background picture and the game route circling around the country. When the players are playing the game, they in turn click on the “throw the dice” button (in the upper left hand corner), upon which a dice animation is displayed above the button and the players’ characters move along on the route according to the result of the throw. When a player arrives in a question square, a pop-up window opens showing one randomly selected question out of the series of questions attached to the game. In multiple-choice questions, the players get points for knowing the right answer. All answers are logged in a file that can be later monitored by the teacher via a specific teacher’s user interface.

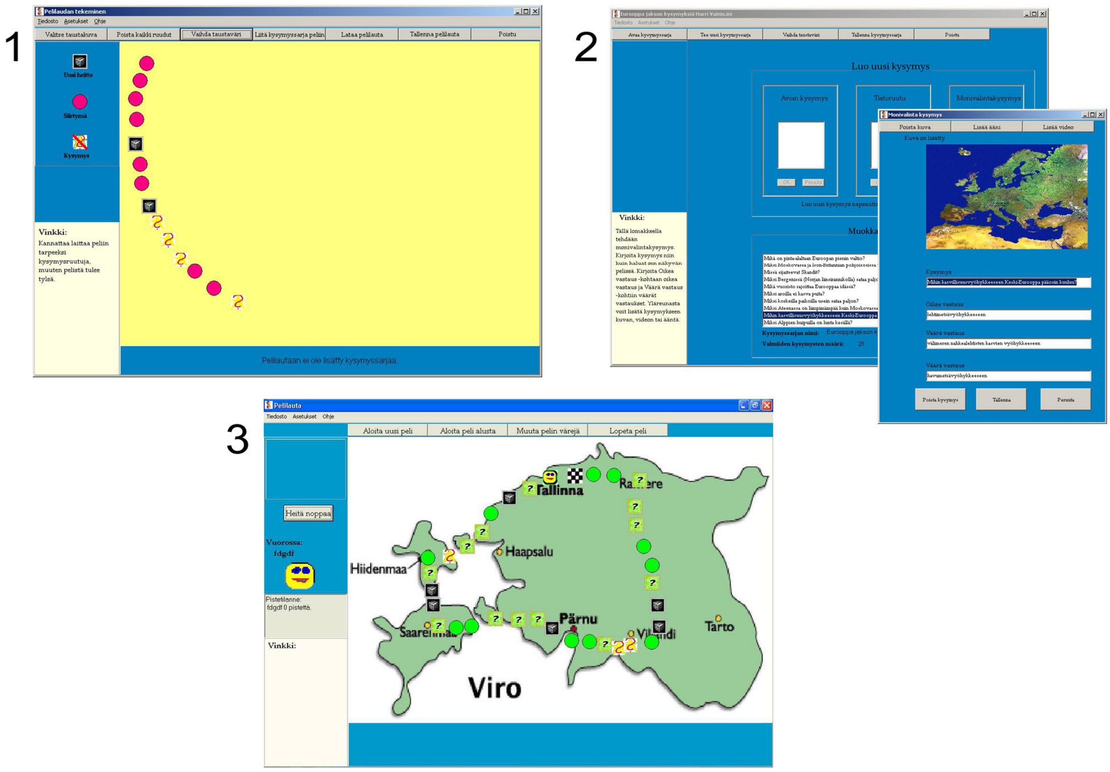

FIGURE 19 Pictures of the Talarius pilot application: game board making (1), question making (2), and game playing (3)

At the end of the pilot project, the partner class was invited again to **an informal get-together** at the university to wrap up the project. Snacks were served, and the project and the pilot application were informally talked about. An additional activity was the listening and evaluation of the sound effects and the music of the application. The sounds and music were played on loudspeakers, and the children were asked to act as critics and rate the sounds on a scale. Integrating sounds and music into the application had been a frequent wish by the children, but the sound effects and music had not been finished until after the introduction of the pilot application. Therefore the evaluation of sounds was included in the final get-together. Its aim was to let the children know that their idea of the sounds and music had been realized, and to receive feedback as to how well the sound effects and the music corresponded to what the children had had in mind.

In the following, I will examine the developers' experiences related to the prototype evaluation activities. As described above, the partner class evaluated Prototypes I and II, the parallel class evaluated Prototype II, and the partner class freely used and commented on the final outcome of the project. In the original plans made by the developers, there were not that many different occasions for user-conducted evaluations. As the developers decided to increase the role of evaluation in the project and, consequently, allocate more time to preparing and carrying out the evaluation sessions, the resources they had reserved for the task were exceeded – which in turn required them to reallocate their time resources altogether.

As with the UI mock-ups, the developers considered also the prototype evaluations very fruitful for their work, and they reported to have acquired "more information than expected" from the evaluation sessions. They were slightly concerned, however, whether the sessions would reveal relevant issues. This concern was expressed, for instance, as a risk in their Risk Management Report for the implementation phase. The developers sought to deal with this risk by defining as specifically as possible the questions to which it was particularly necessary to pay attention in each session.

> Out of the testing sessions [we] got considerably more information than [we] had thought beforehand. […] As a whole, this task surpassed all the benefits and expectations set for it, even though it required a great deal of resources. (Phase report: Implementation phase)

Evaluation sessions were enjoyed by the children: more than a half of them stated in an open-ended question in the final questionnaire that playing and/or testing the application had been the most interesting thing in the project. Also, the statements related to whether it was boring or fun to test the application extremely clearly indicated that the activity was enjoyed. Figure 20 presents the results of the statements related to the evaluation activities.

The two first statements in Figure 20 deal with whether the children enjoyed the evaluation sessions, and both of the statements indicate that they did. In the first statement, 15 children out of 23 agreed strongly and four to some extent that it was fun to test the Talarius application, while none of the

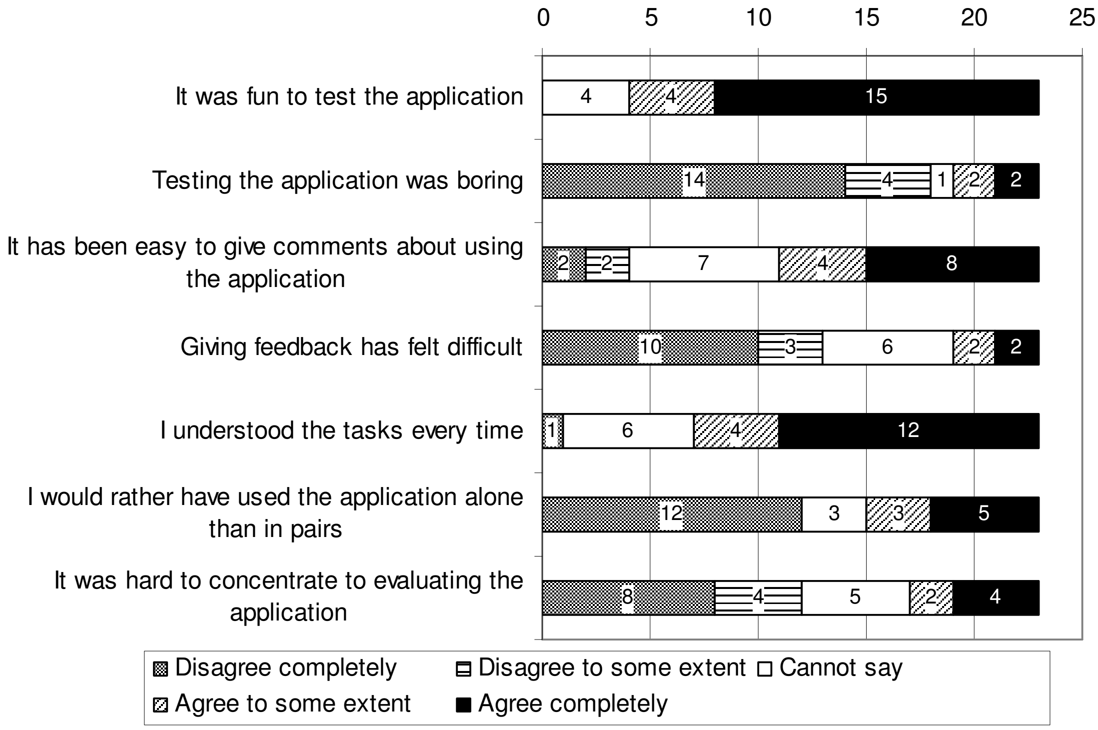

FIGURE 20 Children's views on the evaluation activities

children disagreed. The same question was asked also in the form of a negation of the first statement (i.e. it was boring to test the application), and it confirmed the answers to the positive statement. In the negative statement, however, four children altogether agreed that it was boring (two strongly and two to some extent). Hence, although the evaluation of the application was generally an enjoyable experience, the sessions entailed some less pleasant aspects as well.

Two clearly most common explanations for liking the evaluation sessions were, firstly, that playing games and using computers were interesting and fun activities in general, and secondly, that the sessions were different from normal school activities. As mentioned above, one potential reason for the drawing activities not having stood out was that they closely resembled normal art class tasks. The evaluation sessions, on the contrary, provided the children with entirely new types of activities in that they were able to critique a technological application under development. Also, with the school computer lab being in heavy use among all the classes of the whole school, during the participation in this project they had a great deal of activities in the computer lab within a short period of time, and additionally, they also got to visit the university computer labs.

> It was fun to try all the different features!
>
> It's always nice to use a computer.
>
> There was something else for a change than just 'ordinary' subjects.

On the other hand, those who did not like the evaluation sessions explained their stance mainly with disappointment related to the application not being as polished as they had hoped ("not very fancy"). This was a manifestation of the developers' concern that because the prototypes already have functionality, children – and users in general – might get the impression that they are more sophisticated than they actually are yet. Some children also pointed out that they had had some problems with coming up with comments or explaining the rationales for their opinions every now and then. However, the ways of giving feedback (written feedback forms and oral questions asked casually during the evaluation sessions) as such had not been too problematic, as only four of the children felt that it was not easy to provide comments about the application and, in a corresponding reversed question, the same number of children considered it difficult to give feedback (Figure 20). According to many of the children, being able to discuss the issues with a friend had also made it easier for them to give feedback.

During the evaluation sessions, however, some children expressed wishes to use the application by themselves rather than in pairs. Due to this somewhat surprising observation, the children were asked about this issue in the final questionnaire. When presented with a statement *"In the evaluation sessions, I would rather have used the application by myself than with a partner"*, twelve out of the 23 children strongly disagreed whereas eight students agreed – five agreed strongly, and three somewhat agreed (Figure 20). Those who preferred pair work emphasized that it was more enjoyable to work with a friend, and giving feedback felt less difficult when the children got to compare their opinions with each other and talk about the application together. For example, one child in the pair might have an opinion about an issue which the other did not have anything to say about, and in this way they were together able to work out comments to the feedback forms and to answer questions asked during the evaluation. Some children explained, however, that cooperation with their partners did not go very well – (s)he might, for example, have dominated the pair's work too much or behaved in a distracting way – and therefore they would have preferred to do the evaluations by themselves. On the other hand, some of the children would have wanted to evaluate the application alone because then they would not have needed to share the computer with another child and thereby could themselves have played more, without having to take turns or share tasks.

> It would have been fun to evaluate [the application] just by myself, because with a partner you couldn't play as much, but giving feedback was easier with a partner.

As regards the children's concentration on the evaluation tasks, twelve out of the 23 children stated that they had not had any problems with paying attention to their tasks or focusing on what they were doing (eight strongly disagreed about having trouble concentrating and four disagreed to some extent), as depicted in Figure 20. According to the children, the evaluation activities were interesting and fun, which also made it easy to concentrate on the tasks at hand.

However, six children (four of whom strongly and two to some extent) felt that there had been some problems with focusing on the evaluation tasks. The most prominent negative factor affecting the children's concentration appears to have been the nature of the situations; the sessions were held in the middle of the school day, often in the afternoon, which resulted in some children mentioning that they had been tired during the sessions, or already looking forward to going home after the school day, and therefore it had sometimes been difficult to concentrate.

> It was so much fun that it was easy to concentrate.

> Sometimes it was, sometimes it wasn't [hard to concentrate] because I was tired and couldn't focus.

Furthermore, the sessions were somewhat restless at times, potentially partially due to said tiredness and the fact that a large group of children was simultaneously present at the evaluation sessions. There were few facilitators in relation to the number of children, which made it somewhat difficult to instruct and observe all the children adequately when they were carrying out their evaluation activities. In case the session consisted of several distinct tasks, the developers wanted the children to proceed at the same pace, moving from one task to another at the same time, in order to be able to observe the proceedings of the session adequately. While this made things easier for the facilitators, it led to a situation where some children who finished their tasks faster felt that they had nothing to do while waiting for the others, which affected their concentration on the evaluation negatively. This issue also plays a major role in some children's feeling of being occasionally bored during the evaluation sessions. Moreover, when the facilitators had to help and monitor several pairs at a time, some of the instructions were perceived as slightly unclear by some children. However, in general they did not have problems with understanding the tasks and instructions; only one of the children reported having sometimes had difficulties with understanding the tasks (Figure 20).

Finally, it is worth noting that in the evaluation sessions carried out during the development process, the main emphasis was on the usability and fun-related issues, whereas the learning point of view was addressed in more detail in the subsequent field trials.

Field Trials

As several researchers have pointed out, there is a need to put more emphasis on testing and evaluating applications in the field, in as realistic situations as possible (e.g. Dray et al. 2002; Kantner et al. 2003; Nielsen 1998; Wixon 2003). The evaluations conducted in this project with the partner class and their peers during the development of the pilot application attempted to take the real context into account as well as possible. The activities mainly took place in their own school and within the schedules of a school day, and the prototype evaluations used their current study topics as the basis of testing materials.

However, such short periods of use are unable to reveal many significant issues related to actual use, especially since their emphasis is on the usability and the technical functions of the application. In this case, for example, there was a need to obtain authentic use experiences regarding how teachers would integrate the application into their teaching, whether teachers and children considered the application useful from the learning point of view, what kinds of improvements would enhance its value as a learning tool, and so forth. In other words, the field trials were based on the assumption pointed out also by Dray et al. (2002, 12-16): they enable the evaluation of “utility and usability and the complex relationship between them” and, moreover, increase the likelihood of making “opportunistic findings”, issues that have remained undiscovered in the earlier evaluation sessions but might now arise unexpectedly during the field trial period.

Another point of view of the field trials was to acquire experiences from a broader user population. There was a desire to broaden the scope of the user groups of the application towards younger children. The pilot version relied heavily on reading and writing, and a significant question was whether the same application could be modified to fit the needs of younger age groups or whether a separate version was needed. Although there is a great deal of various guidelines as to what kinds of technological solutions are suitable for children of different ages and developmental levels (e.g. Bruckman & Bandlow 2003; Hanna et al. 1999; Markopoulos & Bekker 2003), these are also context-dependent. Therefore actual experiences are vital in determining the needs of the different user groups of a particular application, and in deciding in what ways and to what extent the guidelines are best put in practice in that particular case.

In this project, the pilot version was in actual use by two school classes (the partner class and another class) for a period of time, and it was piloted in two kindergartens. In the field trial periods in the school, the use of the application was integrated by the teachers to topics they were covering with the children at the time of the trial period. The developer team finished their part in the project once the pilot application was finished; the field trials and further development was conducted within our research group at the Agora Game Lab. Therefore, in the following, the documents and interviews from the perspective of an outside developer group are substituted with internal research journals and documents.

The first field trial was conducted **with the partner class immediately after the project was concluded**. The class used the application as a reviewing tool at the end of the school year. This trial period was carried out independently; there was no researcher present during the lessons but both the children and the teacher were given feedback questionnaires which they filled in after the period. The value of the field trial was great in terms of discovering ways of using the application as well as technical errors which had remained in the pilot version and usability issues that became manifest in real use. As regards the ways of using the application, the field trial period took place in late spring, and therefore the teacher chose to use the application as a reviewing tool with which the children went through the most important topics they had learned in different subjects in the course of the school year. The teacher also provided more detailed information regarding e.g. how many lessons they had spent with the game project, what the sequence of activities was, and how the children behaved when using the application. In terms of usability and technical glitches, both the teacher and the children pointed out issues they had encountered, things they considered especially good about the application, as well as suggestions for improvements and additional features in future developments. The children's comments dealt for a large part with the same issues they had addressed most frequently in the prototype evaluations during the project, such as the variety of options and features included in the application.

Another field trial period with a school class was conducted with **a class of fourth-grade students in the following school year**. The aim of this field trial was especially to address issues related to the point of view of *learning* with the aid of the application. Similarly as in the earlier field trial, the teacher chose a topic in which the class used the application. They used it in geography class dealing with the Baltic and Nordic countries. After studying the issues in class, the children got to choose one country, research it in a group, and create a game about it. In this trial period, a researcher was present during the lessons to observe the use of the application and to assist the children if needed. In each session, the interactions of one group were videotaped. The children answered three feedback questionnaires: one at the beginning, one after they had designed their own games but not yet played the games designed by other groups, and one at the end of the whole period. Moreover, the teacher was interviewed after the period.

The field period yielded observations of the use of the application as well as opinions from both the teacher and the children. Usability issues and technical deficiencies were discovered through observing the use of the application and with interviews and questionnaires. There were several technical difficulties especially with saving the questions, which caused frustration.

> I felt sorry for the students because they encountered so many technical problems again. Other than that, the children were very excited about the application and designing games, but continuous problems with saving [the questions], and the disappearing of the questions, which happened to a few groups, clearly caused frustration. (Field journal)

The field trials also revealed some patterns in the ways the children used the application. It turned out that the children had quite different preferences as regards the activities that could be performed with Talarius: some were focused on the making of questions and seemed to enjoy the question-inventing process, some made a very elaborate game board with precision and played the game by using their own board with different questions sets, while some were interested in making their own game characters to suit the game they were about to play. Some of the activities were innovative and also supported learning. In the group that tried many different question sets with one board, the children were proud of their own decorative game board but at the same time they were also interested in the questions created by the other children. Moreover, when planning the games, one group pondered whether they should only make multiple-choice questions and no open-ended ones at all, in order for the players to be able to gather points from every question they encounter (open-ended questions did not give any points to the players). This showed that they were considering the players' experience when planning the game, but it simultaneously contained a risk of reducing the versatility and the learning effects of their game, as the players would not have to explain anything in their own words. From this group's own point of view, however, making only multiple-choice questions was a fruitful decision in terms of learning, as they were required to put effort on coming up with creative and plausible wrong answer alternatives as well. There were, however, also such ways of using the application that might get in the way of learning: while playing, some children answered the questions in the game carelessly in order to proceed in the game as quickly as possible. By doing this, they did not have to think about the questions or the right and wrong answers at all – they were only focused on finishing first, not on collecting points by answering correctly.

> Once the students got to the playing, they appeared to be enthusiastic and seemed to have fun while playing. I noticed, however, that at least one group did not actually try to answer the questions but rather guessed something quickly to be able to proceed. (Field journal)

> Some groups clearly pondered the questions (and some were thinking about the fact that the "teacher's going to read" the answers, and therefore tried to answer [the questions] as well as possible), while others just quickly made a guess upon arriving in a question square, in order to get ahead in the game. (Field journal)

As the focus in this testing was on learning, the children were also enquired about what they learned by using the application. At the beginning of the period, they were asked about their expectations related to what they thought they could learn with the Talarius application. After creating the games, they were asked to reflect on what they had learned by making games. Similarly, after playing games created by their classmates, they described their thoughts about learning by playing.

The children's *initial impressions* of the Talarius application were mainly positive. In the first session of the field trial period, the researcher demonstrated the game to the children in class with the aid of a video projector, and based on this session, 15 out of the 20 children who were present felt that the application appeared nice and easy to use, both in terms of playing and making games. As the basis for their good impressions, the children especially emphasized the different features for creating the games and making them look like they wanted them to look like. This was in line with the issues emphasized by the partner class children during the development process, and indicated that it had been important to take the children's ideas regarding these aspects into account in the development, as it now was an important factor in leading other children to get a positive general impression about the application. Those children who had a negative impression, explained their opinion e.g. with the lack of game-like features and some technical glitches that still remained, similarly as did those partner class children who were disappointed with the final product.

> Cool features, as you can make a background picture, you may choose your game character, and you make the questions yourself.
>
> Really nice because you can add sound, pictures and video to the game.
>
> Well, it's a pretty nice game but it sure could be improved a bit.

Most of the children also felt that they would learn with the aid of the application; only two of them were doubtful about its usefulness for learning. They especially brought up the usefulness of the application in terms of learning the topic areas dealt with by using the game, but in addition to that, also technology-related skills and game planning skills were mentioned.

> [You can learn] about the themes. And how games are made.

As regards the teacher's point of view, at the beginning of the field trial period the teacher of the class saw great potential in the Talarius application especially as an enhancer of the children's motivation. He pointed out, however, that the children might face some restrictions as they come up with such ideas for their games that cannot be realized due to the limited features of the application.

> The teacher felt that it will be interesting and motivating for the children to use the application; technical limitations might restrict the realization of some [of their] ideas, though. (Field journal)

After the children had made their games, they were asked about their experiences of *creating the games*. When it comes to learning by making games with Talarius, the children reported several things that they felt they had learned: information about the subject area, computer skills, and skills related to designing games. In other words, these were to a large extent the same issues as they had expected to learn with Talarius. Collaborative skills were also mentioned by one of the children. In general, their feelings about their own learning were somewhat divided, however. Approximately half of the students reported learning something new. Similarly, a bit more than half of them felt that they learned more by making games than in normal classes: some children rationalized this view by pointing out that making games helped them remember things better. Many also felt that making games was more interesting.

> [You learn] to make games and not just play them.
>
> Sometimes you had to think hard about the answers to your own questions.
>
> Now I know how to [import] a picture from the Internet.

However, a bit fewer than half of the children felt that they had not learned from the designing of the games: they felt that computer-based studying was not as effective as teacher-led studying, that it was a more individual type of studying, or that it did not prepare them for tests as well as normal classroom learning.

> It's easier for me to learn if someone tells me things, than finding out about them myself, though it's good to learn that, too.

> [I learn better in normal classes] because in normal classes we study for tests and such.

On the other hand, this different nature of learning was also seen as positive when it comes to the enjoyment of the activities: most (16 out of 20) of the children felt that making games with Talarius was more interesting than regular classroom activities. The students considered the Talarius sessions more fun and felt that they also provided some more variety to their school work. Some of the children did not even regard the game-making as studying or learning at all. The making of both the questions and the board were considered fun, as well as the playing of the game. Being able to work in groups and to use computers were other factors leading to the children being satisfied with making games with Talarius. Majority of the children (16 out of 20) preferred making games in groups or pairs to doing it by themselves. It was more fun to work in groups for several reasons. The children were able to discuss things together, and they helped one another in the group. Group work was also seen as more productive than solitary work because they felt that they achieved more in a group than by themselves. Four children would have preferred solitary work, in order to be able to make all decisions themselves.

> [Making games is more fun than regular lessons because] you don't have to sit at the desk all the time.

> [It was fun] because we got to work at the computer.

In these sessions, however, technical problems manifested, and for many children the game creation activities were plagued by severe problems with e.g. saving their games. For some children, the problems were rather critical; one child, for example, mentioned that their group had lost their questions three times because of problems with saving. These difficulties were, naturally, reflected on the children's feedback. Some of them reported being frustrated with the technical problems to the extent that they would have preferred normal classroom-based activities. When asked about the pros and cons of making games with Talarius, technical difficulties were the most often mentioned negative aspect.

However, technical problems notwithstanding, the children found it easy to make games with the application. Nearly all the children (18 students out of 20) found it easy to search for information and material to be included in the games, and almost as many (17 students) felt that it was easy to come up with questions. Using school books and the Internet for information searching were considered easy, and many children also stated that they knew much about their topics already when starting to make their games. Some children used a strategy that they only asked easy things – which they already knew – in their questions, which made game-making easy for them and minimized the need to search for information from different sources.

> It wasn't hard to search for information because you could easily find information in the book and on the net.

The children liked making questions, because they had the chance to come up with not only the questions but also the alternative answers in the multiple-choice questions, which made it possible to bring a funny aspect to the games by creating silly answer alternatives to some questions. The children also liked that they were able to work in a group and be with friends. One of the main issues mentioned as the best thing about making games with Talarius was the possibility to add pictures to the questions; searching for and selecting pictures to be used were interesting activities, according to the children.

> [The most interesting and fun thing was] when we searched for pictures.

Only two children felt that it was difficult to search for information, and for three children it was difficult to come up with questions. These difficulties were mainly due to technical problems with saving the questions. Moreover, some children pointed out that it was sometimes hard to come up with good and matter-of-fact questions, to come up with different types of questions, and to estimate an optimal level of difficulty for the questions. Some children mentioned that as they had to make many questions related to the same topic, they were forced to search for information in other books than their school books and on the Internet, which was tricky at times.

> It was difficult to assess if the question is too difficult or too easy.

The developers' conclusion that Talarius was easy to use was, to a large extent, supported by the children's opinions. Most of them (15 students out of 20) considered it easy and fun to enter text and import pictures to the application. Some of them pointed out that they could already do it well; hence the use of the application had been easy to learn. Five of them reported having difficulties – the manifestation of technical problems was again a major reason for this. An interesting observation was that many children (8 students) mentioned that they did not get much experience on entering information to the game, because someone else in the group took care of that for the most part. The children appeared to have clear roles in their groups as regards the using of the application. They all discussed things together but divided the tasks related to the concrete use of the application rather clearly; someone was responsible for inputting the text and attaching (image) files to the questions, whereas someone else worked on building the game board.

As regards the children's motivation to use Talarius in the future, most of them (17 children) were interested in using the application again in school, and about half of them (11 children) also at home. The topics of interest varied greatly from sports to history and from music to general knowledge. Three children also mentioned that it would be nice to be able to freely choose the topic of their game.

After making their games, the children played games made by their classmates. After the playing sessions, they were asked about their experiences related to *playing games with Talarius*. The children felt that they had learned many things, especially about the content area and computer use, by playing the games. However, more children felt that they had learned more by designing the games (13 students) than by playing games made by others (7 students). They reported having learned similar issues as by playing, but also skills related to planning and designing. Importantly, when it comes to the factual content-area knowledge, they felt that they remembered better the information they had learned while designing the games than the information encountered while playing. While making games, they used textbooks and other sources to help them in the question-making, which helped them learn better. Moreover, coming up with questions and discussing them while making the game was experienced as supporting learning better than only answering them. When it comes to mere playing of the games, slightly over half of the students (12 out of 21) felt that they learned new things also by playing, while seven students felt that they did not.

> More things stick in your mind after designing the games [than after playing them].
>
> [I learned more by making the games] because we had to make questions.

While a little more than half of the children considered the making of the games more effective in terms of learning than normal classes, slightly fewer than half of them felt the same about playing the games. They did not consider playing the games as "studying", and many children also pointed out that they already knew many of the things asked in the games. However, those children (four students) who did feel that they learned better by playing Talarius games than with regular classroom work, pointed out that playing was more motivating and exciting and thereby also enhanced their learning. This manifested also when the children were asked to compare playing Talarius games and normal classes in terms of how fun they are: 16 out of the 21 children saw playing games with Talarius as more interesting. It provided variety to their regular classes, was less boring than exercises in their books (as pointed out above, some children did not even regard the playing as studying at all), allowed the children to talk with their friends while playing, and gave the students a chance to use computers. Again, negative impressions were due to technical problems to some extent, or to the students' experience of not learning as much by playing as in normal classes. Moreover, if the Talarius session happened to be arranged at such a time slot that it replaced the class of a favourite school subject of a child, it also affected his/her experience of the activity.

> [You don't learn as much by playing as in normal classes] because it's [only] playing.
>
> [You learn better by playing because] playing is more exciting.
>
> [It is better than normal classes because] you don't have to do boring book exercises.
>
> [I would have preferred regular classes because the game] got stuck all the time, and we would have had an art class.

Eight children regarded playing itself as the best or the most useful thing about Talarius, and eight mentioned things related to the making of the games (designing and creating games or, specifically, making questions). Group work and learning new things were also mentioned. Although there were many positive things, more than half of the children also reported having difficulties. The main reason was technical problems; the application did not work as it should have. Another reason mentioned several times was the still rather limited functionality of the application.

> [The best thing is that] you learn to design games and to use Talarius.
>
> Sometimes the game didn't work very well.
>
> [The most problematic thing was that] we didn't find what we had saved and couldn't save properly.

Group and pair activities were preferred, similarly as in the making of the games. Twelve children wanted to play with one friend and ten in a bigger group. Only one student would have preferred solitary playing. Reasons for playing in pairs and groups entailed e.g. that it gave the chance to compete against each other, help one another, and to be with friends while playing. Some children preferred playing in pairs over playing in bigger groups because it was faster than with more players, and not as hectic. On the other hand, playing in groups was enjoyed because the children felt it brought more excitement and challenge to the playing.

Regarding their motivation to play Talarius games at school or at home, the results were in line with those that dealt with making games. Sixteen (out of 21) children wished to play at school, and nine at home. One major reason for wanting to play at school was the possibility to play with classmates and the view that playing was more interesting than normal classroom-based activities. Those who did not want to play at school (five children) felt that the school setting was too restless for concentrating on the game, and it was not necessarily possible to choose with whom to play. These were also the main reasons for being interested in playing Talarius games at home; they would be able to choose the topic freely, and to play by themselves or with those with whom they wanted to play. Some children did not want to play because they considered the games boring.

To summarize the children's perspective to the use of Talarius in the school, the idea of the game was considered rather successful for school use. The children liked several aspects of the Talarius sessions: to be able to make their own games (to come up with questions, to search for pictures and other material) and to play them, to be able to carry out these activities in groups or pairs, and to be able to use computers. The negative comments were for the most part due to the technical difficulties the children encountered while playing, not the idea of the game as such. Regarding the application itself, the most negative thing, according to the children, was that it was still rather limited in features and functionality.

As regards learning with the application, the children saw the making of games as more effective than playing them. They reported having learned by searching for information to be included in the game and by formulating questions based on this material. On the other hand, some of them considered the Talarius activities merely as playing and not learning or studying at all. This can be both a pro and a con; it is an indication of enjoyment but may also imply that the children who felt this way made the game-making and playing as easy for themselves as possible, by making easy questions based on very little background material, and by guessing their way through the games while playing. The important role of good instructions and a clear structure for the game making process is highlighted by these observations.

The teacher was also interviewed after the field trial period regarding the different aspects of the use of Talarius. The general idea of Talarius was regarded as very good by the teacher. He described it as an application which falls between subject-specific, ready-made educational software and plain editor tools such as word processors: the application allows the children to create something themselves but offers a clear structure which guides them, and they do not have to start everything from scratch. The teacher stated that children find using computers very motivating and are excited to work at computers, but was somewhat sceptical regarding potential improvements to learning outcomes brought by the use of technology. He had observed that the children's motivation to use Talarius maintained relatively high despite the technical problems they encountered along the way. Also the groups collaborated equally well in the Talarius activities as in group work in general.

> **[About the basic idea of Talarius:]** Well, one good thing in general is that there are these… kind of templates that are ready-made in some way. Someone inputs some information, and be it a teacher or a student, it looks like you have made it yourself. […] There has to be this kind of [applications], they're good alternatives to totally ready-made teaching software, in that they are not sort of totally ready-made educational applications and they're not [tool] applications either, like word processing or image editing programs, but [they are] something in between, well suitable for school use.

As regards what children can learn by using Talarius, the teacher pointed out especially social skills, content area knowledge, and computer skills. The fact that children pondered and discussed issues together, especially when making games, was seen by the teacher as the most important issue. Knowing that others will play the games they make encourages them to make careful decisions and think things through, as well as to think about the issues from the perspective of the one who plays the game – what they can ask, what kinds of answer alternatives they should provide, whether the questions are adequately challenging yet not too difficult, and so forth. The teacher felt that factual information about the content area could be learned both by making and by playing the games, as well as computer skills and experience on using computers and computer software. Moreover, as the children's own creativity plays the key role in the use of Talarius, it may also provide feelings of success if the children manage to create a game that they are satisfied with and proud of. This can be enhanced also by the feedback obtained from the classmates who play the game.

> **[About the learning effects:]** Social skills increase when they have to ponder together what to do. It works well as pair work, […] or what could be the maximum, maybe three per group. So they can negotiate how they are going to do it and think a bit about [the fact that the game] will not only be for their own use but for others as well, for the whole class. And it might even be that the finished [games] will be played by their parents in a parents' meeting, or in whatever way one wants to make use of them. They will seriously think about who might play it, if you mention that to them. […] Factual information [is what the children learn], and some things about how it works, and of course the content, […] what has been entered into it, if they play a game made by another group. On an emotional level, of course, you would think that there are experiences of success if they feel that they managed to create a good […] game board. And always, when you're at a computer, some kind of dexterity skills improve for some, too. 'You make it like this, and click like that, and…'.

Aside from the technical problems that still remained in the application, the teacher did not see any specific negative aspects in using the game. The only potential challenge might be related to some children's ways of using the application. As pointed out above, some of them did not see the Talarius activities at all as having to do with learning, which might be due to them wanting to "take the easy way out" and not taking the activities seriously. This was also pointed out by the teacher, but he emphasized that this problem exists in all somewhat independent activities and was not limited to this application.

According to the teacher, the flexibility of the application which covers principally any school subject was a major benefit in comparison to subject-specific learning software. The application might be usable even in subjects in which computer applications are rarely used, such as physical education or music. With some minimal additions to its functionality, the application could provide more chances to use it. For example, in this version it was only possible to include one picture, sound clip, or video clip to each question. Implementing a possibility to attach these files to each alternative answer in multiple-choice questions would, according to the teacher, open up a great deal of new ways of using the application. For example, sound clips of different birds chirping could be included in a question. In general, the teacher saw reviewing things that have already been studied as the principal purpose for the use of Talarius; the multiple-choice questions, for instance, provide a way for the children to test what they know and remember about a specific topic.

> **[Contexts of use:]** Well, one could actually think about it in that way, that 'where would it not be possible [to use the application]?'. I don't think that here in the elementary school classes, there are such subjects. You could use it for a change at the end of a period in physical education or music. Like 'let's make a little quiz at the end of the orienteering period', or in music, when composers have been studied, for example, a small quiz can be made. […] And maybe it's more suitable for a reviewing [tool] because it has got these multiple-choice questions and then you can test your knowledge.

In addition to the field trials conducted with elementary school children, there was a need to explore the suitability of the application to other target groups, especially to younger children who either could not read at all or were just learning to read. Therefore field trials were also conducted in **two kindergartens**. The kindergarten trials were conducted on a one-time basis, in order to collect initial suggestions as to how the application ought to be modified to be better suited for this user group. In these trials, the application was used by kindergarten teachers and children together, with a researcher observing and asking questions while they were using it. The goal was to identify issues that might be problematic for young children and would need to be addressed in future development, and to obtain information related to the possible use situations of the application in the kindergarten context. The issues addressed were related to e.g. how easy it was for a young child to use the application, in what kinds of situations it could be used, and how it should be improved to suit for younger children better. At this time, the application heavily relied on reading and writing skills; for example, although pictures and videos could be attached to the questions, the questions were nevertheless fundamentally based on text. The kindergarten teachers had useful insights on the improvements that would enhance the usability and feasibility of the application for younger children, and many of these issues were confirmed when the children used the application. These kindergarten field trials were of great value, and they indicated that no dramatic changes would be needed for the application to become more suitable for a broader target group; instead, large improvements would be accomplished with only minimal changes.

An important outcome of the field trials was the abundance of use contexts that the kindergarten teachers came up with. Like the school field trial, also the kindergarten trials yielded very positive feedback on the general idea of the application. In general, the application was seen useful in that it could be used with virtually any topic. It was seen as especially suitable for project-based periods when making games can be one way of approaching the topic area of the project. Games related to the children's immediate environment could also be made, the application could be used as a tool for reviewing things learned on a field trip, or children could create games about their own interests and hobbies. The kindergarten teachers also suggested that it could be used in different ways with children of different ages. Firstly, adults and/or older children could make games for younger children to play. With younger children, the game could also be used together with word cards: there would be a picture and a word on a card, and the task for the child would be to identify the right word in the game. Also, the children could make games in small groups consisting of children of different ages, some of whom can already read. Finally, the application could also be used in such a way that the whole group would make one common game to which each child contributes a question or two. The topics could range from the children's own areas of interest to different learning areas (math, language learning, music) and to the children's immediate surroundings or nature more generally.

In the kindergarten field trials, technical problems did not manifest to the same extent as in the school trial. The feedback regarding improvements was focused on the usability of the application from young children's perspective. Issues such as increased font size, symbolic pictures to the function buttons, keyboard shortcuts, and a clearer presentation of the number resulting from throw of the dice were brought up. In terms of functionality, the possibility to add attachments to each multiple-choice alternative was seen as an important feature, as was also brought up in the school field trial. This was especially highlighted in the kindergarten trials, as the use of pictures is essential for children who cannot read yet. The kindergarten teachers also pointed out that searching for material on the Internet is difficult for young children, and therefore a broad collection of pictures (an image bank) could be included in the application.

Observing children using Talarius and the comments they gave yielded information about how they saw the application. The ease of learning was supported also by the kindergarten field trials; after some hesitation and problems at the beginning, the children soon mastered the idea and smoothly created the game paths and made questions. Saving and other tasks which required the use of the function buttons were also carried out successfully with some aid from the adults. The importance of pictorial presentations in the function buttons manifested when the children used the application. The main window of the application included four buttons leading to the different modes of the game (question making, game board creation, playing, and teachers' section), each of which also had a symbolic picture representing the mode. Once the children knew the idea of the application, they understood very well, based on the pictures, which mode was associated with each of the buttons. The small size of some buttons or radio buttons was problematic for some children, and in the playing mode it was also difficult for them to keep track of whose turn it was and where on the game path their tokens were.

> It was difficult for the children to hit some buttons and radio buttons with the cursor. [...] It was difficult for the children to see where their game token was, especially if the game path was very complex. […] It was also not clear at all times, whose turn it was. (Field journal)

In general, the idea of the game and most of its functions proved to be successful also from the kindergarten point of view. Similarly as in the school field trial, the flexibility of the application to suit different contexts was its main benefit. The principal suggestions for improvements were related to enhancing the use of non-text-based presentation forms in the application more clearly. Whereas limited functionality and lack of variety were the main areas of criticism for older children, for younger children this simplicity seemed to be a positive quality.

4.2.3 Functioning of the Team

Above, the phases of the development of Talarius and the different methods used in various phases have been discussed. In this subsection, another aspect related to the process is addressed, namely issues related to the functioning of the team. Regarding collaboration and teamwork, the analysis of the data revealed the following categories: children's role, motivation, and scheduling and time constraints. In the following, I discuss each of these categories.

Children's Role

An interesting issue that calls for attention in terms of the collaboration between the developers and the children is the role in which the children (and the developers, on the other hand) were considered to be in the project. Crucial questions at the beginning of the project were, firstly, to what extent the developers were prepared to involve children in the process, and secondly, what their stance was towards the notion that children's ideas can contribute to the development of the application. Interviews, meetings, and project documents revealed that the concept of children's involvement had indeed been a rather vague idea for the developers at the beginning, but as the value of the collaboration became apparent in the course of the project, children's participation began to be viewed as an integral part of the project process.

> According to the group, […] at first it had not been very clear to them, how active children's participation was expected of the project. Therefore, at the beginning, the project had seemed more straightforward and easier to manage than it actually was. The requirements and the goals of using the [user involvement] approach became clearer in the course of the process, however, and the group appeared to start seeing the children's participation as a natural part of the project. (Research journals)

At the very beginning of the project, the developers' comments in meetings and in the interview indicated that the meaning of children's involvement or the concepts of e.g. user involvement or participatory design were not very clear to the developers as they had not been involved in projects employing such approaches before. They expressed concern about managing to choose successful methods that would both enable the children to express their ideas and the developers to make use of the children's ideas. In the interview after the very beginning of the project, it became apparent, however, that the concept of participatory design had become clearer, and the developers paid attention to examining methods and practices that would bring out the children's expertise.

Drawing was the principal method considered by the developers to be used in the project, as they felt that it was a familiar and natural activity for the children.

> I got an impression that the concept 'participatory design' or what 'involving children in the design' means is not clear to everyone. […] Therefore it seemed important to emphasize that, right from the beginning, all participants 'speak the same language' and that concepts have the same meaning to everyone, so that obscurity and misunderstandings are avoided. (Research journals)

When comparing the approach of this project to the roles of children introduced by Druin (2002), the developers saw it being closest to the *informant* role, stating that the design partner role would have required more intensive collaboration. Besides informants, the literal terms used in the project documents to refer to the children included *actors*, *active participants*, and even *design partners*. This implies that the developers wanted to emphasize the children's active role and suggest that the collaboration went beyond the role of an informant even if it was the closest equivalent in terms of Druin's role classification.

> It is likely that the application would have become different if the students of the partner class had not been involved in the development of its usability, as active informants. […] The pupils of [the partner class] have had an informant-like role in the Talarius project. Actual design partnership would require regular design sessions and considerably more resourcing for designing together. […] [We have attempted to] improve the usability through participatory design. The goal […] is that the users participate in the design process of the system [in the role of] as active actors as possible. (Usability analysis report)

The children's comments on the collaboration, on the other hand, implied that they saw themselves mainly as feedback providers who played with the prototypes and pointed out their pros and cons; the testing sessions were the foremost thing by which the children defined their participation. For example, there was a question in the final questionnaire in which the children were asked to describe how they had participated in the project. Out of the 23 children who answered the question, 14 brought up testing or feedback-giving, and for most of them these were the only things mentioned altogether. The UI drawings, for example, were mentioned by none of the children.

It was difficult for the children to estimate whether, and how, their participation had helped the developers: as many as 16 children chose the "cannot say" option (3 on the scale of 1 to 5) for the statement *My comments have helped the developers of the application* in the final questionnaire (Figure 21). Also, the open-ended question accompanying this statement yielded very vague comments regarding how the children believed their participation had helped the developers.

> [My participation has helped because] I've pointed out some mistakes and given feedback.

> I don't know really, maybe [my participation has aided] the development, at least some.

Hence, it appeared that the children had not been thinking much about their role in terms of how their contribution added to the outcome, nor had the significance of their participation – which was an issue repeatedly mentioned by the developers – been communicated to the children in a way that they would have taken in what their contribution meant from the developers' point of view. Moreover, a clear majority of the children disagreed, most of them strongly, with the statement *"I would have liked to participate also in other ways than those that were used now"* (Figure 21). This result and the previously mentioned one may be connected; if the children were uncertain about the significance of their contribution, they did not want to have any other ways of participation either, as they were not sure whether these would benefit the development. Also, they might have been unaware of what these "other ways" could be. Some children also mentioned that the ways of participation that were used now were just fine.

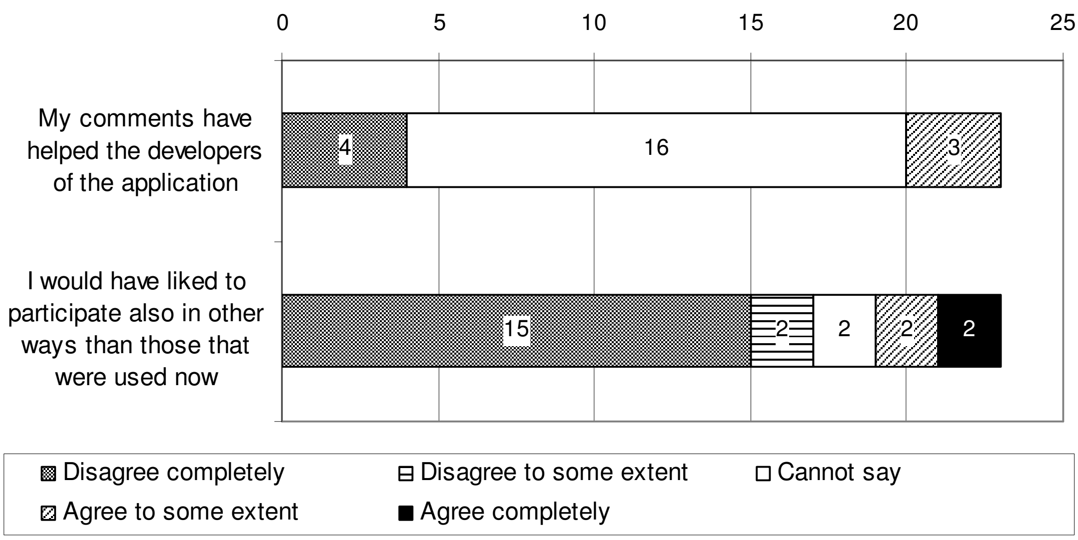

FIGURE 21 Children's views on the significance of their participation

A distinct issue related to the children's roles in this project was that, in addition to the partner class, the project also involved a parallel class in a supporting role. This other class only participated in one testing session, the aim of which was to either confirm or challenge issues discovered with the partner class by bringing in children who were not yet familiar with the application.

Moreover, the children's feeling of the extent of their empowerment is closely related to how they see their roles in the project. I will not delve into this issue here, however, as the children's experiences about empowerment and the manifestation of their ideas in the outcome will be discussed in more detail in separate subsections (4.2.5 and 4.2.6).

Motivation

Motivation was heavily emphasized by the developers. They often referred to their own good motivation and how it was enhanced by the collaboration with the children, and they also saw the collaboration as a motivating activity for the children. The positive effect of the collaboration on the developers' motivation was related to different aspects of the teamwork. Firstly, the setting in general – working with children – created a motivating environment for working. As the developers stated, their motivation was especially good when they were going to meet the partner class and work with them. Secondly, the direct feedback obtained from the children was a motivating factor: the developers got very detailed and precise comments and suggestions from the children, which gave them a concrete picture of the children's ideas and a good basis for further development. Finally, seeing the children's investment in the project and the prototypes of the application being used by the real users enhanced the developers' view of the importance of their development task.

> In this phase, we were highly motivated to work, which was highlighted every time when we were about to go and work with the children. (Phase report: Implementation phase)

> In both phases, [our] work motivation has been excellent […]. The good motivation is possibly partially explained by the fact that [we] considered it an important task to make this application for the pupils of the partner class, and we did not want to disappoint them. All the members of the group have been very committed to the project work in both phases. (Phase report: Take-into-use and closing phases)

Moreover, according to the developers, they had a rather firm belief that the participation process motivated also the children to use the application: similarly as the children's participation motivated the developers in their development work, participation and investment in the development project of the application would motivate the children to use it. The quotation below demonstrates how the developers explained this view.

> Through participatory design, the actual users of the application could be motivated to use the application, since they know they were themselves involved in the design of the application, and they understand the choices and solutions made [during the process] especially well. This is supported also by the results of the 'motivation meter'. Participatory design motivated the developers as well, because the direct feedback motivated us to improve the application. (Usability analysis report)

As regards the children's motivation, a considerable majority of them deemed the project to have been interesting: in the final questionnaire, 8 out of 23 strongly agreed and 10 somewhat agreed (Figure 22). Based on the children's comments, the main aspect motivating them appeared to be the fact that participation in this project provided them with a different type of activity than what they were used to at school. Design and evaluation sessions brought variation to their everyday school work. Moreover, different special activities, such as visits to the developers' premises, were an additional factor related to

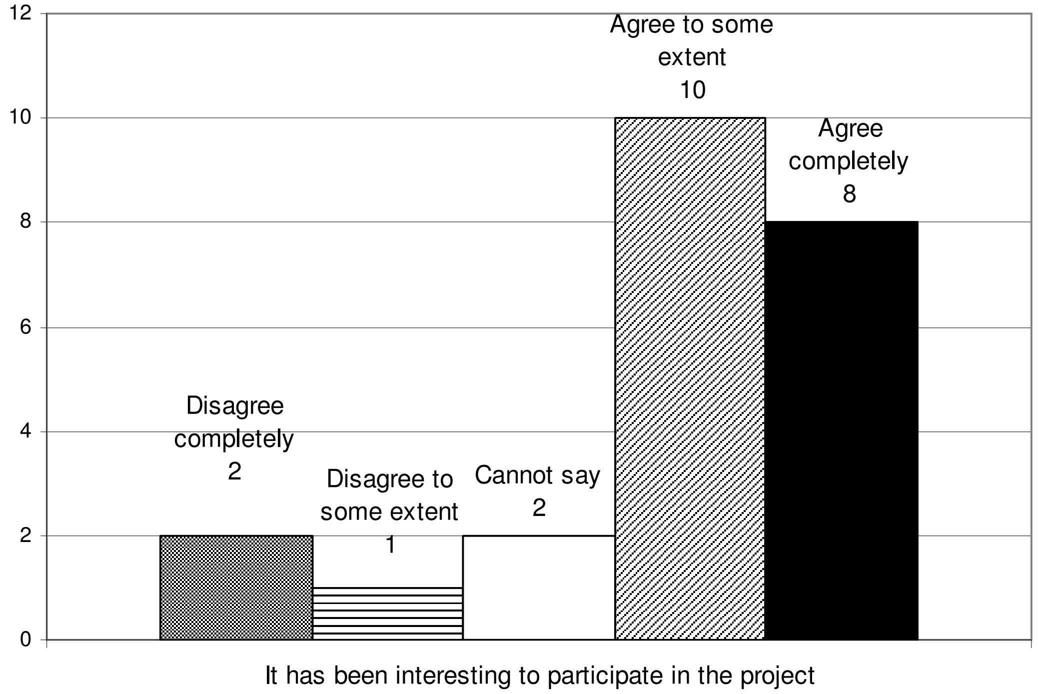

FIGURE 22 Interest as a constituent of the children's teamwork experiences

this. Furthermore, the children were participating in the development of a real application, which was a chance to do something that was not possible for everyone. This uniqueness of the opportunity to be part of something like this was brought up as a motivating element as well. Some children also compared their own level of participation to those of others, stating for instance that they had participated in the project exactly in the same way as everyone else or, on the other hand, mentioning that they had been exceptionally enthusiastic in the collaboration and been more motivated than some of their classmates.

> [I have participated] more than many others, because me and Jani [name changed] wanted to give feedback on [the application]!

> Different from normal classes… Not everyone has the chance to take part in something like that.

> I was able to concentrate well when I thought that "I could be in a boring math class right now".

Children's behaviour during the project activities is closely linked with motivation, as behaviour is how the children's motivation, or lack of it, manifests. Above, children's motivation was discussed in terms of the children's own experience of their motivation, whereas here the focus is on how they acted. The children showed interest in the project by asking questions during the participation sessions about e.g. the progression of the project and the features of the application. In the UI mock-up evaluation session, some children also were interested in hearing whether their UI drawings had been useful to the developers. This type of interest extended to the children of the parallel class as well although they only participated in one testing session ("are we the first ones who get to see this version?"). On the other hand, it is likely that also in the case of the parallel class, motivation would have gradually levelled out if they had participated in several sessions when the initial novelty of the situation would have worn out. The children of the partner class behaved particularly enthusiastically during the visits to the developers' premises, which for its part reflects the issues stated above about variation to a normal school day making the children excited.

> The children also had the chance to ask us questions about the project [during the art class]. Some asked e.g. what kind of a program it was going to be, how far the project had advanced, and when the application would be finished. (Research documents)

> [T]he children also competed for the facilitators' attention by posing questions related to the application. (Usability analysis report)

All in all, the sessions were somewhat hectic at times. The whole class (or sometimes half of the class) was present at the same time, and in case someone encountered a problem and a facilitator was not able to attend to him or her immediately, it caused frustration, which consequently led to the whole group becoming very restless. Some children remarked this as well and commented in the final questionnaire that other children had disturbed or distracted them.

> The children's activities in the testing sessions have been principally enthusiastic, and they have given plenty of comments about the application and development suggestions. The testing situations have all been quite hectic, as either the whole class or one half of the class, depending on the situation, has been present at a time. (Research documents)

> In the testing session of the parallel class, even though the whole class was restless in the beginning […], little by little their concentration on playing improved and the group calmed down. (Usability analysis report)

> Others disturbed me sometimes. (Children's final questionnaire)

> [T]he boys were a little noisy. (Children's final questionnaire)

Scheduling and Time Constraints

Issues related to the schedule of the project and its different phases and activities were potentially the greatest cause of frustration for the developers, whereas for the children they were a non-issue as the children were not aware of the time-related problems or constraints. The collaboration between the developers and the school class was somewhat difficult as each party had its own schedules and deadlines which did not match very well. Schedule problems manifested especially at the beginning and at the end of the project, and in these stages it appears also in the developer group's Risk Management Reports from each project phase.

> [The main challenge has been] scheduling, between all the stakeholders of the project. (Developers' e-mail interview at the end of the project)

> The project has several stakeholder groups, the schedules of which are difficult to match up with one another. We attempted to manage this risk by negotiating about the schedules with the stakeholders as early as possible, and by being active [in contacting them]. (Phase report: Implementation phase)

These difficulties did not cause dramatic problems, however. In the Risk Management Report concerning the final phase of the project, for example, the developers estimated schedule problems to be very likely (4 on a scale from 1 to 5) but not critical (1 on the same scale). The most visible shortcoming caused by schedule problems was the failure to carry out one of the planned sessions because a suitable time for arranging it could not be found without causing considerable delay for the development activities as a whole. This might have constituted a risk regarding the usability of the application but it was later compensated by another activity. It could be said that the most serious effect of the time-related problems was the uncertainty they created.

> According to the developer group, fitting schedules together, for example when planning dates for the user testing sessions, was one of the problems of the project. For instance, the evaluation of existing applications failed to be carried out because of time-related issues [...]. (Research documents)

> Especially schedules presented problems in the gathering of the requirements. One method planned to be used for gathering requirements was a method in which children are observed as users of existing applications of the same type, and thereby attempt to obtain information, for example, about the ways of using menus or the mouse. This was not carried out, however, due to schedule problems, which, according to the developers, enhanced the [...] risk that the user interface will not meet the goal set for it related to the ease of use. (Research documents)

The subsections above have dealt with the issues related to the themes dealing with the process of user involvement. Starting from the next subsection, the focus shifts onto the goals of user involvement; how they were addressed and to what extent they were attained in the Talarius project.

4.2.4 User Expertise and Context

This subsection addresses two issues related to the goals of user involvement, namely user expertise and real context. First, I will examine questions related to how the users' expertise was addressed in the project by the developers and how the children saw their own expertise in the project. Then I will proceed to take a look at how the real use context was taken into account in the Talarius project.

User Expertise

Children's and developers' conceptions of the children's role in the project have been discussed above. The developers saw the children as active participants or informants who provided them with a great deal of useful input. This leads to the question about the types of information the developers sought from the children's participation – in other words, the aspects in which the developers especially needed, and learned from, user expertise.

The developers openly brought up their lack of experience with designing technology for children, and especially for that reason they acknowledged the importance of getting ideas and feedback from the users. The main focus was on user-interface-related questions. For the most part, they emphasized the evaluation of prototypes as a valuable source of information.

> [Risk:] User interface usability. The members of the group do not have much experience of designing user interfaces intended for children. We will attempt to manage the risk by carefully focusing on the creation of user interface prototypes. The focus groups will test the user interfaces […] and give feedback on them. (Risk management report: Analysis phase)

In order to obtain relevant information and to focus the gathering of information, the developers emphasized the importance of planning carefully what kind of information was especially needed in each phase and from each participation method, and how this information could best be obtained. The developers' experience about the ways of eliciting information increased in the course of the project, and with each participation activity they were able to focus the goals more. In the UI drawings the children were basically free to express whatever (UI related issues) they wanted, in whatever way they wanted; they were not invited to pay special attention to any specific aspect of the UI, nor was it defined which elements they ought to include in their drawings. The only instruction given to them was that they could draw either the playing mode or the game creating mode of the software. From the drawings the developers received a variety of different ideas regarding UI solutions, and in the next phase they began to narrow these down. They started looking for the best solutions with the aid of UI mock-ups, with which they tested the successfulness of different interaction styles and UI elements. With the functional prototypes, they sought information about specific usability issues and preferences, in addition to observing the use in general.

> [We] pondered what new information we wanted […] from the testing, and chose the appropriate ways of testing. After this we planned the testing setting, carried out the testing, and reported the test results and the observations from the testing. (Phase report: Implementation phase)

> The goal of the user testing of […] Prototype I was to find out what kinds of user interfaces the partner class students want to and can use. During the testing session we also examined the partner class students' computer skills and ways of using computers (for example, observed the use of Windows-type file menus). (Usability analysis report)

User expertise was sought especially related to 1) the usability, 2) the appearance, and 3) the functionality of the application, 4) the ways of using the application, and 5) the learning effects of the application. Table 8 describes the information sought, and obtained, about each of these aspects. The first three

TABLE 8 User expertise in different aspects

Aspect	Issues discovered	Source
Usability	Navigation	UI drawings, mock-up evaluation, prototype evaluation
	Mouse interaction styles	Mock-up evaluation
	Importance of Help function	UI drawings
	Ease of use	Mock-up evaluation, prototype evaluation, "motivation meter"
	Motivation to use, fun aspects	"Motivation meter", mock-up evaluation, prototype evaluation,
	Suitability for different age groups	Field trials
Functionality	Important features in games	UI drawings, requirement interviews, prototype evaluation
	Sound effects and music	Requirement interviews, mock-up evaluation, prototype testing
	Importance of help function	UI drawings
	Suitability for different age groups	Field trials
Appearance	Colourfulness	Board games, UI drawings, requirement interviews
	Layout	UI drawings
Usage	Ways of interacting with the application	Prototype evaluation, field trials
	Real use contexts	Field trials
Learning effects	Learning by designing games	Field trials
	Learning by playing	Field trials

points were emphasized by the developers as the main focus areas of user involvement during the pilot project, whereas the two latter points were stated as the main objectives of the field trials. These aspects were addressed with the different methods used in the course of the project – sources of user expertise included the board games created by the children before the project, their UI drawings and the related interviews, as well as the different evaluation sessions and the field trials which were conducted after the pilot project (at this stage, the pilot version developers were no longer involved in the project).

In terms of *usability*, the children's involvement in different phases of the project was in an important role. Both the drawings at the earliest stage of the project and the evaluation sessions in later phases elicited outcomes that guided the developers in choosing appropriate interaction styles and UI structures. From the drawings, they identified issues related to navigation and e.g. the availability of help, and the evaluation sessions shed more light on these issues. Regarding the help function, the quotes below illustrate that while the drawings showed, on a general level, the importance of quick access to the help function, the prototype evaluations informed the developers whether a specific type of help function was a successful solution in terms of usability. From the drawings the developers concluded that it was important for the children to have easy access to the help feature. With the aid of the different evaluation sessions they tested different ways of realizing the help function. The evaluation session of the first prototype suggested that a "balloon"-type help function might work, but the subsequent testing sessions did not confirm this: it was noticed that the children tended to close the help windows without paying attention to them. This led the developers to place the help texts and hints to a space in the corner of the game window so that they were readily available at all times, not forcing the children to read them but not tempting them to ignore them either.

> The menus are in rather traditional locations. […] Several of the pictures include a help function. […] [Practically applicable ideas obtained from the drawings are related to] the appearance of the user interface. Some ideas [have been obtained] also for the functionality (such as the help function). (Developers' interview at the beginning of the project)

> The testing of Prototype I with the pupils revealed that a "balloon"-type help function would be good in the application. Based on the feedback obtained from the pupils, we implemented a help function of this type in Prototype II. (Phase report: Implementation phase)

> Help function of the desired type was implemented. When testing [Prototype II with] the parallel class, we noticed that pupils who have often browsed websites that have a lot of pop-up windows closed the instructions without reading them. The implementation of the help function succeeded well technically, but based on the testing with the parallel class, it might be that this type of a help function is not the best possible help function after all. The successfulness of the help function will be tested another time in the testing to be held with the partner class on February 10, 2004. (Phase report: Implementation phase)

Evaluations also provided information on mouse interaction styles – whether the children preferred to add game squares on the board by clicking or dragging. The children's preferences, as well as the rationales for their preferences, were in line with the results of previous studies about children's mouse interaction (Inkpen 2001): Most children preferred clicking, justifying this by stating that they felt that they were able to place the squares more precisely by clicking than by dragging. A few children liked the dragging style, explaining this e.g. by saying that by dragging the squares, holding the mouse button down, they knew better that the square they were about to move was actually moving with the mouse. In each evaluation session, the developers also asked the children to answer the "motivation-meter". With the aid of this questionnaire, they were able to monitor the children's motivation to use the application, and to compare it with the parallel class who only took part in one evaluation session. In addition to the other aspects of usability (e.g. Nielsen 1993, 24–27), it was essential to address the subjective opinions as well. Finally, examining and assuring the usability of the application from the perspective of other user groups than the direct target group of the pilot application required expertise that could be obtained through field trials. The kindergarten field trials were valuable in guiding how the usability could be improved to suit younger children better.

Likewise, user expertise for designing the *functionality* of the application was sought through similar steps. UI drawings and related interviews gave an overview of what the children wanted from a board game creation tool, and the evaluations provided more focused and concrete information on their ideas and requirements. Different game elements and especially sounds and music were considered important by the children. The above discussion of the help function, which was very clearly visible in the children's UI drawings, is also one concrete manifestation of the functionality-related requirements. As with usability issues, the expertise from field trials was valuable in that it provided information on how successful the features of the game were from the point of view of other user groups, especially younger children whose reading and writing skills were not yet well developed.

As regards the *appearance* of the application, the UI drawings were a successful way of having a concrete representation of the children's ideas. Colourfulness and layout solutions were the principal issues discovered from the drawings by the developers – colourfulness was evident also in the multi-coloured and carefully made board games that the children had created earlier, and brought up by the children also in the interviews in which they were asked for requirements. However, it led the developers to ponder that if the children make very colourful games, it might be better if the user interface of the application itself uses somewhat more subdued colours. The decision they ended up with was that the final application had one principal background colour which the children were able to change from a menu.

> Colourfulness [was evident in the children's requirements]. [...] Should the application itself be subdued in terms of colours if the children make colourful games with it? (Developers' interview at the beginning of the project)

Ways of using the application and its learning effects were issues for which the users' involvement was needed especially at the later phases of the project – and after the actual development process, when the field trials started. In terms of *usage*, two main areas required input from the users; firstly, how the users interacted with the application on the level of one use session and, secondly, how the application was used in a broader sense. In terms of the former point, the developers' observed that the children discussed much with one another while using the application in the evaluation sessions. Another observation was the children's tendency to make more multiple-choice questions than open-ended ones, observed in a field trial session. The latter issue entailed the situations in which and topics with which the application would be used and how a sequence of Talarius lessons would be constructed.

The field trials also yielded information – both observations and the users' subjective experiences – on the *learning effects* of Talarius. In the participatory activities during the development project of the pilot application, the requirements and suggestions related to learning with the aid of the application were obtained almost solely from teachers or teacher students. From the children, the developers (in their feedback forms and the questions they asked during the sessions) mainly sought contribution to issues related to how boring or fun, and easy or difficult the application was; issues related to learning were not in a key role. When the children were asked, in the interviews about the board games created by them before the project, how they thought their games would help players to learn, they had considerable difficulties answering this question. Perhaps because of this, the children's contribution to the learning perspective was not especially sought until in the field trials.

As mentioned, evaluating the fun and the boringness of the application and its different aspects was the central focus of the children's expertise. Partially this was because the children were asked about these entertainment-related aspects (e.g. the "motivation meter" and the feedback forms that the developers created for the evaluation sessions heavily concentrated on them), but partially because these issues were what they brought up the most in e.g. the requirements gathering interviews.

> With Prototype I, we aimed to find out which functions and features the students want to have in the program, in other words to specify with the aid of a concrete example, what was fun and what was boring. (Phase report: Implementation phase)

Easy and difficult aspects were the other main area of seeking user expertise from the children. The developers stated, for example, that they had been able to implement more complex features than they would have assumed, as the children had proved to be such skilled computer users.

> The appearance and functions of each module have been realized based on the feedback obtained from the children. Because the children can use computers very well, we were able to implement solutions that we first considered too difficult. (E-mail interview at the end of the project)

In general, the users' expertise surprised the developers positively. They did expect the children to give honest and straightforward feedback, but the preciseness and detail of their comments took them by surprise. They also obtained quantitatively more information than expected, especially from the evaluation sessions. In order to be able to manage the feedback well, the developers emphasized the significance of planning carefully what kind of information they needed. This did not mean, however, limiting the children's ability to express their expertise. Also, in order to enhance the children's conception about the importance of their expertise, the developers aimed to emphasize to the children that their opinions and choices were important for the development of the application.

As stated earlier, the children mainly saw their role in the project as that of feedback providers, and it was difficult for them to estimate if their contribution had been useful to the developers. The children's thoughts about their own expertise were on a rather general level: they felt that they had brought opinions and ideas into the process. More specific issues the children felt they had contributed included the fun aspects of the application, the ease of use, suggestions about different features, and sound effects. Their contribution to how fun the application became was especially emphasized.

> [My comments have been useful] because it has become more fun.
>
> Well, [if we had not participated, the application] could be more dull and the music could be a lot more boring.
>
> [Without our participation, the application might be] more boring somehow, and more difficult to use.

Some children also emphasized that they had provided the users', i.e. children's, point of view. One child stated that if this class had not participated, another one would have, and the application would in the end have become rather similar to what it was now. At least this student felt, thus, that the issues they brought into the process were something that children universally would bring. In general, the children's views on whether the absence of their participation would have caused the application to become different were very evenly scattered along the scale; approximately as many felt that their expertise did bring something unique to its development as that it did not (Figure 23).

> They got an idea of what the users think.
>
> I think that [if we had not participated,] improvements wouldn't have been made for children, but for adults.
>
> It wouldn't be different because some other class would have participated in it.

The children were also asked whether they would have wanted to influence some aspects of the application more than they did (Figure 23). Only six of the children would have wanted to influence it more; however, some children had many examples of aspects to which they would have wanted to contribute more. Issues related to the appearance of the application were mentioned several times: the appearance of the game tokens, backgrounds, squares, and dice; and the graphics of the game in general. Another issue they would have wanted to influence more was the variety of content and options: that there would be more ready-made backgrounds, videos, and pictures to be used in the game,

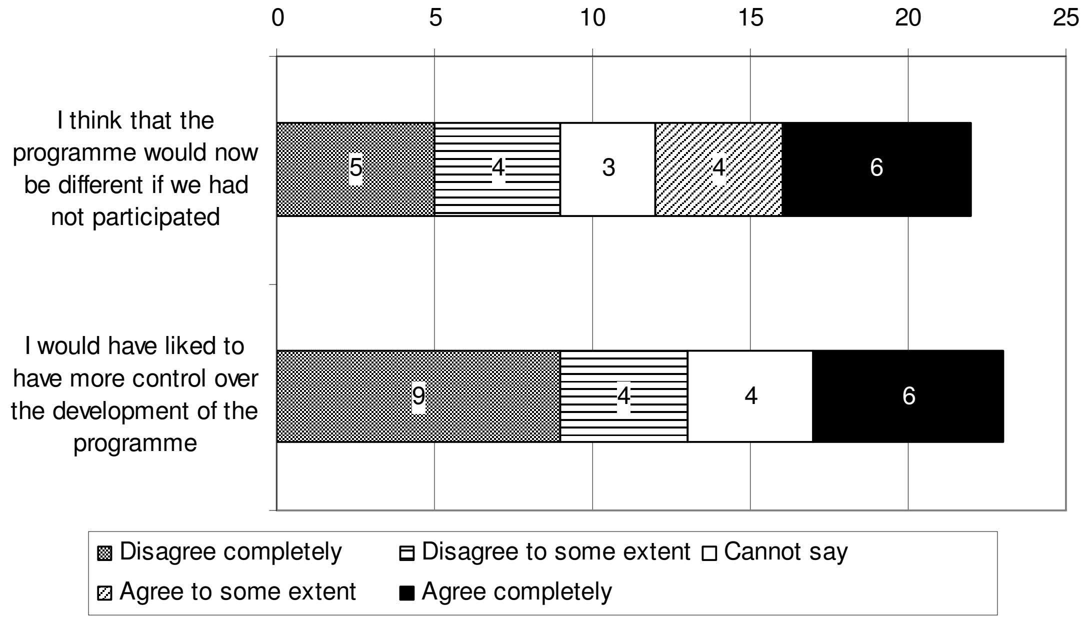

FIGURE 23 Children's views on their expertise in the project

and that there would be more freedom of choice in general. Some children also expressed that they would not have wanted to make this type of a game (i.e. a board game or a learning game) in the first place; for example, an adventure game would have been more interesting for some children. The children's answers to this question support the notion that the entertaining features were in fact the issue on which their expertise and interest focused the most. This raises, however, an interesting question about what was the cause and what was the effect; the fun features are, of course, important to the children, but it is possible that the emphasis they put on these issues was partially due to them being the main focus of their participation throughout the project, as the developers especially sought to find out fun-related points of view through the children's involvement.

Addressing the Actual Use Contexts

Taking the actual use contexts into account is one of the key components related to user involvement (e.g. Good & Robertson 2006; Karat 1997). In the Talarius project, two dimensions to the addressing of the context were identified: environment and content. Both had the same goal – to play a part in ensuring that the application fits the real purpose, in this case, to serve as a learning tool in classroom. As regards the former point, the *environment*, the major part of the activities was carried out in the children's own school settings. The evaluation sessions carried out in the school computer lab enabled the developers to observe issues related to the children's actual school day which might be interesting also from the point of view of developing the application. When the class has computer activities, sometimes they are all present in the lab and sometimes just one half of the class at a time – and it was noted in the project that the nature of the sessions was somewhat different depending on the number of children present. The developers also noticed the significance of good instructions of tasks – in other words, the teacher's crucial role in how successful a Talarius session is. This issue was pointed out also in the research journal, in the case of observing some children not paying attention:

> […] This was an indication that instruction and monitoring has a great significance in the use of an application like this: in real use situations, there is a need to keep an eye on the interactions of some students in order to assure that they indeed do something 'useful'. (Research documents)

The real environment informed some technical issues as well. It was observed that a solution in which the application automatically saves the children's games and questions in the same folder with the application itself would not work because the children did not have the rights to save any files on the hard drives of the computers. Hence, a feature which was intended to make saving the games easier for the children (as they would not have to use the file management window) made it in fact much more difficult. For the same reason, in the take-into-use session the developers were not able to instruct the children to install the application. The role of the real environment was greatest in the field trials, which were conducted completely according to the needs and schedules of the school.

The latter aspect of addressing the context of use, namely *content*, manifested through the material that was used in the game in the evaluation sessions. The question sets used as pilot content in the evaluation were based on geography-related questions that the children had created in class, and in this way they were related to issues the children were actually studying at school at that time. In this way, the evaluation sessions were integrated as a part of the children's actual school work. Moreover, having these questions in the game was important to the children; they were delighted to see their own questions appear in the games when they were testing the application.

4.2.5 Empowerment of Users

One of the main agendas behind user participation is to empower the users and let them have a say in issues that have to do with their work – or in this case, school work. Issues related to the children's feeling of influencing the development of the Talarius application have been touched upon above, and this subsection will discuss this aspect of the participation in more detail and aim to discover how the children experienced their influence and empowerment. Figure 24 illustrates the children's opinions related to their feeling of having influence over the development of the application and feeling ownership of the outcome, as reported in the final questionnaire after the project.

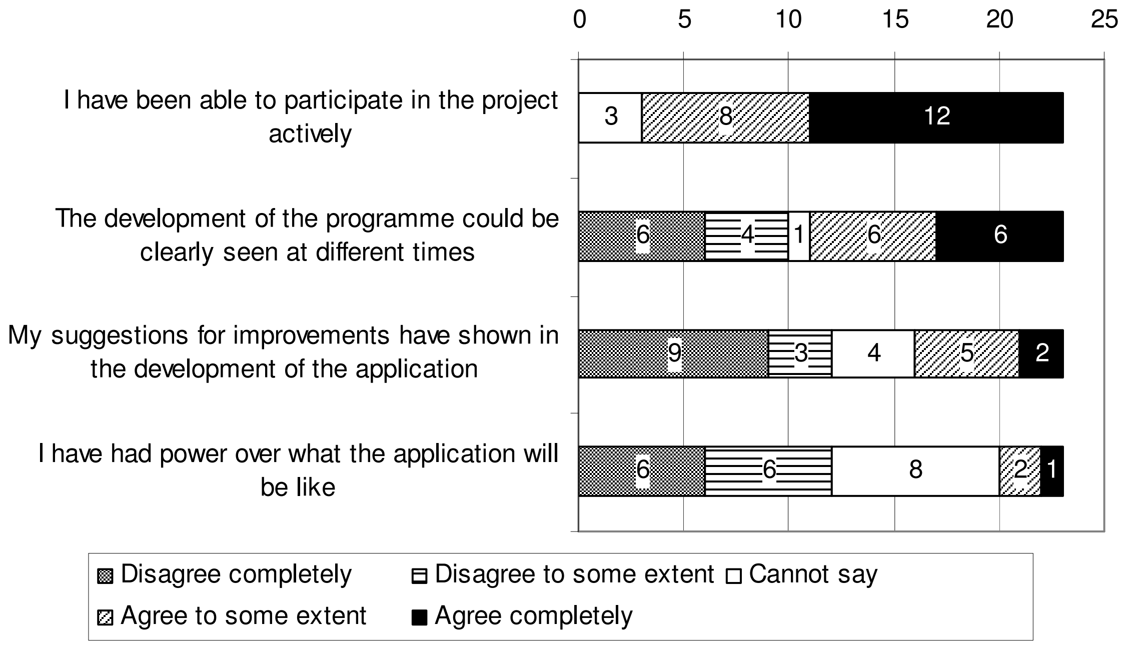

FIGURE 24 Issues related to the empowerment of users in the Talarius project

The children felt that they had been able to participate actively in the project; none of them felt the opposite (Figure 24). Despite being able to be active in the project, when it comes to the manifestation of their ideas and suggestions they still felt that their opinions did not show in the outcome. Even though many children reported noticing, in general, that changes were made to the application after each time they gave feedback and provided ideas (Figure 24), individual students did not feel that their ideas "got through". Nine students strongly disagreed and only two strongly agreed that their ideas had shown in the application (Figure 24). Additionally, according to the figure, only three children felt that they had influence in the development of the application: two somewhat agreed and one strongly agreed with the statement. All in all, as noted in the subsection dealing with the children's roles in the development collaboration (Subsection 4.2.3), estimating what their participation meant in terms of the development of the application was rather difficult for the children.

> My own ideas haven't really shown, [but] something has been done [to the application] anyway.
>
> Well, it's kind of hard to say, but [the prototypes] have been different because I've said my opinions.
>
> [I have been able to influence] at least a little, because the final decision was mostly [the developers'].

The children felt the most empowered regarding the sound effects and the appearance, especially the colourfulness, of the application. This is consistent with the issues discussed regarding the analysis of the manifestation of ideas: several improvements related to colourfulness were made to the application in the course of the project (e.g. background colour of the whole application and more colour choices for the different elements of the games created with it). Other issues which some of the children reported having been able to influence included the fun aspects of the game, some specific functions, playability, and the questions (the set of questions created by the children which was included in the application as an example set).

The children were also asked why they thought their ideas did not manifest in the outcome, and some children felt that this was because their suggestions were bad, or because they just were not taken into account by the developers. An underlying idea that was common to most of the comments was that the children strongly felt that the developers had the final say; for example, the children gave suggestions of improvements but the developers judged whether those improvements were "needed". An interesting observation was also the comment of one child who stated that it was probably because there were not enough resources – a fascinating indication that by listening to the developers, some children also had obtained an idea of the realities of a development project.

> [My ideas have not shown because] they were bad suggestions or others had better ones.

> Maybe [the aspects I pointed out in the feedback] didn't need to be fixed.

As discussed in the subsections dealing with the functioning of the team and user expertise, the children mainly saw themselves as providers of feedback, testing and evaluating the application and responding to questionnaires or interviews. Their role as initiators of ideas did not come out as clear (which is likely to be partially also due to the timing of the final questionnaire: the evaluation activities were more recent and therefore better remembered). The fact that the children's involvement was heavily focused on evaluation activities – first the mock-ups, then two different prototypes, then the final outcome, and finally the sound effects – was likely to add to the feeling of being in the role of feedback-providers, even though the developers reported obtaining many guiding ideas from the children's drawings and the requirement-gathering interviews.

From the researcher point of view, potential problems with the feeling of influence were seen as a risk from the beginning of the project. The developers' initial plans did not include much interaction with the future users, and although they were then modified into a more user-focused direction, there was still some uncertainty as to whether the users' perspective would be adequately addressed. As it has been described in this section, there were several sessions in which the users participated, but for the most part, they were focused on testing the application. At the early stages of the design process, the developers sought ideas from the existing board games, the UI drawings, and the interviews conducted while the drawings were being made. However, as seen above, to the children there were no clear links between these and the prototypes created, and they did not consider these activities an integral part of the project. Those children who did see connections between their ideas and the outcomes referred to the feedback they had given in the evaluation sessions, not to the earliest participation activities.

> The plans [for carrying out the project] had already been made [by the developers] for the most part, but does the children's perspective come through adequately (and especially, at an early enough stage)? (Research journal)

> We've actually gotten to decide the most part of the final result, by testing different alternatives. (Children's final questionnaire)

Although the developers reported having benefited greatly from the children's creations, they used them in a rather ad hoc manner instead of a systematic analysis of the drawings, games, and interviews. As seen above, the conclusions drawn from the drawings were of a rather general nature: they were colourful, the navigational elements resembled traditional Windows applications, and they were used as a "source of inspiration" in the course of the project while they were on the walls of the office. This was naturally partly due to limited time resources available, but it also raises the question whether there would have been ways of analyzing the material quickly, yet more systematically. Additionally, the conclusions drawn from the drawings, board games, and interviews were not presented to or discussed with the children. In this way, the process by which their ideas affected the final outcome remained hidden to them, and they had a hard time filling this gap when evaluating whether their participation had influenced the development of the application. In other words, the children participated by providing ideas in their sessions and the developers used the ideas to aid them when making the application, but these two dimensions remained too separate in the children's eyes.

4.2.6 Manifestation of the Users' Ideas in the Outcomes and Meeting the Children's Expectations

The influence of the children's expertise and the children's own perceptions of their empowerment have been discussed above, with somewhat controversial results. The value of the children's participation has been significant to the developers who have stated that the children's ideas and suggestions have informed greatly their design solutions. However, the children's feeling of empowerment has been somewhat lacking. The discussion above has been based on the perspectives of the developers, the children, or the researcher – a detailed analysis of the *artefacts* themselves has not been made yet. As mentioned above, such an analysis was not conducted in the course of the project, but it was seen as necessary to conduct it afterwards to see whether a more systematic analysis of the children's drawings and comments would have yielded some observations which remained undiscovered in the project. In this subsection, the outcomes of the participation sessions will be compared to the application itself; the aim is to understand whether, and how, the children's suggestions at different phases of the process actually show in the outcomes and whether there are some crucial issues that were not unveiled during the project.

In the following, the results of this analysis will be presented. The first issue to be addressed is how the elements presented by the children in the *UI drawings* manifested, firstly, in the mock-ups and, secondly, in the final Talarius 1.0 prototypes. A similar analysis will be conducted about the requirements brought up by the children in the *informal interviews* which were held while the children were working on their drawings. Third, it will be analyzed how the *feedback given by the children about the UI mock-ups* manifested in Talarius 1.0. Finally, after the analysis of the manifestation of the ideas, the children's views on whether the application met their expectations will be examined.

UI Drawings vs. UI Mock-ups

The UI mock-ups contained mainly very basic functions (such as making the game path, making questions, throwing the dice). The goal of the developers, according to them, was to test different specific types of UI solutions and interaction styles (placing squares on the board by clicking vs. dragging, using menus etc.), and therefore the only the most basic features were included in these mock-ups. It was important to get clear results about those most important issues without risking that other distracting factors would come in the way.

The drawings were analyzed one by one, by identifying and listing all the elements that appeared in the drawings. Special attention was paid to those issues that were mentioned by the developers as their main conclusions from the drawings: the different functions that the children wanted, the way in which the navigational elements were arranged, and colourfulness. Thus, as regards functionality and navigation, each element in the drawings was labelled in terms of its function (e.g. Help), type (e.g. button, checkbox), and location (vertically and horizontally). In terms of colourfulness, the drawings were analyzed in terms of how many colours they included and which colours were used.

Table 9 presents the comparison between the different elements that appeared in the children's drawings and the features that were included in the first UI mock-ups. This table is related to the functionality depicted in the drawings. In the first column, elements from drawings are categorized into general elements (which appear both in drawings depicting the editor mode and the playing mode), editor elements (features used for making games, from those drawings that depicted the editor mode), and playing elements (functions needed for playing the games, from the drawings depicting the playing mode). The mock-up columns illustrate which of these elements showed in each mock up. There were three different UI versions (V1, V2, V3) for each mode of the game (making questions, making game board, and playing games). The versions differed from one another in terms of navigational solutions, mouse interaction styles, and some functionality.

TABLE 9 Comparison of the functions of the UI mock-ups to those presented in the children's drawings

Mock-ups (modes) / Features in drawings	**Make questions**			**Make game board**			**Play game**		
	V1	V2	V3	V1	V2	V3	V1	V2	V3
GENERAL									
Help							x	x	x
Exit / Close	x	x	x	x	x	x	x	x	x
EDITOR MODE									
Make/Choose background						x			
Record/Add sound	x								
Save	x	x	x			x			
Name of the game/player				x					
Choose/Draw character									
Write questions	x	x							
Make/Add animation	x		x						
Preview	(x)	(x)	(x)	(x)	(x)	(x)			
Square colour / Draw square					x	x			
Square shape / Draw square						x			
Add text (to game board)									
Main menu / Program menu	(x)	(x)	(x)	(x)	(x)	(x)	(x)	(x)	(x)
Colour of dice									
Define rules									
Square type									
Number of squares				x	x	x			
Shape of game path				x	x	x			
Choose number of players									
Choose school subject									
Choose level of difficulty									
Add a button									
New page									
Open old page									
PLAYING MODE									
Game standings/status							x	x	x
Questions							x		
Start/Load/Continue/Next							x		
Time									
Dice							x	x	x
Save / Pause							x		
Level of difficulty									
Choose/ Make game token									
Videos/ Animations									
Back / Previous									

The table illustrates that, in terms of functionality, quite a few elements from the children's drawings existed already in the UI mock-ups although the mock-ups were not necessarily functional yet, or at least had a very limited functionality. The UI mock-ups were not even intended to entail a great deal of different functions, but instead to serve as a way to compare different alternatives. The colour and shape of the game squares could be changed, for instance, but the choices were very limited; there were only a few options to choose among. The shape of the game path was freely definable, as was the number of game squares. Questions could be typed, and sound and animation could be added to the questions in some of the versions. In one version of the board-making mode, the children could choose a background. There was no separate Preview function, but the questions and the game boards were created in a "what you see is what you get" manner; in other words, they looked the same in the playing mode as they did when they were being created in the editor mode.

All game-playing versions included the dice and a presentation of the standings of the game. One of them included also the possibility to create questions, a specific start button, and the possibility to save a game. A help function was available in all game-playing mock-ups but not in the editor mock-ups. Basic features such as Exit and the main menu (or File menu) were included in all versions. Some functions that would appear in the later versions, such as choosing or editing the appearance of the game character, were not yet included in these mock-ups. Moreover, some of the elements in the children's drawings are somewhat unclear and it is difficult to interpret their purpose and thereby assess their manifestation in the outcomes. For example, the elements "new page", "open old page", and "back"/"previous" may mean that there are several fields or boards in a game, and the player can move back and forth between them, but they might also refer to something else.

In addition to the types of different functions, another issue for which the developers reported to have obtained ideas was navigation, and especially the location of different navigational elements. As discussed above, the developers reported observing that the locations of the UI elements in the children's drawings were typical of those of regular Windows software. Based on the analysis of the drawings, in some cases this was very clearly true; for example, if the closing button was included in the drawing, it was in almost all cases located in the upper right hand corner. Interestingly, though, in many drawings, button rows and certain other elements (such as game standings) were placed at the bottom instead of being at the top as in most Windows applications. This was especially clear in the drawings that depicted the playing mode – it is possible that the children had played games in which the layout was structured in this way, and were inspired by them. In the following I will discuss the element location issues in more detail.

In the drawings, *function buttons* were more common than menus. In the UI mock-ups, however, solely menus were used. In the pictures, button rows were most commonly placed at the bottom of the page, whereas the mock-ups included menus at the top of the page or, in one of the alternative versions, in a pop-up menu which opened by clicking the right mouse button. The *Help function* was a rather common element in the drawings; it appeared in 9 pictures out of 20. It did not, however, have any especially frequent location: its place varied between different corners or sides of the window. However, it was almost always a clearly visible button; only in one drawing it was placed in a menu. Figure 25 presents one drawing of the game-making mode, displaying buttons for several functions on the left hand side ("Make squares", "Make questions", "Make animation", "Set number of players", "Sound effects", and "Draw characters"). Furthermore, there is a "Quit" button in the lower right hand corner.

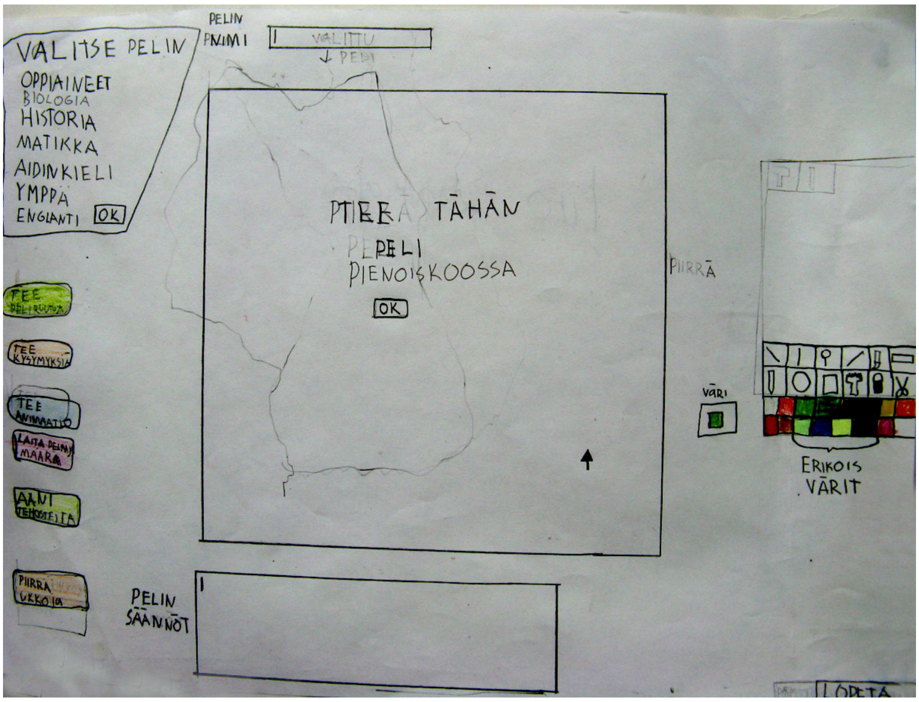

FIGURE 25 A drawing of the game-making mode

In the mock-ups, the Help function was realized as a separate menu in the menu bar, similarly as in Windows applications in general. In the pop-up based version, it was placed as one option in the pop-up menu. As stated above, the *Exit* or *closing buttons* were most often placed in the upper right hand corner (this was its location in seven out of the 11 times it appeared in the drawings). The button was depicted either in the form of a button with the text "Exit" or "Close", or as a typical "X" symbol. In the mock-ups, the closing function was in a menu ("File" menu, "Game" menu, or a pop-up menu). Additionally, in two versions out of three, there was also a typical "X" in the upper right hand corner.

Rather surprisingly, only four of the children's drawings featured the *dice.* In all of these, it was located in the lower parts of the screen, in three cases out of four in the bottom right hand corner. In one of the mock-ups, the dice was in this corner. In another one, the dice was in the upper right hand corner, and in the third version, the dice was thrown via a menu and the rolling dice was displayed in a pop-up window in the bottom left hand corner. The *standings and status* of the game (e.g. player information and score) were very clearly visible in the drawings (see Figures 14 and 15). The ways in which they were presented varied (points, energy, objects, etc.), but they were always very prominent in the drawings – and included in every one of them. This information was mostly placed horizontally along either the top or the bottom of the window. In the mock-ups, the standings and status were located in the following ways: In one version, the objects collected by the players were horizontally at the bottom, while the players' scores were in a vertical column on the right side of the screen. The "high scores" table could be accessed from a menu. In the second version, all standings and status information was vertically on the right, whereas in the third version, this information was not constantly visible. Instead, if one wanted to view the standings, one could go to a menu to open them in a pop-up window. The *questions* that are presented to the players during the game did not appear in many of the children's drawings. Only five drawings included a question in a certain location; in three of these, the questions were in a pop-up window which opened next to the specific square to which that question was attached. Only one of the mock-ups had so much functionality that a question could be opened. In this version the question opened in a pop-up window in the middle of the screen.

The locations of the elements were rather different from one mock-up version to another, hence the most common elements – and their locations – from the drawings manifested in at least one of the three alternate mock-up versions of the playing mode (Figure 26).

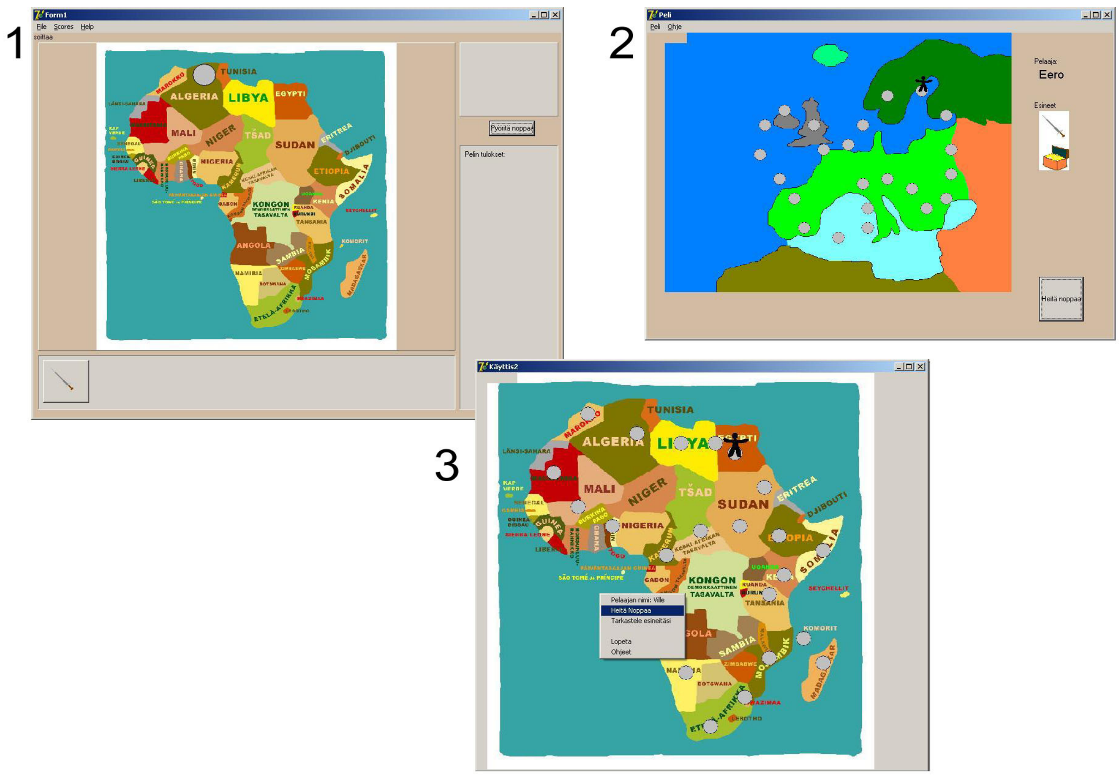

FIGURE 26 The playing mode of each UI mock-up

In Version 1, the closing "X"-button in the upper right hand corner and the collected items at the bottom were in locations which were most common in the children's drawings. Moreover, the question was in a pop-up window but not beside the related square, as in the children's drawings. In Version 2, the location of the dice in the lower right hand corner corresponded to the most common location in the drawings. In Version 3, only the closing button matched the drawings in terms of element locations. However, in all of the mock-up versions, there was one clear shortcoming in comparison to the drawings; in the children's pictures, selection of functions was made principally with buttons, whereas the mock-ups were solely based on menus.

The purpose of this detailed analysis is not to suggest that the design of the user interfaces should be solely based on single elements depicted in the drawings – and it would be impossible to follow every observation – but to emphasize that the drawings can be used as guidance in developing a clear and coherent layout which entails the crucial functions and in which the elements are based in a logical way. As pointed out, some preferences (the use of buttons over menus, clear presentation of game standings etc.) were very evident in the children's drawings, and issues such as these are a useful basis for the UI design.

UI Drawings vs. Talarius 1.0

Above, the children's drawings have been examined in relation to the different UI mock-ups. This examination will be now followed by a similar analysis comparing the drawings and the final pilot application, Talarius 1.0. Table 10 illustrates which of the elements from the children's drawings can be identified in the final product. When comparing the manifestation of the elements from the children's drawings in Talarius 1.0 with their manifestation in the UI mock-ups (Table 9), elements added to the application included the possibility to choose the appearance of the game character, different game path square types (a normal square, a question square, and an extra-throw square), and the possibility to determine the number of players.

As regards the locations of the different elements there were also some changes compared to the mock-ups. As described above, selections were made in the children's drawings mainly with *buttons* instead of menus. While the mock-ups were completely based on menus, to the final version the developers added also quick-access buttons for the most important functions in each mode of the application. In this respect, Talarius 1.0 corresponds better to the children's views about the UI than the first mock-ups. The buttons are located at the top of the page, immediately below the menu bar. In the children's drawings they were, as mentioned, either at the bottom (especially in the game playing mode) or at the top (especially in the game creation mode) of the page. Figure 27 shows the game board making mode with the buttons that were added to the application after the mock-ups. The buttons include (from left to right) "Choose background picture", "Delete all squares", "Change background colour", "Add a question set", "Load a game board", "Save the game board", and "Exit". The same functions are available also in the menus above the buttons ("File", "Settings", and "Help").

TABLE 10 Comparison of the functions of Talarius 1.0 to those presented in the children's drawings

Talarius 1.0 (modes) / Features in drawings	**Make questions**	**Make game board**	**Play game**
GENERAL			
Help	x	x	x
Exit / Close	x	x	x
EDITOR MODE			
Make/Choose background		x	
Record/Add sound	x	x	
Save	x	x	
Name of the game/player	x		x
Choose/Draw character			x
Write questions	x		
Make/Add animation	x		
Preview	(x)	(x)	
Square colour / Draw square		x	
Square shape / Draw square		x	
Add text (to game board)			
Main menu/Program menu	(x)	(x)	(x)
Colour of dice			
Define rules			
Square type		x	
Number of squares		x	
Shape of game path		x	
Choose number of players			x
Choose school subject			
Choose level of difficulty			
Add a button			
New page			
Open old page			
PLAYING MODE			
Standings/Status of the game			x
Questions			x
Start/Load/Continue/Next			x
Time			
Dice			x
Save / Pause			
Level of difficulty			
Choose/ Make game token			x
Videos/ Animations			
Back / Previous			

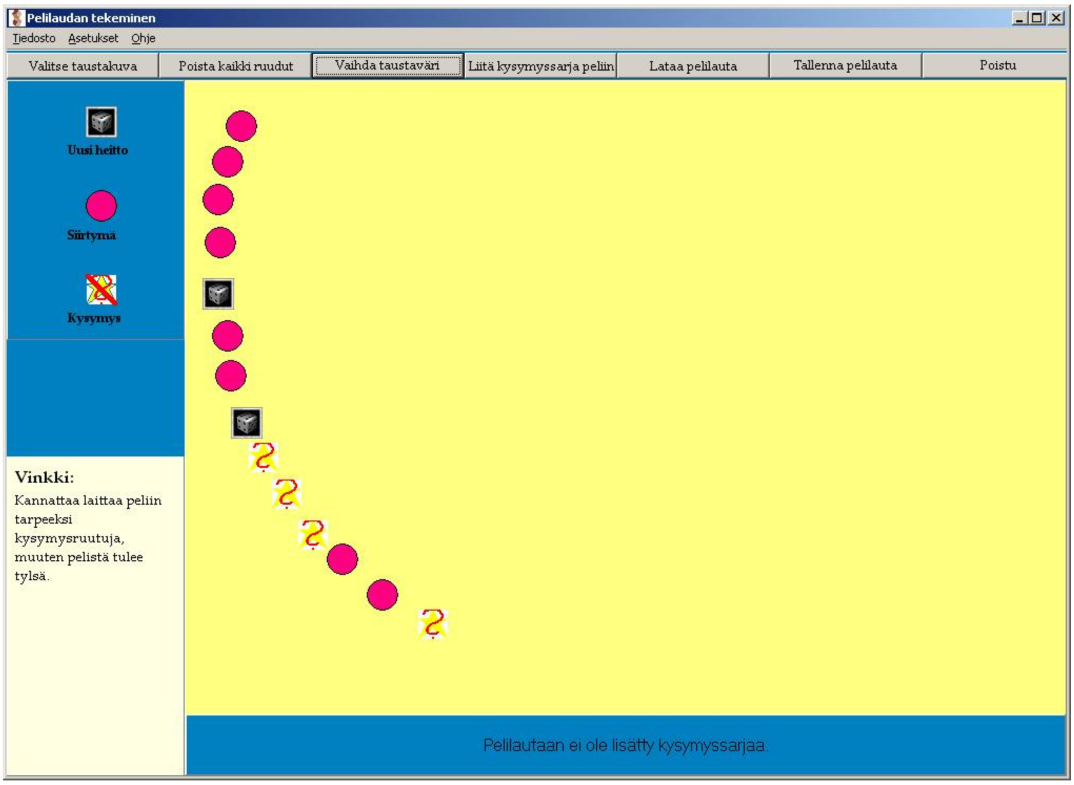

FIGURE 27 Function buttons in the game board making mode

The placing of the *Help* function varied greatly in the children's drawings, but in most of the drawings there was a specific button for it. In the Talarius 1.0 version, the Help function exists as one main item in the menu bar, but there is no quick-access button for it. The Help text is displayed in the same window as the game, in the bottom left corner. The game is *exited* by clicking on a standard "X"-button in the corner of the window, as in most of the drawings. Many of the drawings also had a button marked with a text "Exit", "Close", or the like (which also was often located in the upper right-hand corner). In Talarius 1.0, the developers implemented such a button; it was located in the rightmost place in the button row at the top of the page. Additionally, it was possible to exit the application via the File menu, as in Windows software in general.

In those drawings that featured the *dice*, it was most often placed at the bottom of the window, especially in the bottom right-hand corner. In Talarius 1.0, the dice is located immediately below the button row, in the upper left-hand corner of the window. The *standings and status* of the game, in the children's drawings, were usually presented horizontally either at the top or at the bottom of the window. The developers had placed this information in the Talarius 1.0 application in the following way: The scores and standings of the game were presented on the left side of the window, below the dice. The information related to the current state of the game (e.g. whose turn it is, whether someone has arrived in a special square, feedback from answers), on the other hand, was presented horizontally at the bottom of the window. In those drawings in which a question was visible, it was located next to the associated question square, in a pop-up window. In the Talarius 1.0 application, the questions are in pop-up windows which open in the middle of the screen.

In summary, in terms of the elements presented in the children's drawings, the most essential change between the mock-ups and Talarius 1.0 is that in addition to the menus, also button rows have been implemented. This is an important improvement, as the children's drawings heavily emphasized the use of buttons to be able to access functions quickly. The choices of the locations of the dice, help text, game standings, and status information were presumably based on the need to optimize the use of space; in the children's drawings the functions, standings, and other information were often laid out horizontally at the top and bottom of the window, but adhering to such a way of locating elements would have made the space of the actual game board very wide and low. Rather than to follow strictly the specific locations of single elements, it is more important to pay attention to *which* elements were included in the drawings and in which forms (e.g. menus, buttons) they were presented. The locations of the elements are in a rather big role in the analysis for the reason that the developers brought it up as one of the main issues discovered from the drawings: the locations of the navigational elements were, according to them, similar to typical Windows applications.

Requirement Interviews vs. UI Mock-Ups and Talarius 1.0

Above, the mock-ups and the final prototype have been compared with the drawings. Another source of ideas regarding the functions and appearance of the application were the informal interviews which were held while the children were drawing their UI pictures. In the following, the manifestation of these requirements is compared, firstly, to the mock-ups and, secondly, to Talarius 1.0. A summary is provided in Table 11.

As regards the *features that were required of a good game,* issues related to the appearance of the game – such as colours and images – were essential in the children's opinion. In the mock-ups, which entailed only the basic functions and no special attributes, it was only possible to choose the colour and shape of the game squares, and the number of options was very limited. In Talarius 1.0, in contrast, the player was also able to choose pictures to represent their game characters or tokens, choose a background picture and to change the main colour (or "skin") of the application itself. There was a larger selection of optional images to choose among, and users could also import images they have e.g. drawn themselves or downloaded from the Internet. Hence, the users could principally make their game look exactly the way they wanted. The Talarius 1.0 application itself was, however, still rather simple graphically and appearance-wise. The children also wished e.g. animations and three-dimensionality from good games; these were not realized in Talarius 1.0, apart from an animated dice. As stated earlier, the simplicity of the application seemed to disappoint some children, as they perhaps were accustomed to expect games to be graphically complex and polished.

TABLE 11 Comparison of the mock-ups and Talarius 1.0 to the requirements obtained from interviews

Requirement	Mock-ups	Talarius 1.0
1. What kinds of features should a good game have?		
Colours, images	Possible to change the colour and shape of game squares (a few options to choose from)	Possible to change -pictures of game squares -pictures of characters/tokens -background images of games -background colour
Animations	Animated dice	Animated dice
3D, first-person persp.	No	No
Challenge	(Depends on content)	(Depends on content)
Bonus levels	No	No
Versatility, diversity, several game boards	Only one board per game	Only one board per game
Action, constant activity, obstacles	No	No special squares except for question and extra throw
Collecting points / objects / energy, and using collected items	No	Collecting points only
Possibility to play as a multiplayer game at the same computer	No	Yes
Saving and resuming from where one left off	No	No
2. Which attributes of a game should one be able to edit or decide when making a game with a game design tool?		
Game board / background / environment / appearance of game	No	Possible to -choose freely the background for a game -make a free-form game path
Colours	Possible to change the colour and shape of game squares (a few options to choose from)	Possible to change -pictures of game squares -pictures of characters/tokens -background images -background colour

(continues)

TABLE 11 (continues)

Requirement	Mock-ups	Talarius 1.0
2. Which attributes of a game should one be able to edit or decide when making a game with a game design tool? (continues)		
3D	No	No
Rules	Not possible to determine	Not possible to determine
Level of difficulty	No different levels	No different levels
Making and editing characters	No	Possible to -choose a character (game token) from different alternatives -import an external image to be a game character (game token)
Music (adding sound, making music)	No	Possible to -attach sound files to questions -switch sound effects on or off Not possible to make music
Recording sound	No	No
Large selection of options for each attribute	No	Possible to choose or import -background image -sounds/images/videos for the questions -picture for the character/token -shape of the game path -images for game squares

Other issues emphasized by the children were challenge and versatility; games should be challenging and have diverse features, bonus levels, and constantly something to do. In the case of Talarius 1.0, the level of difficulty and challenge were largely dependent on the games that were created with it; a game could be very easy or very difficult depending on the questions it entailed. However, the basic structure of the games that could be made with Talarius 1.0 was very simple and did not provide much variety. For example, a game consisted of only one board or field, and there were no bonus levels or tasks. In the UI mock-ups, there were no special squares to be used in the games, and the only special squares in Talarius 1.0 were the question and extra-throw squares. The students also wished that they could collect points, objects, energy, or other items that could somehow be used in the game, for example in order to proceed to a specific square. In Talarius 1.0, points were the only items being collected (the players acquire points by knowing the right answers to questions posed to them), but the points could not be used in any way (e.g. for buying something that helps the player advance in the game). There were also wishes that it would be possible to play the game as a multi-player game, gathered around one computer, and that the game could be saved and resumed from where it left off. The mock-ups did not allow either of these activities. The main idea of Talarius 1.0, on the other hand, was exactly what the children mentioned – a multi-player game on one computer – but it was not possible to save and resume a game.

Another point of view of the questions asked in the requirement interviews was *what the children wished to be able to do with a game creation application*. Appearance-wise, the children wanted especially to be able to influence the colours of the game and what the game board looked like. In the mock-ups, the only choice that could be made was to pick the colour and shape of the game squares out of just a few options. Instead in Talarius 1.0, as mentioned above, the children could choose the appearances of the squares, the characters, and the background image of the game, as well as the background colour of the application itself. The shape of the game path could also be determined freely. The children also wished that it would be possible to edit the characters and create their own characters; Talarius 1.0 did not enable those activities, but it was possible to import a picture that had been created e.g. in Paint or another image editing software, and set it as the character picture. Possibilities to edit and determine the rules of the games and define the level of difficulty were also mentioned by the children, but this was not possible in the Talarius 1.0 version.

Being able to influence the sounds and the music of the games was another wish of the children. The mock-ups did not include any sound effects or music at all, and while Talarius 1.0 did, it did not enable the children to record or create their own music or sounds. However, as with images, it was possible to attach sound files (and video clips) to the questions; the children could record sounds with another application and then import the files into Talarius. In Talarius 1.0, there was also background music – as well as sound effects for different events in the game – which could be turned on or off.

One requirement of a general nature was that even if the application would not include *many such features* that can be controlled by the user, it would be important that those features that can be tweaked by the users have a *great deal of options* to choose among. For example, if game squares cannot be freely drawn, the application should offer a wide selection of different shapes and colours for them. Talarius 1.0 allowed the user to freely determine the shape of the game path and to choose a background image, pictures/sounds/videos for questions, appearance of the character, and the images used as game squares – either by selecting from existing options or by importing downloaded or self-made material. Nevertheless, searching for or making pictures and other material is very time-consuming, and therefore, in order not to spend too much time on these activities, a comprehensive collection of ready-made objects would be needed.

Overall, in terms of freedom of choice, the users had a great deal of liberty in creating a game according to their own idea of what they wanted it to look like. The application as such was, however, very simple and clearly prototype-like as far as graphical quality is concerned. When it comes to functionality, the application contained the basic functions: users could make questions and the board for their games, and play them as single- or multiple-player games. One shortcoming related to the functionality was related to the scoring system: it was very simple and there were no possibilities to do anything with the points collected, neither could the players collect any other types of items than merely points. Moreover, the maker of a game could not determine the number of points a specific question is worth, which would give the users a possibility to take differences in the level of difficulty into account when creating questions. Related to this, the users were also not able to determine the rules in any way. To summarize, requirements suggested by the children were realized to some extent, which was also acknowledged by the children. However, the manifestation of the ideas that aimed to enhance the versatility and attractiveness was still very limited, and – as discussed earlier – it is likely that the scarce functionality and unpolished appearance were a major factor influencing the experience of those children who were disappointed in the application or the project in general.

Feedback about UI Mock-ups vs. Talarius 1.0

The final perspective of the analysis of the concrete manifestation of the children's ideas in the outcomes deals with how the feedback that the children provided about the UI mock-ups affected the development of the final version of the application. Table 12 illustrates how the children commented on the UI mock-ups, and how these suggestions showed in Talarius 1.0. The comments are divided into those related to the different modes of the application (question making, board creation, and playing) and those of a more general nature.

Out of the different versions of the mock-up of the *question making mode,* the children preferred the alternative in which "everything was visible". Consequently, the question-creation mode of Talarius 1.0 was structured so that every element and function needed in the making of a question was visible to the user all the time in the question window. Regarding the layout, there was one comment stating that the button locations were not good – a rather vague comment, the manifestation of which is difficult to estimate. Again, issues related to colours yielded many comments. It was pointed out by some children that the colours were boring, which was addressed in Talarius 1.0 by implementing a possibility to choose a background colour for the application.

The most preferred version of the alternatives of the *game board making mode* was the one in which the squares were placed on the board by clicking instead of dragging. It was also seen as positive if the colour of the squares could be changed. Both of these features were realized in Talarius 1.0. There was one negative comment about the changing of the square colours as well, dealing with the fact that it was very slow to change the colour of the squares, because it could only be done one by one. An improvement to this was realized in Talarius 1.0 in which the colour-changing was conducted in the similar way

TABLE 12 Manifestation of the children's mock-up related comments and suggestions in Talarius 1.0

	Suggestion/comment about the mock-ups	**Manifestation in Talarius 1.0**
Make questions	+ Everything was visible	All the functions needed for making a question are constantly visible in the question window
	– Colours were boring	Possibility to change the background colour of the application
Make game board	+ It was quick to [add squares by] click[ing]	Squares are placed on the game board by clicking, not dragging
	+ Colours were visible [the colour selection options]	It is possible to change the colour (and image) of the squares
	– Changing colours was slow	It is possible to define the colour of the squares one is about to add, by changing the colour/image of the square selection button
Play game	+ The menus were in Finnish	The menus are in Finnish
	– Too few colours	It is possible to change the background colour of the application and the colour/image of the squares and characters
	– The names of the countries [if a map is used as a game background] should be displayed by right-clicking	No
	– It was slow to [re]start a game because it was done via a menu	There is also a quick button for starting or restarting a game
General	Different game character options	There are different options for game characters. Other images can also be imported.
	Possibility to draw a game field / to make background images	No embedded image editor but it is possible to use self-made images as backgrounds
	Easiness	Based on the testing results, the application was easy to use
	Sound effect for the dice	The dice has sound effects
	It should be possible to advance in the game (to next level)	No
	Collectible objects that have a significance	No
	Animations	None in the application itself (except for the dice). It is possible to attach (animated) image files and videos to questions.

as e.g. the colour of a paintbrush is selected in an image editing application: one first changed the appearance of the square-selection button (by picking a desired shape and colour in a pop-up window), and once that was done, all the squares added to the game board after that looked like the one in the button. It was also still possible to change the pictures of the squares one by one.

In the mock-ups of the *game playing mode*, issues related to colours were prominent again; the children criticized the lack of colours. Similarly as both the other modes, the game playing mode of Talarius 1.0 allowed the children to set the background colour of the application to whatever colour they wish. In the game playing mode, the picture of the game character/token could be changed as well. In the mock-ups, starting a game was too slow, in the children's opinion, because it was done via a menu. In Talarius 1.0, there was also a quick button for starting or restarting a game. One playing-related wish (although it is actually more related to the making of a game board) was that if the background of the game is a map, the name of a country could be displayed when the country is right-clicked. This, or any similar background-related functions, was not realized in the application. Finally, in one of the game-playing mock-ups the menus were in English (presumably because the developers wanted to explore how accustomed the children were to using computer software with English user interfaces), which yielded negative feedback from the children, and it was a clear choice to make the final version completely Finnish.

When the children evaluated the UI mock-ups, they were also asked to give *general feedback and suggestions* regarding the application, based on their reflections on which features from their favourite games they would like to see in Talarius. Also in these ideas, colourfulness came up. Additionally, the children wished to have more different game characters to choose among; in Talarius 1.0, there were more of them, and the players could also import their own pictures to the application to be used as characters. Again, also the wish to be able to draw background pictures for the games came up. As stated earlier, there were no drawing tools in Talarius 1.0 but pictures created with other drawing software could be imported into the games. Some children requested a sound effect for the dice – which was later realized in Talarius1.0 – and animations. It was possible to attach animated images and video clips to the questions, but there were no animations in the application as such, apart from the animated dice. According to the children's suggestions, there should also be several levels or fields in the game so that it would be possible to proceed to e.g. new levels. There was only one board per game in Talarius, so this idea did not manifest in the final outcome, neither did the idea about collectible items that could be used in some way in the game – which was brought up for the first time already in the requirements interviews at the very beginning of the project. Additional wishes included easiness and "more speed", the manifestation of which is difficult to analyze due to their generality. However, the evaluation session results suggested that the application was easy to use and to learn to use.

Meeting the Children's Expectations

The topics above have dealt with the analysis of the design session outcomes in relation to the different versions of the application. The following will focus on the children's own experiences on whether the application met their expectations or not. Whether the product met their expectations appeared to be difficult for the children to estimate. In the final questionnaire, more than half of the class (13 out of 23) chose the "cannot say" option when they answered a question related to the fulfilment of their expectations (Figure 28).

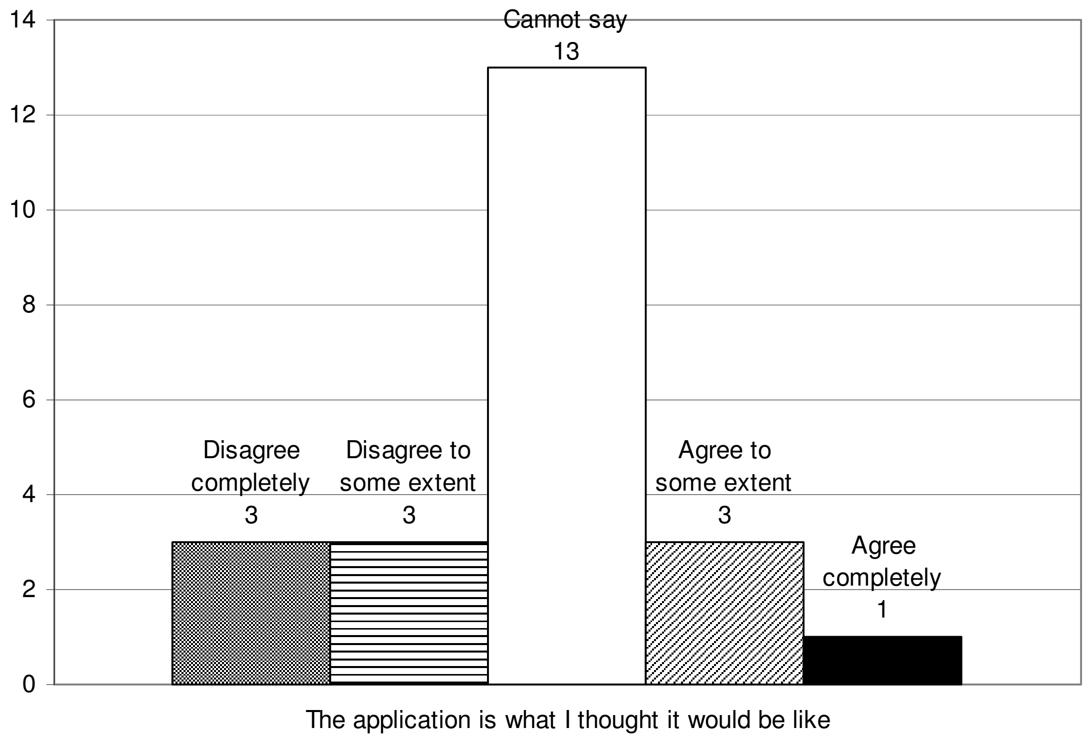

FIGURE 28 The children's opinions on whether the application met their expectations

Many of the children stated that they actually had no specific expectations regarding the application; they had really not thought about what the application would be like at all. Those who had expectations of some kind, mainly felt that the application was not as sophisticated as they had wished: it was simpler and more unpolished than they thought it would be. There were, however, also some children who had been positively surprised by the outcome. Some children had also had certain misconceptions about the goals of the project – e.g. the game created in the project would be an adventure game, or that the idea would be to create a board game that takes place on a map (which it can do, but does not necessarily have to) instead of a game creation tool with which the children themselves could make a game related to whichever theme they wanted. The concept of a game-creation application in general was new to the children, which was likely to be a major reason for the children not having specific expectations – and consequently also for having difficulties with estimating whether their expectations had been met.

> I don't know really [if it meets my expectations], because I didn't think about what it would be like.

> It's not exactly like I imagined but pretty good!

> I didn't really imagine it to be anything, or I didn't really have an opinion. But actually it's poorer than I expected.

The aspect related to the manifestation of individual ideas became apparent in this question as well. In one comment, a child pondered that it was hard to say whether the outcome met her expectations because she was aware that if she was in the minority requesting for a specific feature – specific intro music, for example – the children who were in the majority requesting some other feature or alternative "won". An individual idea was not realized but the opinion of the majority was, and this might have conflicted with what a child suggesting the idea that was in the minority was expecting.

> Well, you know, if you want for example some [specific] intro music and some [others] want something else and there are more of them so then they win, in a way, if there are more of those who said that.

In some cases, choosing an idea based on the wish of the majority of the participants can be a good solution, but this is not necessarily always the case. Going with the majority's opinion produces an outcome that is more likely to please the majority, but this may take place at the cost of discarding very innovative individual ideas. Again, this issue highlights the problem that the solutions made were not adequately discussed with the participants. This led to two problems. Firstly, the children whose ideas were not realized remained unsure why this had happened – had their ideas not been good enough, or was it because they were in the minority. Secondly, the children were not aware of each other's ideas: an idea suggested by an individual child might have been supported by others as well if the ideas had been discussed together more than was the case now. The inadequateness of direct communication was indeed identified as one of the major factors with regards to the children's lack of a feeling of having an influence.

Regarding the visibility of the gradual development of the application, the children's opinions were clearly split. Twelve students felt that they had recognized the development of the application from one evaluation session to another, at least to some extent, while ten of them felt the opposite (see Figure 24). Those who had perceived gradual development stated that the development manifested especially as improved and more versatile functionality. The same reasons as above are likely to be reflected in this question as well. It appears that when answering this question, some children were more focused on the development in general, i.e. comparing the latest version to the previous ones and paying attention to the reduction of technical bugs in the course of the development, while others assessed the development through their expectations regarding the manifestation of their own ideas.

> The first time [we saw the application] it was simple, but the last time it worked very well!
>
> [You could see the development because] there were more colours, sounds and other functions.
>
> It doesn't always show [if the application has changed] if it has changed so little.
>
> I think it stayed always the same.

A Summarizing Overview on the Manifestation of Ideas

In summary, the realization of some of the children's suggestions and ideas was very clearly identifiable in the final version of Talarius 1.0, while some of them just as clearly did *not* manifest in the outcome. Moreover, while some suggestions were concrete and clear ones, the manifestation of which was easy to examine, some were vague or so general by nature that it was difficult or even impossible to analyze whether they were present in the final outcome or not. The main conclusion from the analysis is that the final outcome attempts to give the children much freedom of choice when it comes to determining the *appearance* of their games: with the aid of e.g. background images and game square images, the users can create a game board that looks exactly like they want; the appearance of the game characters can be chosen freely; and the background colour of the whole application can be switched. On the other hand, while appearance-related features have been realized to a considerable extent, attributes dealing with the versatility of the functionality have been realized to a fairly small degree (very simple scoring system, no collecting of items, no user-definable rules, etc.).

As discussed earlier, the ideas obtained from the drawings were considered very fruitful from the developers' point of view, but the children had trouble recognizing their input in the outcome. When the children create individual drawings, it yields a very large amount of material to analyze. In other words, the advantages caused by the quickness and easiness of the creation of individual drawings is revoked in the analysis phase; systematic analysis of a large number of drawings (including the identifying, categorizing, and counting of all different elements) is very time-consuming. Within a development project, there are often no adequate resources for doing this, and thereby the observations about the drawings and their influences on the outcomes are discovered more in an ad hoc manner, or based on a rather superficial analysis. Moreover, as there is a large number of drawings (in this case, for example, there were twenty), they also include very different, even conflicting ideas. Except that the analysis of so many drawings consumes a considerable amount of time, it also leaves much room for interpretation and unavoidably causes some of the ideas presented in them to transform a great deal in the course of the process. This, consequently, may lead to the children's feeling of influence getting lost. Additionally, if the drawings are used in an intuitive or ad hoc manner, the problem is that the features implemented cannot necessarily be authentically traced back to the drawings; this is a shortcoming in terms of the traceability of the requirements, which should also extend to the early phases of the design process when the user requirements are gathered (cf. Gotel & Finkelstein 1997).

As all specific ideas will not, and cannot, be realized in the outcome, it is important to search for ways of making a coherent whole out of them, yet without losing single points of view in the bulk. Therefore Guha et al. (2005), for example, suggest using a step-by-step approach – together with the children – in merging children's drawings or other creations together, in order to make the analysis process a logical and transparent sequence for both the developers and the children.

4.2.7 Conclusions and Inferences from the Talarius Project

To summarize the children's opinions about their involvement in the project, a general conclusion was that participation in itself was interesting. The children were motivated by the fact that they had a chance to take part in a real project and help in the design of an actual application. The participation methods appeared to have been generally successful but there were certain noteworthy problems, the foremost challenge being related to the children's feeling of control: their overall impression of having an influence was weak. Even though they felt that they had been listened to and had a chance to be actively involved and express their opinions, they did not recognize their input in the final product. Only a few of the children felt that they had really had a say regarding the development of the application.

From the developers' perspective, as brought up above, the children's contribution was important in many aspects: it guided the development of the appearance, the functionality, and the usability of the application. An interesting point was also the positive effect that the collaboration with children had on the developers' work motivation. The developers remarked that close collaboration with children had been an extra motivator for them: they got to know the children they were working with and did not want to let them down. The direct and immediate feedback also encouraged their work. Rich user involvement required a great deal of resources, however, and the scheduling of the activities presented a number of problems in the course of the project. This was manifested especially in the matching of the design sessions with the schedules of the school.

The developers had little previous experience of designing applications for children, and during the project they gained a great amount of new knowledge, skills, and experience about the topic. They had some misconceptions at the beginning of the project as to what was meant by participatory design or children's involvement in the design process, but the multidisciplinary and multi-party collaboration of the project led them to gain a broader understanding about the design of technology. This was also partially due to the fact that as a part of the project, in order to learn more about the area, the developers participated in different training sessions and seminars related to e.g. children and technology. Moreover, learning technical skills is naturally an expected outcome of a technology development project, but the involvement of children brought a special aspect to this area as well. Namely, the development of the UI mock-ups gave also those members of the group who had less programming experience a chance to practice their skills. The mock-ups entailed only little functionality – and the functionality they did include was very basic – which allowed also the less experienced coders to partake in the programming without causing the work to slow down.

The process of user involvement in the Talarius project followed largely the UCD cycle (ISO 13407, 1999), consisting of several iterations, each of which ended with an evaluation phase in which feedback about the solutions and suggestions for improvements were obtained. The process contained a hands-on method (the UI drawings) which was aimed to aid the children to express their ideas and thus bring a child-focused perspective into the process. The users were involved already at early stages of the project when requirements were gathered, but all in all the emphasis in the process was rather heavily on the evaluation. As discussed in the subsections dealing with the functioning of the team (4.2.3) and user expertise (4.2.4), the children mainly saw themselves as providers of feedback. Their role as initiators of ideas was not something they recognized. This reflects the notion of the users' role in UCD being "too little, too late" (Scaife et al. 1997) and the UCD process placing the users in a reacting rather than initiating role (Scaife et al. 1997; Nesset & Large 2004). Moreover, attempts were made to take into account the educational point of view and thereby direct the approach towards learner-centred design.

Although successful from the developers' point of view, this structure did not adequately convey feeling of control to the children who participated in the project. The process was not transparent enough, and the children's contributions were not concrete enough. Instead, when the developers took ideas from e.g. the drawings and the interviews, merging children's individual ideas in the process, the children got an impression of a "black box" into which their suggestions and ideas went and later came out as something they no longer recognized as their own. They saw the gradual development of the prototype but had a hard time picturing a link between this change and their individual ideas, thereby losing their sense of ownership of the ideas. Similar observations have been made with younger (preschool) children (Guha et al. 2004; 2005), and the experiences from the Talarius project suggest that the problem exists with older children as well. Guha et al. (2004; 2005) have addressed the challenge by developing a method called Mixing Ideas, in which the individual ideas of young children are merged into common ideas. This technique is a gradual, three-phase process consisting of 1) the creation of individual ideas, 2) one or more sessions for mixing initial ideas, and 3) the mixing of the "big idea" (Guha et al. 2004). This method, or a variant of it, is likely to be fruitful also with older children – and can also respond to another need, namely reducing the developers' work load when it comes to analyzing design session outcomes.

Another issue related to supporting the children's feeling of control is the observation that they were pleased to see their own set of questions as pilot material in the application and some of them viewed it as their principal concrete contribution to the final outcome. It would seem that in order to feel ownership over the outcome, children need to see their input very concretely. The main goal of having children design a sample question set was to make the evaluation activities fit their school work better, along the lines of learner-centred design (LCD), but it turned out that this content creation had a bigger significance to the children than expected. In addition to supporting the transparency of idea elaboration through Mixing Ideas or other related methods, it might therefore be useful to plan the development process so that it includes certain content creation activities as well, if such an approach is suitable regarding the nature of the application to be developed.

In conclusion, it would look as if the traditional UCD approach, or the more pedagogically oriented LCD approach, as such is not necessarily adequate when it comes to designing educational game-based applications with children. These approaches appear to yield very useful outcomes regarding the development of the application but in order to meet the other main goal of participation, namely promoting the children's sense of involvement and ownership, there is a need to broaden the approaches and look for additional ways of working.

While UCD and LCD as such are multidisciplinary by nature, borrowing principles from psychology and educational sciences, they mainly approach these disciplines from the point of view of developmental suitability and pedagogical feasibility, not paying attention to the children's feeling of ownership to the same degree. There are, however, approaches in e.g. educational sciences and sociology that particularly deal with issues related to children's empowerment and active participation. It is likely that these principles and methods have something to give to technology design projects conducted with children. Moreover, the field of game design is not usually included in UCD/LCD approaches either. Especially issues related to user-generated content – which is a really prominent phenomenon in the field of games today – are closely linked to what we observed in the Talarius project: the children's desire to see their own concrete creations in the final outcome. In the next chapter I will elaborate the idea of a genuinely multidisciplinary process for developing game-based educational applications with children, broaden the background framework to comprise the aforementioned new perspectives, and present a case study of using the broadened approach.

5 THE SECOND CYCLE: CASE VIRTUAL PEATLAND

In the previous chapter, the first cycle of the study was addressed. This chapter will move on to discuss the second cycle comprising of, firstly, the broadening of the background framework and, secondly, the development of Virtual Peatland, a game-based learning environment dealing with peatland ecosystems. The structure of the chapter follows that of the previous chapter. Section 5.1 broadens the background framework towards a more multidisciplinary direction and discusses the principles and methods entailed in this approach. Section 5.2 focuses on the development project of Virtual Peatland: the project and the methods used in children's involvement are described, analyzed, and discussed.

5.1 Broadening the Scope of Children's Involvement: An Extended Multidisciplinary Framework

Child-computer interaction (CCI) and learner-centred design (LCD) have extended the traditional HCI view by making technology development projects respond better to educational and developmental needs. Their main concerns are, firstly, to develop participation methods that fit e.g. the attention spans and cognitive skills of children of a certain age and, secondly, to make the process of user involvement pedagogically feasible, for example by incorporating the participation activities to the children's actual school tasks. In these aspects, the CCI and LCD perspectives have been found very successful. As seen in the previous chapter, however, there is one essential goal of participation that is more difficult to reach, namely the children's feeling of control and ownership over the outcome. Methods used within this framework may not be adequate because children have a more concrete perspective on issues: they need a hands-on experience of their own contribution. Therefore, it might be useful to explore certain other disciplines which specifically emphasize and aim for empowerment, because there is much to learn from approaches that have traditions in participation in contexts other than technology design. In this study, the broadened framework entails sociological approaches to involving children in decision-making, approaches of early childhood education which emphasize children as actors in their learning, and the growing phenomenon of user-/player-created content.

5.1.1 Broadening the Framework

This subsection presents the approaches that are used to broaden the framework of user involvement presented in Chapter 4. First, as regards user involvement in association with games, the background ideas of player-centred game design and player-created content are discussed. Secondly, from the field of educational sciences, the principles of child-centred pedagogy are addressed. Finally, the subsection deals with what it means to promote children's empowerment and active citizenship in the field of childhood sociology.

User Involvement and Games

An essential field bringing its specific perspective to the involvement of children in technology design are game-related approaches, namely player-centred game design and player-created content. Issues related to the users' (players') roles in the development of games have not yet been very widely discussed. They have been touched on in game research literature as well as by some HCI researchers, but the field of *player-centred game design* is only just emerging and methods for carrying it out at different phases of the game development process are not yet clearly established (e.g. Sotamaa et al. 2005; Sykes & Federoff 2006). For example, approaches that involve players throughout the whole process have not been largely adopted in game design yet. Players are generally included in the process as testers, but at earlier stages of design their participation is often overlooked although it has great potential in eliciting the players' actual preferences and insights. (Ermi & Mäyrä 2005; Sotamaa et al. 2005; Sykes & Federoff 2006)

Digital games clearly belong in the HCI realm, as they are software applications used by people via an interface (Barr et al. 2007). However, while user-centred methods often are applicable to game design as well, it must be kept in mind that the goals of games and productivity applications are considerably different from one another. As Ermi and Mäyrä (2005) formulate, "instead of requiring low mental capacity, games should be challenging and entertaining and the goal of the design should be to create meaningful play". Games differ from or even conflict with other types of applications in terms of several aspects. Firstly, in games the focus is on the process rather than on the results. Secondly, the goals are defined within the game, not imported from outside. Thirdly, as regards usability, games impose constraints whereas productivity applications aim to eliminate them, and games emphasize variety while consistency is vital in productivity tools. Finally, in games the use of graphics and sound creates environments, whereas in productivity applications they are used to convey functionality. (Barr et al. 2007; Charles et al. 2005; Pagulayan et al. 2003)

In practice these differences are displayed, for example, in the ways of evaluating different types of software. The evaluation of games with users emphasizes the collection of subjective experiences rather than measuring performance, which is a major issue in productivity applications (Pagulayan et al. 2003). Hence, the objective of involving users in the development of games is not so much to ensure productivity as to make sure that the game is as much fun as possible (Pagulayan et al. 2003). Barr et al. (2007) point out that even though it is acknowledged that there exists a multifaceted distinction between productivity and entertainment applications, the implications of these differences on usability/playability research have not been characterized in enough detail to construct a "game HCI" approach.

When the goal is to design an *educational* game, yet another perspective comes into play. Norman and Spohrer's (1996) three dimensions of instruction and educational applications – engagement, effectiveness, and viability – were already touched upon in Section 4.1. As it shows, these issues overlap both entertainment and productivity applications to some extent. *Engagement*, which according to Norman and Spohrer (1996) is a crucial source for motivation, can be seen as a key rationale behind gaming. The pleasure of playing games consists of many factors and is closely related to e.g. the concept of game flow (see Salen & Zimmerman 2004, 329–361). In learning applications, motivation plays a key role in whether a desired learning outcome is achieved (Norman & Spohrer 1996). *Effectiveness*, along with the other traditional usability components (e.g. ISO 9241-11, 1998; Nielsen 1993), is an essential issue in productivity applications, referring to whether the application enables the user to complete tasks successfully. In the context of educational applications, on the other hand, effectiveness refers to the learning outcomes (Norman & Spohrer 1996). Finally the third dimension, *viability,* means that the application needs to fit to its actual use context in the real world (Norman & Spohrer 1996). Viability can be mapped to the concept of utility which, in Nielsen's (1993, 25) taxonomy of system acceptability, is one of the two main components of system usefulness, usability being the other one. Alternatively, from a broader perspective, viability can be seen as equivalent to practical acceptability which includes the already mentioned usefulness along with other issues affecting the practical value and suitability of an application, such as cost, compatibility, and reliability (cf. Nielsen 1993, 25).

Hence, it can be seen that there are several equally essential dimensions that the design of educational game applications – and the involvement of users in it – needs to be able to address successfully. Table 13 summarizes and compares the key issues of the design of productivity software, entertainment games, and educational applications.

User-centred design and participatory design have traditionally been used mainly in the design of productivity applications such as office software and production tools. In these approaches, the goal is to develop solutions that are useful and well integrated to the work environment and the users' ways of

TABLE 13 Issues to be addressed in the design of different types of applications

Domain	Key issues addressed	Approach for user involvement
Productivity Applications	Focus on traditional usability metrics and utility. Emphasis on effectiveness/productivity of use.	Traditional user-centred and participatory design
(Entertainment) Game Applications	Focus on fun and engagement. Emphasis on subjective player experiences.	Player-centred game design
Educational (Game) Applications	Focus on effectiveness, engagement and viability in real use: all dimensions equal.	Approach combining elements from e.g. HCI, game design, and educational sciences

working (e.g. Cherry & Macredie 1999; Karat 1997; Kensing & Blomberg 1998). The objectives and benefits of involving users in the development of productivity applications can, for the most part, be seen as being associated with the better quality of the application on the one hand and the users' increased understanding of the application on the other, which in turn result e.g. in increased productivity, decreased errors, and reduced needs for training and support (Maguire 2001). In other words, it principally comes down to issues such as productivity and effectiveness of use.

As brought up above, the objectives of player-centred game design differ a great deal from those of the development of productivity software. Instead of emphasizing the effectiveness of attaining a certain level of performance, the focus is on the games' ability to entertain and engage. Although traditional usability metrics have their place in game design and evaluation as well, the nature of games makes it necessary to emphasize the players' attitudes and subjective experiences in order to gain deeper insight on the issues related to the motivation of playing the game (e.g. Pagulayan et al. 2003). However, the involvement of players in game design is, as said, a not much explored area, and therefore the full potential of user involvement at the earliest stages of game design is still largely undiscovered (e.g. Sotamaa et al. 2005).

As the engagement – effectiveness – viability triangle suggests, the design of learning game applications must deal with both dimensions of issues; those that are especially characteristic of productivity applications and those that are distinctively related to games. Moreover, although viability is an issue in productivity applications and entertainment games as well, it presents novel questions in educational game design. Productivity applications are often developed to respond to a concrete need in the working environment, and entertainment games have their place as a leisure activity for large numbers of people. Educational applications, on the other hand, often attempt to enter areas where their potential is not necessarily fully recognized or acknowledged. The viability of educational applications is a complex issue that "depends upon social, cultural, and political issues as much as in evidence of engagement and effectiveness" (Norman & Spohrer 1996, 27). The development process of one single educational application can hardly answer all issues related to viability. As Norman and Spohrer (1996, 27) formulate, "[v]iability is the most difficult dimension to assess, for nothing short of the development of complete curricula and test deployment in school systems will suffice to answer this question". However, the involvement of users and the focus on real context in the development process provide case-based evidence to support the feasibility of the application and may help set signposts to direct future studies (of effectiveness, engagement and viability alike) in a more extensive scope.

On a related note, more and more interest is being taken in *content creation done by players* – an increasingly widespread activity among player communities. Within their "mod" communities, players of digital games have long modified and expanded existing games (e.g. Humphreys 2005). Recently game content creation has become all the more popular and widespread, and members of different game-based virtual environments are provided with tools for creating various new game objects (OECD 2007, 16). Currently the attention paid by game developers to user-conducted content creation only addresses games that are already released, in an attempt to explore and influence player behaviour (Sotamaa et al. 2005). There is, however, a potential link between user involvement in technology design and this type of voluntary active participation of the players: content creation can be used a source of new ways to carry out user involvement in the development of technology, especially game-based learning environments.

Child-Centred Pedagogy

Designing technology in a user-centred, and especially child-centred, manner requires multidisciplinary research and design approaches. Learner-centred design brings educational and developmental theories into the process to guide the development, but educational sciences can have a great deal to offer for the design methods as well. An especially fruitful source of ideas for the development of ways of working with children is child-centred pedagogy (child-centredness), adopted from the field of early childhood education.

Child-centredness is an ambiguous concept, and there has been a great deal of debate over the definitions of the term. Components that have been suggested as basic tenets of child-centred pedagogy include e.g. the active role of the child, concrete experiences, play, participation, focus on context, environment-directed activity, social relationships and the social nature of learning processes, as well as the individuality, personality and uniqueness of the child (e.g. Hujala 2002; Kinos 2001; Tauriainen 2000).

An intuitive definition for child-centredness is that children and their needs, interests and perspectives are put in the focus and favoured in the planning of activities (Fleer 2003). There have been, however, several interpretations of this idea over the years. The view closest to the idea of what child-centredness could mean in technology design is to see the child as an active participant who directs his own activities (Chung & Walsh 2000). This view, adopted e.g. by several Finnish researchers and practitioners in early childhood education, sees the child as an actively participating subject who can take part in the making of decisions regarding her own activities. The view emphasizes activities that originate from the child's own world of experience; the fundamental idea is that activities are based on the children's own culture and interests. (Hujala 2002; Kinos 2001, 2002)

What the different interpretations of child-centredness have in common is the importance of allowing children to be active and taking their own preferences into account. In other words, children should be seen as actors in their environments instead of passive receivers of instruction (e.g. Kankaanranta 1998). Involving children in the design of technological applications that are to be used as their learning tools is one way of giving them a voice in issues that concern them. Clark (2005) defines "listening to children" as a fundamental stage in participation. She points out that listening is not a passive process; it entails two-way discussion and interaction between children and adults, and utilizes also other forms of expression besides verbal interaction. Therefore finding appropriate methods for enabling children's active participation is an essential issue.

Children's Empowerment and Active Citizenship

The debate surrounding the definition of the concept of child-centredness has been largely taking place within the field of educational sciences, for the most part in early childhood education. However, ways of giving children a voice have been an object of interest in other areas as well, especially sociology. In this field, children's active participation has been prominent in studies related to the participation of children in the design of their school and living environments (e.g. Francis & Lorenzo 2002; Gallagher 2004; Johnson 2000; Kiili 2006). One of the main aims has been to explore the possibilities and challenges of involving children as active participants in the making of decisions regarding issues that concern them.

From the sociological perspective, children's participation in environmental planning has been characterized e.g. in terms of the roles they are given, on the one hand, and the roles they themselves adopt, on the other hand. Historically, children have been represented "in the future voice as adults in preparation, in passive voice as recipients of adults' attention and treatment or as objects of structural determinations" (Downes 1999, 334). Francis and Lorenzo (2002) have introduced "seven realms of children's participation", seven perspectives from which children's participation can be seen and how its significance has been defined and justified in the context of city planning (Table 14).

In Francis and Lorenzo's (2002) classification, rationales for involving children in city planning projects range from views seeing children as planners with no adult involvement to approaches in which the children are not directly participating in the process at all but instead only advocated for or represented by adults. The *romantic* dimension of children's participation means that

TABLE 14 Seven realms of children's participation (Francis & Lorenzo 2002)

Realm	Goal
1 Romantic *Children as planners*	Child-defined outcomes
2 Advocacy *Planners for children*	Representing the children's interests via adult advocates
3 Needs *Social science for children*	Defining children's needs and incorporating them into design
4 Learning *Children as learners*	Emphasizing the learning effects of participation
5 Rights *Children as citizens*	Protecting children's rights to participate
6 Institutionalization *Children as adults*	Children's participation is required
7 Proactive *Planning with children*	Developing plans and designs together with children

children – being innovative and often coming up with very good ideas – are the planners, often with no adult involvement. However, as there is no involvement by adults during the process, the children's ideas are often overruled by adults after the planning process. In the *advocacy* realm, adult planners promote children's interests and aim to come up with solutions that benefit them. Children themselves are not directly part of the decision-making process, they are only advocated for. The *needs* dimension acknowledges the necessity of considering children's unique needs and bringing them into general awareness, but it assumes that research alone can account for considering children's needs, and children's direct involvement in the planning is not needed. In the *learning* realm, learning is seen as an important outcome of participation, even so that the results of the design process may be secondary to the goal of learning. (Francis & Lorenzo 2002)

The aim of the *rights* dimension is to guarantee and protect children's rights; the approach emphasizes the ideals of democracy and empowerment. There is a risk, however, that the participation focuses more on the rights of the children on the level of principles than on their actual needs and ideas. In the *institutionalization* realm, children are treated like adults; they are expected to have the same power and knowledge, and they participate within institutional boundaries. More spontaneous and child-centred involvement is ignored, and this may lead to results that do not really correspond to what the children actually want. The *proactive* dimension, on the contrary, views participation as a communicative process in which both children and adults have an important role. Ideas created through participation are incorporated with principles derived from research in order to aim for good and implementable results. A significant advantage is children's increased feeling of control. Carrying out participation in this way may not be possible in every project, however, and using this approach successfully may require that the adult participants be specially trained. (Francis & Lorenzo 2002) This view is parallel to that of child-centred pedagogy, where the child is active but needs the adults' support and guidance.

Apart from examining the roles children are assigned in design projects, it has also been analyzed what kinds of roles children themselves adopt in participative projects. According to Kiili (2006), different children get different things from the participation. She identified four different roles reflecting the children's goals regarding their participation in a children's parliament: change-oriented, critical, activity-oriented, and child-centred. For *change-oriented* children, participation offered social resources and a chance to get in contact with decision-makers who would otherwise have been difficult to reach. *Critical* children, on the other hand, were especially interested in tackling everyday questions and having a say in concrete issues. *Activity-oriented* children were motivated by concrete doing and activities, whereas *child-centred* children appreciated the possibility to collaborate with other children without being directed too much by adults. According to the study, a common aspect in all of these types was that the children still needed the support of adults, both on a practical level and in terms of appreciation. (Kiili 2006)

Hence, some children are inspired by having the possibility to change things either on a general level or on the level of more concrete everyday issues, whereas others are motivated by the participation activities themselves or by the possibility to collaborate with other children without too much adult direction. These differences ought to be kept in mind when planning the participation process and activities. As the above examples show, the framework of participation set by the adults has a significant role in determining how the children are able to act. It is the adults' job to enable the children to express themselves by providing them with arenas of involvement and ways of communication.

An Extended Multidisciplinary Framework

The perspectives discussed above are used to broaden the framework of user involvement (pictured in Figure 10). Figure 29 illustrates the aim to extend the framework further and create a multidisciplinary approach for involving children in the design of game-based learning applications.

The dashed line represents the scope of user involvement discussed in Chapter 4, entailing the HCI view consisting of user-centred and participatory design as well as usability research, and the learner-centred design/child-computer interaction view enhanced with the use of developmental theories and pedagogical principles. This view is broadened with the approaches discussed above. On the one hand, the scope of human-computer interaction extends to game development and the use of games, in the form of player-centred game design and user-created content. On the other hand, the LCD/CCI view expands to approaches that more strongly emphasize the role

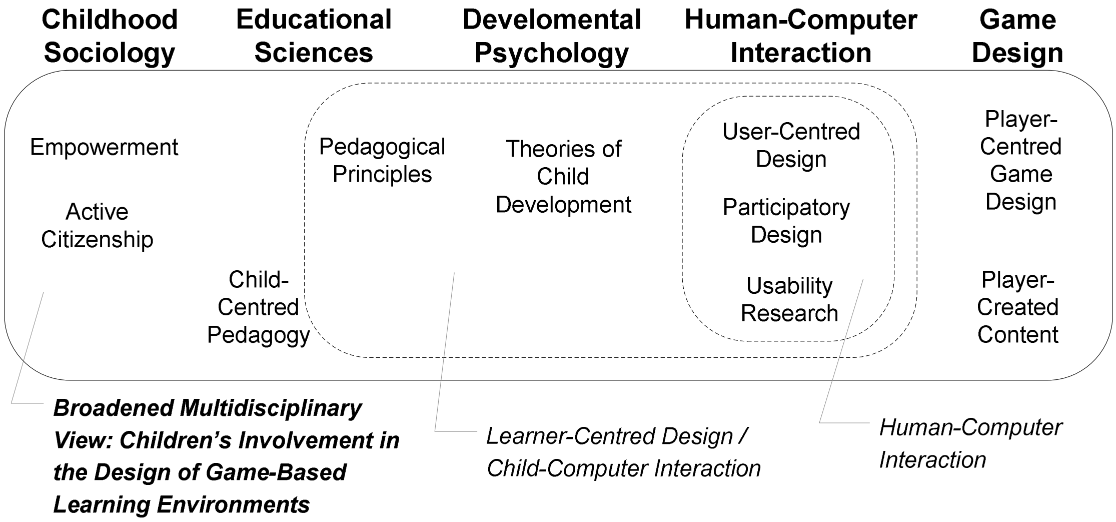

FIGURE 29 User involvement: extended multidisciplinary framework

of children as active participants in different areas of their lives, namely child-centred pedagogy in the field of educational sciences, and active citizenship and children's empowerment in the field of sociology. The next subsection will address these views more closely in terms of the methods used to put them into practice.

5.1.2 Methods Extended

Subsection 4.1.2 in Chapter 4 discussed methods used in the basic HCI view and in the CCI and LCD approaches. Below I will look at what the additions related to the aforementioned extended perspective, as well as the experiences obtained from the Talarius project, bring to participation methods. The text follows the same structure as Subsection 4.1.2, categorizing the participation methods into requirements gathering and idea generation on the one hand and evaluation on the other, in addition to which it introduces content creation as another main area of participation.

Requirements Gathering and Idea Generation

In the same vein as in the previous chapter, the methods for requirements gathering and idea generation can be grouped into 1) observation-based methods, 2) verbal, narrative, and drama-based methods, 3) documentation with photographs or in writing, 4) art- and crafts-based methods, and 5) game-like design methods.

The first category entails **observation-based methods**. Observation, especially *participant observation*, has an essential role in child-centred pedagogy, since observation makes it possible to follow and interpret children's actions and serves as a basis for other methods (e.g. Clark 2005; Clark & Moss 2001, 12-15). Clark and Moss (2001, 15) emphasize that although it is important to look for new ways of bringing out children's perspectives, established practices – such as observation – ought not to be discarded either, especially when used together with other methods. Observation is usually carried out from an adult point of view, and therefore it suits well to be combined with participatory methods that place children in a more active role (Clark & Moss 2001, 15).

The second category is related to **verbal, narrative, and drama-based methods** aiming to encourage verbalization of ideas and opinions. *Interviews* can potentially reinforce the children's understanding about the importance of the issues at hand. Children are aware that – unlike e.g. drawings which are often only of superficial or passing interest to adults (see Hart 1997, 162) – interviews usually bear importance and give them a chance to really have a say, for the reason that they have seen interviews in important contexts, for instance on television (Hart 1997, 172). Interviews conducted by the children themselves are an essential method of children's participation as well, similarly as in some aforementioned technology design methods. Hart (1997, 172-174) suggests that children prepare and conduct their interviews in groups, as they might feel uncomfortable doing it alone, especially if they are interviewing an adult.

In child-centred education, storytelling has been one way of attempting to avoid problems related to traditional interview settings: children have been allowed to tell stories without any restrictions as regards the topic, content, form, or length of the story (see e.g. Karlsson 2005). In this method, called *storycrafting*, the children are first and foremost given a chance to express what they want to say exactly the way they want to say it, and secondly, they are shown that adults appreciate their way of thinking (Karlsson 2005; Riihelä 2001). In the basic storycrafting procedure the idea is to let the children themselves come up with a topic, but it has been used also as a variant in which the children have been asked to tell a story related to a particular theme (e.g. Riihelä 2001). This topic-based form of storycrafting can be used in technology design projects to gather children's initial associations about a certain theme, to help uncover possible use scenarios, and to create new design ideas.

Stories are strongly present in the methods of child-centred pedagogy also in other ways. Martin (2004), for instance, describes a *storytelling- and drama-based method* in which children create their own fictional characters, play the roles of their respective characters, and create a common story entailing all the characters. Drama and role play methods adapted from the context of child-centred pedagogy to that of technology design can be fruitful for instance in exploring what kinds of game story ideas children come up with related to a specific topic area. In child-centred approaches, storytelling and drama-based methods have been seen as good ways of acquiring information from children's viewpoint, and as they resemble play, they are natural ways for children to express themselves (Clark 2005; Clark & Moss 2001; Martin 2004). Overlapping both game design and educational perspectives, Lacasa and Martinez (2006) have used role play as a method of analyzing the influence of digital games on the development of children's narrative thinking. Their principal aim has been to explore the potential of using video games in teaching (Lacasa & Martinez 2006), but the basic idea of the approach is well applicable also to the early stages of technology design projects: after exploring an existing game, the reconstruction of the story of the game through role play can reveal what the children consider to be the most essential features in a game and thus set early directions for the design process. In environmental design with children – similarly as in participatory design – the main goal of using drama is to identify important issues to be addressed and improved. Moreover, drama is a useful tool in the communication of ideas to others. (Hart 1997, 189)

Documentation with the aid of photographs and written accounts is the third group of requirements gathering methods. In the field of child-centred pedagogy, the underlying idea behind using *photography* has been to give children a chance to record and document their own lives, their interests and, for instance, topics that they find interesting related to some specific theme (Clark 2005; Clark & Moss 2001; Pakkanen 1998). In a similar vein, in environmental design and community planning, photographs have acted as a way for children to point out pros and cons about their surroundings (Hart 1997, 184). Clark and Moss (2001, 24) point out that children are aware that photographs are generally valued in the adult world (they are present e.g. in family albums, books, and newspapers), more so than children's drawings. This is one point supporting the use of photography to get children to express their opinions and to be taken seriously in doing so. It is a useful basis for technology design projects as well; children are allowed to express themselves rather freely, producing material that reveals requirements regarding use contexts and children's ways of acting.

Fourth, **methods based on arts and crafts** (drawing, creating low-tech designs, etc.) are often the first methods that adults think of when it comes to designing with children, as these methods are familiar to the children, easy and inexpensive to carry out, and generally considered fun by the children. The main idea of using *drawing* as a participation method is to make children aware of and bring out their ideas about the visual aspects of the design task. Drawings can also act as a basis for further discussion or activities. However, the process of analyzing drawings entails a great deal of interpretation, which does not necessarily ensure that the children's ideas are understood in the way they are actually meant. (Hart 1997, 162)

These problems can be addressed by putting more emphasis on group tasks. Creating *collective drawings* enables each child to express his/her own idea while at the same time placing it in a shared context and thereby moving towards a common outcome (Hart 1997, 162). However, as pointed out above, children might generally feel that adults usually do not consider their drawings important or take them seriously. Children's feeling of the significance of the task can be supported, for example, by promoting more active child-adult interaction in other ways, such as having children present their creations to adults and/or annotating children's drawings based on their instructions (ibid., 162-163). Listening to children talk about their drawings has also provided useful views into their ways of seeing things (Clark 2005). Moreover, Clark (2005) points out that the process of drawing may reveal issues the final creations do not carry. As mentioned previously, having children present their creations and listening to them talking about their drawings while working on them were considered good practices in the Talarius project as well.

Moreover, children might feel apprehensive about expressing their ideas by drawing if they feel that they are not good at drawing. An alternative method requiring less drawing and supporting collaborative expression better is the creation of *collages* using photographs, drawings, writing, and clips from newspapers and magazines (Hart 1997, 163). Hart points out that collages may actually end up being more spontaneous and creative than drawings, due to the spectrum of different ways of expression used in their creation. Another method, used also in technology design contexts, are comic-strip-like *storyboards* that are structure-wise very familiar to children (ibid., 162).

Ironically, the use of **game-like design methods** has been studied rather much in association with the design of utility applications, while in the field of game design there are few reports of applying such methods. One such invention is GameGame (2006), a *card game* about digital game design, which can be used, for example, as a brainstorming aid in creating initial ideas for game concepts. Sotamaa et al. (2005) define their *cultural probe-based approach* (cf. Gaver et al. 1999; 2004) as a game-like participation method as well. The self-documentation kit used by informants to complete different types of tasks in the course of a certain period of time was designed to resemble a game in terms of e.g. packaging, rules sheet, bonus task cards, and other features (Sotamaa et al. 2005).

Evaluation

In game design, the objectives of evaluation are somewhat different than in the evaluation of utility applications – for which most evaluation methods are intended. However, issues related to the performance of the game or reasons behind certain user behaviour or specific usability problems in games can be revealed with the aid of **behaviour-based evaluation methods** (Pagulayan et al. 2003). A method called RITE (Rapid Iterative Testing and Evaluation) has been used in usability evaluations of games, aiming to uncover game usability problems efficiently by involving fewer participants in the evaluations but carrying out more evaluation cycles (Pagulayan et al. 2003; Wixon 2003). This conforms with the UCD and PD principle of continuous user involvement. Another issue characteristic of the use of RITE is that the whole developer team is observing the tests (Wixon 2003), which for its part is consistent with the goal of improving communication and understanding between the users and designers.

Attitudinal evaluation is especially important in the evaluation of game applications. Games characteristically underscore the entertaining nature of the playing process instead of the efficiency of producing certain results, and therefore **opinion-based evaluation** is emphasized in the evaluation of games over performance-measuring metrics (Pagulayan et al. 2003). When discussing methods for technology design with children, I brought up Read's smiley-o-meters (Read et al. 2002; Read & MacFarlane 2006). Using smileys as an aid especially in surveys aimed for younger children has been recommended also in the field of child-centred pedagogy (e.g. Clark 2005). *Pictures of happy and sad faces* have been used in child-centred activities also by asking children to express with them how they feel about different places they see during a tour in their close environment (National Early Years Network/London Borough of Redbridge, cited by Clark 2005). In the same vein, the children in Kiili's (2006, 61) study placed different *colour tags* onto a map of their residential area in order to highlight places with positive and negative connotations. In technology design, a method based on the same idea can be applied in the evaluation of e.g. user interface mock-ups or paper prototypes, particularly when working with younger children.

One particular method used in child-centred education to listen to children and reveal children's opinions is *child conferencing*. Clark and Moss (2001) have used child conferencing as a part of their "Mosaic" approach: the children answer a survey regarding a certain topic, and the results are discussed together. In the next meeting, the children can reflect on their earlier answers and bring up potential changes and new points of view in their opinions (Clark & Moss 2001). Clark (2005) points out that child conferencing is a way of recognizing that while many children like playful methods of participation, some children prefer to participate in a more structured and formal way. This method can easily be adapted to the evaluation of technology, and it is especially well suitable for evaluating the children's own input and contribution to the development of the product. Children's suggestions regarding the application can be reviewed together, and the children then have an opportunity to comment on how they feel their ideas show in the outcome.

Content Creation

As seen above, the broadened view of user involvement brings some new methods and practices to requirements gathering, idea generation, and evaluation of game-based learning environments. Probably its most important contribution to the development process is, however, that it provides one completely new dimension, namely content creation which can take place at any phase of the development process, not only at the end. The value of adding content creation methods to the development process is that it can be seen as a response to the problem of children not getting a hands-on feeling of contributing to the design, an issue identified in the Talarius study as well as in other contexts (e.g. Guha et al. 2004; 2005).

The inclusion of content creation by users into technology design corresponds to practices that have emerged or been developed in game design on the one hand and in child-centred pedagogy on the other. In gaming culture and in the use of game-like virtual worlds, content creation by users has become a very popular phenomenon, giving the users a possibility to expand the games and to alter them to fit their interests and needs better. The exceedingly participative nature of the Internet provides people with an extensive environment for publishing their own creations ranging from the aforementioned game elements to various other types of contents such as images, stories, quizzes, videos, music, and special contents with different goals such as education or citizen journalism (e.g. OECD 2007, 15-20).

The OECD report on issues related to participative web (OECD 2007, 4-8) defines three main elements of user-created content. Firstly, it is published for others to view. Secondly, its creation is not part of professional practices; instead, it is motivated by factors such as self-expression, recognition, and social connection with others. Third, it includes some creative effort and added value, i.e. constructing something new or modifying existing material.

5.1.3 A Summary of the Principles and Methods

The aim of this section has been to broaden the previously formed framework with game-design approaches and approaches from educational sciences and sociology that emphasize children's active participation in their immediate world. The purpose is to inform the project that comprises the second development research cycle in this study, namely Virtual Peatland. In line with the principles of development research, the results obtained from the Talarius project play also a significant role in the planning of the methods used in the Virtual Peatland project.

The inclusion of content creation is the most notable change in comparison with both the Talarius project and technology design projects conducted with children in general. The content creation perspective is inspired both by the growing phenomenon of player-created content and the approach of child-centred pedagogy. The former enables users to produce and share concrete content items with a large number of other people, while the latter emphasizes children's active role in thinking about their own learning and what they consider interesting and motivating ways of learning about different things.

Moreover, the Talarius project as well as experiences discovered reported by other researchers (e.g. Guha et al. 2004; 2005) brought forward the need to structure the participation process better. The children may have difficulties with perceiving how different ideas are merged and transformed in the process from idea generation to implementation – and the developers may have difficulties with conveying this process to the children. Therefore the process of participation sessions should be made gradual both on the level of one session or activity and on an inter-session level. As regards the former level, the Mixing Ideas approach by Guha et al. (2004; 2005) is an example of making individual creations collective through a gradual merging process. When it comes to the inter-session level, the main point is that the activities of each session build upon the outcomes of the previous ones and thereby form a logical and clear continuum.

How the aforementioned points were addressed in the Virtual Peatland project will be discussed in the following section.

5.2 The Extended Perspective in Practice: Case Virtual Peatland

As described above, the extended framework described in the previous chapter was put into practice in the development project of Virtual Peatland (Virtuaalisuo), a web-based learning environment about peatlands. While the Talarius pilot project was the first of the development research cycles presented in this study, this project represents the second one.

The structure of this section is similar to that dealing with the Talarius project. First, in Subsection 5.2.1, the Virtual Peatland project is presented generally. The two following subsections (5.2.2 and 5.2.3) focus on the research questions that are related to the process of participation: describing in detail how the process was carried out and which methods were used, the experiences obtained from the process, and finally, the team-work-related issues discovered in the project. The next subsections move from the process-related questions to those dealing with how the goals of user involvement were attained in this project. Subsection 5.2.4 looks at the project from the viewpoint of user expertise and the addressing of the actual use context. In Subsection 5.2.5, the focus is on the empowerment of users, i.e. to what extent the children felt that they were able to influence the process. Subection 5.2.6 deals with the contribution-related issues from another point of view, namely the analysis of the manifestation of the ideas in the outcomes. Furthermore, I have raised the issue of learning from design collaboration as an additional issue to be addressed (Subsection 5.2.7). Finally, the results will be summarized and their implications discussed in Subsection 5.2.8.

5.2.1 The Virtual Peatland Project

The goal of the Virtuaalisuo (Virtual Peatland) project was to design a web-based learning environment for enhancing the understanding and appreciation of peatland nature especially among young learners. The aim was that the learning environment would include both a text-based information bank and game-like sections. In the final outcome, these came to be realized as three text-based information sections (Peatland Nature, People and Peatlands, Preservation of Peatlands) and three interactive and game-like parts (a flash-based "Peatland Adventure" game; a "Children's Peatland" section consisting of different kinds of quizzes and tasks, and video clips; and a Talarius-based peatland board game). The application was intended to serve as a learning resource in connection with the Leivonmäki National Park, and therefore it would be aimed for a wide user group. This required several stakeholders to take part in the project – e.g. peat industry representatives, biology and geography teachers, and students from several school levels. The project was funded by the European Social Fund and the State Provincial Office of Western Finland. The active development period lasted for approximately a year and a half, from May 2005 to November 2006.

Participants

One of the most important user groups being school children, an elementary school class was invited as participants. The class consisted of both fifth- and sixth-graders (ages around 11-12). Due to the fact that the duration of the project stretched over three different academic years (from May 2005 to November 2006), the class composition changed twice during the project (the number of children in the class varied between 20 and 26), and not all children participated in all phases. In this study, the main group being addressed are the twelve children who were fifth-graders in the school year 2005-2006 and sixth-graders in the year 2006-2007. They participated in every step of the project except for the very first idea map creation. On the other hand, the children who were fifth-graders in the final phases of the project (autumn 2006), when the focus was on the evaluation of the final application, were basically in the role of testers – as they had not been involved in the actual design activities in the previous school year. Similarly, those who were sixth-graders in the spring of 2005 did not participate in the evaluation of the final application as they were no longer in elementary school at the time of the very last phases of the project.

Unlike the Talarius 1.0 project, the technical development of which was done by one student group in a relatively short period of time, the development of Virtual Peatland was carried out in collaboration between several groups at different phases. For the most part, the environment was developed in the Agora Game Lab (most of the content development, and all of the technical development of the interactive and game-based elements), but there were other groups involved as well. The preliminary technical development of the web application used as the basis of the site was carried out by a computer science student group, while the initial ideas and the first prototype of the game application were created by an interdisciplinary group of multimedia students. Moreover, some images were designed by students of graphic design. As regards the contents of the application, some special content was provided by stakeholders such as peat industry representatives.

The multidisciplinary research/development group within the Agora Game Lab consisted of people representing fields such as education, computer science, information systems science, and biology and science education. Each member had one or more principal areas of expertise in the project. These included education, human-computer interaction and user involvement, content area, technical development, game design, and graphic design. Two of the researchers – the educational specialist (who was also the project coordinator) and the HCI specialist – were responsible for carrying out the design sessions with the children and participated in the activities at the school. In some sessions they were both present and in others only one of them was. One of the school sessions was also led by the content area specialist. The configuration of the group was not constant from start to finish; it experienced some changes both based on the phases of the project and due to personnel changes in the organization. My own role in the team was that of the HCI and user involvement specialist, hence I was one of the two researchers who worked with the children.

Data Collection

Similarly as in the Talarius project, the data collected in the Virtual Peatland project comprised the perspectives of the children, developers, researchers, and the product alike, consisting of questionnaires, interviews, documents, field notes, and different types of design outcomes (see a table of all the data in Appendix 2). A particular object of interest in this study was to examine how the participants experienced the process and whether the problems discovered in the Talarius project were lessened by applying principles from the extended multidisciplinary approach to user involvement.

With regards to collecting data from the children's perspective, the Talarius project showed that instead of focusing the interviews or questionnaires only to one or two points in the course of the project, it would have been better to address the participants' experiences related to each participation method or project phase immediately after the event, ensuring that the children still remembered it clearly. Therefore, in the Virtual Peatland project, the children answered brief questionnaires at the end of most of the design sessions, making sure that each design activity was addressed in an equal way. However, as in the Talarius project, there was also a specific final questionnaire at the end of the project, answered by the sixth-graders who had been involved in all activities save for the very first idea map creation when they were not yet in this class. The final questionnaire was accompanied by final interviews conducted in small groups, aiming to shed more light on their experiences. The interviews were conducted approximately a week after administering the questionnaires.

Hence, all in all, the children's perspective was covered with five questionnaires in the course of the project (each addressing a specific design session or theme) as well as with the final questionnaire and interview after the project ended and the Virtual Peatland environment was published. Each of the mid-project theme questionnaires consisted of 4 to 10 open-ended questions about the children's experiences from the theme in question. The questions dealt with what the design activity or method had been like, whether the children felt that they had learned something from it, and how their groups functioned. The five theme questionnaires were answered by all the children who participated in the activity in question, fifth- and sixth-graders alike.

The final questionnaire (see Appendix 6) consisted of ten questions which were the same ones as in the final questionnaire of the Talarius project. As described in the previous chapter, in the Talarius questionnaire there were 20 questions, ten of which were related to the specific participation methods used in the project and ten were of a more general nature, addressing the children's overall experiences related to the participation. These more general questions, which especially dealt with the children's motivation and feeling of having a say, were used in an equivalent form in the final questionnaire of the Virtual

Peatland project as well. This was done in order to be able to compare[3] the two projects to each other in terms of children's experiences. The twelve children who had participated in the project during two academic years, first as fifth-graders and then as sixth-graders, answered the final questionnaire. It should be noted that as the number of respondents was different from that of the Talarius project (in which there were 23 children answering the final questionnaire), the comparison will be presented as percentages in the figures included in the following subsections. The same children were also interviewed at the end of the project in the form of group interviews, the themes of which are presented in Appendix 7.

As regards the developers' perspective, in the Virtual Peatland project there were no specific developer interviews, as the principal developers were members of the research group and documented their perspectives in different forms: the developers' point of view was studied with the aid of various development documents and field journals. The development documents were expected to elicit especially issues related to the technical perspective of the development work, whereas the field journals – which documented the design sessions conducted with children – included also development-related reflections on the content and pedagogical design perspective and the effect of the children's participation on them. Thus the field journal served as both a research journal and a development project diary, as one of the two researchers who were actively involved in the children's participation had also the principal responsibility over the whole development project.

Establishing Children's Involvement in the Project: Background Principles and Practical Considerations

Like the Talarius project, the Virtual Peatland project was also based on the principle of involving future users in the process and its potential benefits (e.g. Druin 2002; Kujala 2003; Scaife & Rogers 1999). The Virtual Peatland environment is aimed for a very broad user base, school children being one of the main groups. Therefore it was essential to hear their ideas and wishes regarding the content and structure of the site. When it comes to the general structure of the process, the user-centred cycle was largely followed (as in the Talarius project) but the types of participation methods were emphasized differently. The aim was to search for improvements to the shortcomings and problems discovered in the Talarius project. Firstly, the development process was carried out with an attempt to plan the process in such a way that the children's feeling of ownership would be supported better and that there would

3 Due to the differences in the projects (different types of applications, different participants, different methods of participation) there are naturally limitations in terms of to what extent the projects can be straightforwardly compared to one another. For example, specific participation activities and sessions cannot be directly compared. What can be compared, however, are the participants' experiences of the project and their participation in it in general.

be a good balance between more abstract and more concrete design methods and activities to make the participation process as fruitful as possible for both the children and the developers. There was, especially, an attempt to emphasize the feeling of having a continual influence on the development of the ideas with the aid of a more smoothly proceeding series of workshops building on each other – following the same basic aim as Guha et al. (2004; 2005) with their gradual Mixing Ideas method – and to provide the children with chances to make concrete and direct contributions to the final outcome by incorporating various forms of content creation into the design process. Another goal was to put more emphasis on group activities and to make the design process less monotonous by using different types of methods. Moreover, it was essential that the outcomes of the design sessions be as easy to apply in practice as possible.

The collaboration with a school class was also expected to both inform the project about what would be useful for the use of Virtual Peatland in schools and, on the other hand, provide the children with a special learning opportunity about issues related to peatlands through the participation in the project. The particular school was chosen to be asked as a participant because it was located in the close proximity of the National Park for which the application was intended. The particular class was chosen together with the teachers, based on their views on which class would be the most suitable participants. Throughout the project, the teacher of the class had a considerable role in steering the collaboration and planning the design methods.

In the Talarius project, time resources were a major problem as regards the extent of user involvement. While time constraints presented some issues in the Virtual Peatland project as well, they were much less of a problem in this project. Firstly, the development work was, for the most part, conducted by the Agora Game Lab research group, within a project which was defined as both a development project and a research project from the beginning. Therefore more time could be allocated for the planning and conducting of the design sessions and the analysis of their outcomes. Secondly, the school with which the project was carried out was also able to allocate more time for the project, which enabled more frequent and regular design sessions with the children.

5.2.2 Participation Methods and Activities

The design methods and the structure of the project are presented in this subsection. Figure 30 illustrates the timeline of the design sessions. The children participated in the process through various workshop sessions, each of which dealt with a specific aspect related to the structure or the presentation forms to be used in the learning environment. A workshop-based approach was chosen because the project would include many sub-tasks and sub-topics different from one another, such as issues related to the subject matter on the one hand and to the structure and elements of the learning environment on the other. Each workshop had its own internal structure, but a principle common to all the sessions was the intention to emphasize group work and to arrive at negotiated results. Moreover, as the figure shows, the children also made a peatland excursion, and created own content in the form of e.g. quizzes and video clips.

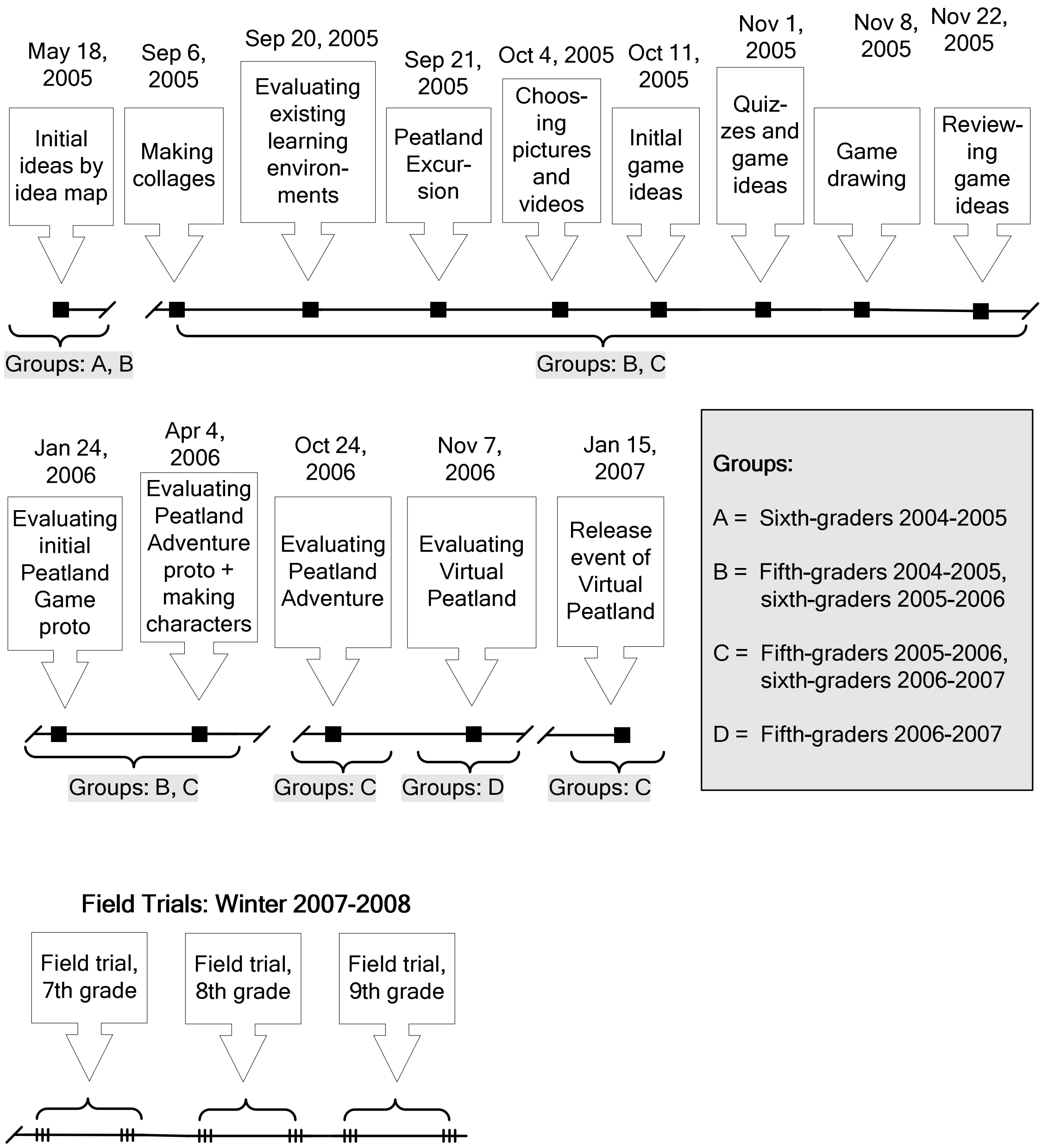

FIGURE 30 Children's involvement in the Virtual Peatland project

The workshops started with an initial idea creation session in the spring of 2005. For one term (autumn 2005) the activities were almost weekly, as the topmost row in the figure shows: there were researcher-led design sessions approximately every other week, and in the alternating weeks the class worked on the tasks on their own, continuing the activities that had been kicked off in the collaborative sessions. For reasons of space, these independent sessions have not been included in the figure but, as mentioned, they were either continuation to the previous or preliminary preparations for the next session. At the later phases of the project, the collaborative sessions were less frequent and were carried out when each prototype was ready to be evaluated (see the middle row in the figure). In addition to the participation of the partner class, field trials were conducted with several other groups later, when the learning environment was finished (the bottom row in the figure). All the workshop sessions, except for one excursion to the peatland, were carried out in school, either in the classroom or in the computer lab. For the most part, the sessions lasted for two regular classes, i.e. 90 minutes altogether (sometimes 45 minutes less, sometimes 45 minutes more). Each week there was a specific time slot reserved for the project activities on the same day of the week.

In the spring 2005, the children's initial ideas were gathered in the form of an idea map. In the first session in the following autumn, these ideas were reviewed with the children and other, more concrete idea maps in the form of collages were created in small groups. In the next session, the children evaluated and critiqued existing learning environments. This was followed by an excursion to the peatland, for which the children had made preparations in an independent (i.e. non-researcher-led) session in the previous week. The goal of the peatland excursion was to take photographs and film videos for Virtual Peatland. In the next researcher-led session, the children looked at the photographs and video clips and chose the best ones out of all the material. After this, the next few sessions were focused on game-related issues: ideas regarding the goals and the plot of the game were gathered, a collective drawing presenting the structure of the game was created, the children drew their ideas about the characters of the game, and various quizzes and other activities or sub-games were created. Finally, the children evaluated the environment at different phases. All these sessions are described in more detail below.

The figure also presents the participant groups. As the partner class consisted of both fifth- and sixth-graders and as the project extended to several academic years, at the beginning of each school year the previous sixth-graders left the project and new fifth-grader entered. Group A represents the sixth-graders and Group B the fifth-graders of the year 2004-2005. Hence, the children of Group B are also the sixth-graders of the year 2005-2006, and Group C represents the new fifth-graders. They, for their part, are the sixth-graders of the year 2006-2007, while the new fifth-graders are referred to as Group D. Hence, Group A only participated in the creation of the initial idea map. Group B participated in all design activities but not in the evaluation of the final outcome. Group C, the group which has been the principal focus of this study, participated in all design and evaluation sessions except for the very first idea map. Group D only took part in the evaluation of the final version of Virtual Peatland.

The participation methods can be categorized in the same way as those of the Talarius project: requirements gathering and idea generation, evaluation during the active development phase, and field trials with the finished application. While in the Talarius project the main focus was – typically of many user-centred projects – on evaluation, the Virtual Peatland project emphasized idea generation and refinement more heavily. A more fundamental difference, however, was that in addition to these three main categories of methods, there was a fourth, equally important one, namely content creation. In the following, the activities of the project are described and the research results related to each method are discussed. The structure follows the categories mentioned above.

Requirements Gathering and Idea Generation

The following deals with the methods that were used to generate ideas and gather requirements for the Virtual Peatland learning environment. The methods are described in detail, and the results related to them are examined. The methods are as follows: 1) initial idea maps about the content and structure of the learning environment, 2) collages about the different information presentation forms and the species to be included in the learning environment, 3) the evaluation of existing web-based learning environments, and 4) methods related to the planning of game ideas: initial ideas, game drawing, and designing game characters.

The collaboration with the children started with a session in which the children and the researchers created **idea maps** together to chart initial ideas about the content and structure of the site. The researchers described to the children some basic information about the aims of the Virtual Peatland project, presenting the background and the general goals of the project and explaining what was meant by a web-based learning environment. There was also more general discussion between the researchers and the children and their teacher about using computers at school and at home, with the aim of getting the children to think about the possibilities of using computers for learning and thereby providing them with a basis for the idea generation related to Virtual Peatland.

The children first made individual lists of their ideas and, based on them, suggested things to be included in a collective list of ideas. They wrote their ideas on sheets on which there were three general questions to help them think about the content and elements: 1) what kinds of things the Virtual Peatland website should include, 2) what kinds of issues the children would like to learn or study with the aid of Virtual Peatland, and 3) in what ways they would like to learn things on the website. In addition to the three questions directly related to the Virtual Peatland website, the children's individual questions included one which was related to their ideas and wishes regarding their participation: they were asked which features of Virtual Peatland they would especially want to have an influence on. After writing down their individual lists, the children gathered into five small groups to talk about their ideas, to adjust and update their lists together, and to discuss which issues they considered the most important.

After this, a collective list was created based on the children's suggestions about the most important issues. They mentioned issues one by one, and the researchers wrote them on a whiteboard in the form of a bulleted list. Once there were no more suggestions, the list was taken as a basis for creating an idea map. Again, the children chose what was especially important: out of the collective list, they highlighted games, pictures, quizzes, animations, and "learning by seeing and hearing" as the most important ways of presenting information on the Virtual Peatland website, and animals, plants, and trees as the most important or interesting content issues. These were taken into further discussion with the aid of an idea map drawn on the whiteboard (Figure 31). Each of the important issues pointed out by the children was placed as a node in the idea map, and the children and the researchers together started building the map around them: each node was discussed together (with the whole class), and the children suggested related items to be added as sub-nodes to the map. The children were specifically reminded that they did not have to raise their hands before suggesting something, like normally in class, but they could instead freely voice their ideas immediately.

FIGURE 31 The idea map on the initial ideas regarding the content and the information presentation forms to be used on Virtual Peatland

The notion of a step-by-step session proceeding from individual to collective has been influenced by the research showing that children need to clearly see their ideas being gradually merged with those of others, in order not to lose the feeling of ownership of their ideas (Guha et al. 2004; 2005). In this study, the goal of the idea map creation was to incorporate the basic idea of this approach to the classroom context and to the limited time slot. While the merging of drawings works well especially with younger children (Guha et al. 2004; 2005), it has also been discovered that children tend to focus on detail at the expense of having all the essentials quickly present in the drawings (Scaife & Rogers 1999). For this reason – and because at this point it was important to concentrate on the content of the learning environment and not so much on its appearance yet – a collective, gradual idea map creation was seen as a potential alternative to a drawing-based task especially to be carried out within a limited time slot. Each of the activities (the steps consisting of creating the individual lists, the group discussions, making the collective list, and compiling the idea map) was carried out in a rather quick pace in order to concentrate on the most essential things and to keep the process as smooth as possible without unnecessary gaps. Furthermore, although the drawing task was rather successful from the fifth-graders' point of view in the Talarius project, there is a possibility that children of this age consider it not to be serious enough (cf. Clark & Moss 2001, 24). The analysis of idea maps and written lists was also expected to be more straightforward than analyzing drawings.

Going into the children's experiences related to the activity, I will start by pointing out that one of the issues discovered in the Talarius project was, regarding some participation activities, that the same aspects of the design work could be both the most motivating and the most difficult ones. This was especially evident in initial idea creation which is an activity that requires a great deal of creativity and entails generating ideas from scratch. This was the case in the Virtual Peatland project as well: coming up with ideas was seen as the best thing about the idea map creation session, but it was also the most difficult thing about the session. The children liked being creative and being able to voice their ideas, but especially the individual idea creation phase at the beginning of the session was considered difficult. Once the session moved from individual to collective idea generation and elaboration, there was less difficulty.

> [The best thing about the session was] gathering all the ideas.
>
> Coming up with ideas [was the most difficult part of the session].

In general, idea map creation was deemed successful by the children: when the children were asked to write down their overall experiences of the session, only one of the children mentioned something negative, while 15 children had positive things to say. In another related question (*What was it like to design Virtual Peatland?*), the results were similar: there were twenty positive and four more negative comments. The positive opinions were related to e.g. the opportunity of the children to say their opinions, the general interestingness of the activity, and the fact that the design session brought variety to an ordinary school day. In other words, the successful aspects were for a large part similar to those discovered in the Talarius project as the motivating aspects of participation in general. The negative opinions were related to general boringness of the session or to the view that the topic of the session (i.e. peatland) was uninteresting as a whole.

> It was quite fun, because you got to say your own opinion and tell your own suggestions.
>
> It was nice. It's fun to be a part of this kind of work.
>
> It was fun, because it was a bit different school lesson.
>
> Pretty boring. The topic is not very interesting.

As mentioned above, the difficulties experienced by the children were mainly related to coming up with ideas individually. As regards the group and collective parts of the session, there were mentions of liking both telling their own ideas to others and listening to others' ideas. The children were specifically asked also about how their groups – in which they discussed individual ideas before the collective idea gathering with the whole class – functioned, and while a couple of children mentioned that the task had been somewhat unclear or that there had been some disagreement within the group, for most children the group work part had gone without problems.

> At first there was some 'squabble' [in our group] about who says [his/her idea] first, but after all it went just fine.
>
> It was a bit confusing but it went well anyway.

From the researchers' perspective, the session was successful in terms of the method used. The phases of the session supported each other well: the general presentation of the Virtual Peatland idea and the discussion related to the ways in which the children used computers at home and at school warmed them up and served as a good basis for combining the two areas, peatland and computers, when they started thinking about the things that could be included on the website.

> The presentation of the project [to the children] went well and we managed to activate the class with our warm-up questions about how computers are used at home and at school. Based on [the ways of] computer use, the children had ideas about what Virtual Peatland could include. […] The question sheets worked well. Especially the first questionnaire [about the children's individual ideas] was a good basis for idea generation. When answering the questions, the children thought about the potential contents of Virtual Peatland, and thereby their thoughts were 'tuned in' on the topic. (Project coordinator / educational specialist in the field journal)

Moreover, the individual idea creation – even though it seemed to be difficult for many children – was an important step from a research and development point of view. The idea map, being a collection of the most popular ideas (i.e. those agreed upon as the most important ones) and being compiled in a researcher-led way, was a filtered outcome, but the "raw data" in the form of the children's individual idea lists was important as well, because not all those ideas ended up in the idea map.

> We obtained contents to the idea map very well, although there were some starting problems at first. Telling their opinions seemed to feel a bit difficult to the children at the beginning, but once they got the hang of it, they started to come up with a lot of ideas. Collecting the ideas in several phases (first the sheets the children filled in individually, then the list into which all the things mentioned [by the children] were written, and after that the idea map based on the most central things) was a good way to gather ideas at least in the sense that in addition to the final idea map we also got some "uncensored" versions of the ideas to examine and analyze. (HCI specialist in the field journal)

What caused some concern for the researchers was the extent to which they conveyed their own ideas and thought patterns to the idea map through leading the creation of the collective map. Finding a balance between facilitating and directing turned out to be difficult. It was necessary to have an active role in the idea map creation in order to accomplish a shared outcome within the time available, but it was hard for the researchers to estimate how big an effect their views regarding the structure or content of the idea map had on the final outcome.

> At some point I was wondering whether we directed the students' thoughts and opinions too much. I don't know if the idea map was made too much according to our model. Maybe, because we started constructing it based on our view. On the other hand, we asked the students which three things they thought were the most important ones, and they were placed in the idea map first. We could, however, have asked their visions/ideas about how we should start working on the idea map. (Project coordinator / educational specialist in the field journal)

As regards the ideas and opinions regarding the development of Virtual Peatland that were elicited by the idea map creation, some issues appeared especially prominent. The children emphasized game-like methods and, in general, elements which entailed something to do; in addition to games, they suggested interactive features such as quizzes, taking a role of a peatland animal, creating animations or a virtual national park of their own.

> In the children's ideas, wishes related to game-likeness and interactivity (building one's own park, taking the role of an animal of the park, making one's own animations etc.) were clearly emphasized. (HCI specialist in the field journal)

In the next session – which took place in the following autumn – the idea map created in the spring was taken onto a more detailed and concrete level with a group-based **collage creation** session. Similarly as the idea map session, the collage creation was based on the need to be able to carry out the task relatively quickly and for each group to finish approximately at the same time. As pointed out above, with drawings or other from-the-scratch methods, there is a risk that too much emphasis is put on detail (Tudor et al. 1993; Scaife & Rogers 1999). Moreover, especially in large groups such as school classes, some children or groups finish the task faster than others, which – as seen in the Talarius project – can cause frustration and lack of motivation in children who have to wait for others to finish and have nothing to do meanwhile. Furthermore, as Hart (1997, 162) has pointed out, collage creation is a useful alternative for drawing, especially as not all children feel that they are good at drawing and therefore might be slightly apprehensive about it.

As there were new fifth-graders in the class now who were not familiar with the project yet, the researchers first introduced the project and the idea of Virtual Peatland to the children. Also, in order to bring the earlier idea map back to mind to the sixth-graders and to familiarize the fifth-graders with it, the researchers and the children together went through the process and outcomes of the spring session, and discussed the ways in which the children would be involved in the process.

The goal of this session was to plan what kinds of media elements (i.e. presentation forms) could be used in the Virtual Peatland environment and to learn about the children's interest in different species (animals, plants, mushrooms etc.) of peatland nature. The researchers had prepared small pieces of paper, each with the name of a presentation form or a peatland species on it. The children's task was, using the paper snippets, to create collages that represented the species they would especially like to learn about and the ways in which they would like to learn about them. Then, the elements in their collages would be counted, and they would start working on the most frequently appearing and/or otherwise most interesting ones.

Before the actual start of the task, the researchers went through all the different presentation forms included in the snippets, and those the children were unfamiliar with were explained to them. For example, the concepts of "diagram" and "timeline" were clarified. The children formed five groups with five children in each group (their teacher assigned the groups). The children worked in the groups to select specific peatland species they considered the most interesting or important and to pick the most appealing presentation forms. Most of the presentation forms were suggested previously in the idea map creation, and a few additional ones were added to the selection by the researchers. Each group created one collage: the children glued paper snippets onto a large sheet of paper and wrote briefly beside each element a reason why they wanted this specific species or presentation form to be included in Virtual Peatland. After the collages were finished, each group presented their outcome to the others. The initial idea was to create just one collage per group, but the teacher suggested that they make another one; this time the collage would be composed of species and presentation forms that were unfamiliar to the children and that they would want to learn more about. This was carried out in a similar way as the first collages, and once they were finished, these collages were also presented to the audience consisting of the other groups, the teacher, and the researchers. Besides ensuring that all the children were aware of other children's ideas, the presentations were seen as a way to support the children's feeling that their ideas were taken seriously and listened to by the adults (cf. Hart 1997, 162-163).

Figure 32 illustrates a detail of one of the collages. The children have chosen bear ("karhu") as one of the animal species they would like to learn about ("I would like to learn about the life of bears. I am interested in them."). Moreover, they suggest webcam, video, and game as presentation forms with which they would like to learn about bears. The collages consisted of several such nodes. The children could decide for themselves how they wished to construct and arrange the nodes.

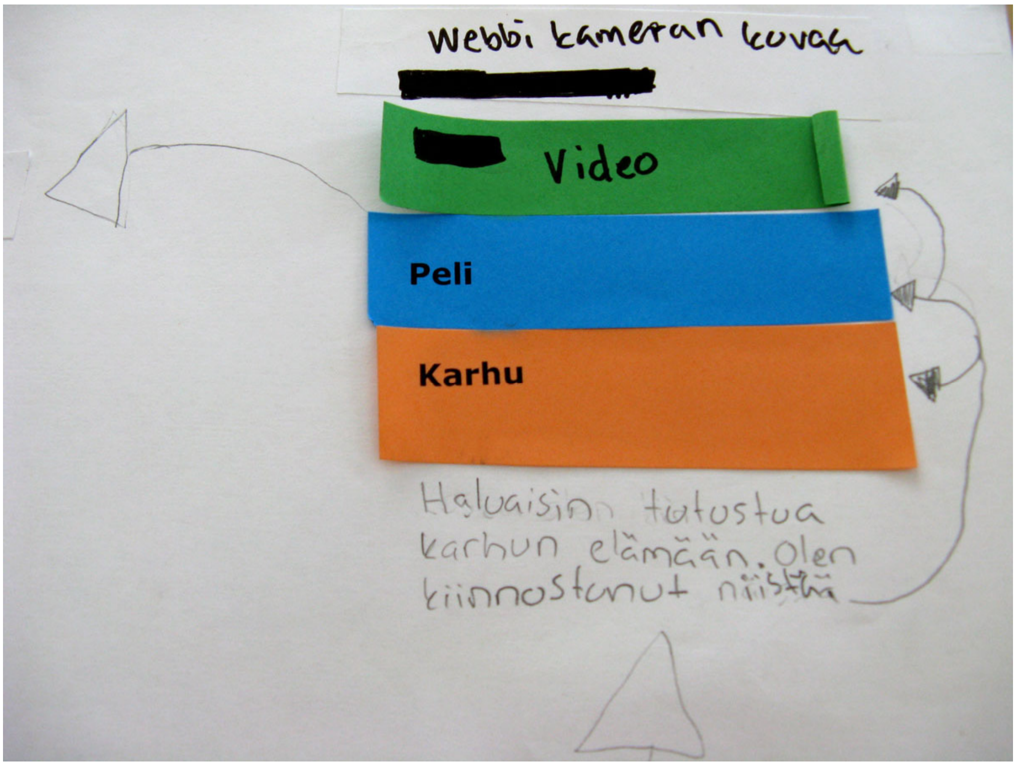

FIGURE 32 A detail of a species-and-presentation-forms collage

Similarly as the idea map creation, also the collage creation session was given principally positive feedback. In the feedback questionnaire gathering the children's experiences regarding the session, the question about general feelings after the collage creation yielded positive feedback from almost all of the children (twenty positive comments), mainly because the children felt that the session had been fun. There was some criticism as well, mainly related to the complicatedness of the method used: it was difficult, everyone worked individually instead of doing team work, the gluing of the snippets was messy, or there were too many items to choose among.

> The design session was fun and good.
>
> I'm eagerly looking forward to the next time!
>
> Hands got dirty because of the glue [and] there were too many snippets. I think the website may become boring.

When asked to specify the most interesting or fun aspects of the task, the children brought up several different issues. Firstly, the physical task of making of the collages as such – gluing, arranging, choosing paper snippets, etc. – was liked by the children. This way of working was also something new to them: as someone pointed out, they learned a new way of doing group tasks. Another aspect they enjoyed was working in groups. Moreover, in a question particularly asking their views about the teamwork during the task, almost all stated that the groups functioned well, everyone behaved well, and the work load between the group members was equal. Furthermore, the children liked being able to design something in general. For some children, also the topic of the session (animals and plants) was an important factor in making the task interesting. However, as noted in the results from the idea map session, this issue divided opinions fundamentally: for those who were not interested in the theme of the project, it affected their feelings about the sessions negatively.

> [Teamwork went fine because] everyone was nice and did the same amount of stuff and talked about [the collage in the presentations].

> Making the first [collage] was a bit of a fuss, but the other one was much better.

Another matter to split opinions was presenting the collages to other groups. For a few children the presentations had been the best thing in the session, while as many of them felt the opposite and considered the presentations the most difficult or least successful part of the whole session. Besides presenting, another issue that elicited criticism from several children were the difficulties with the first collage. The task was apparently somewhat confusing to the children at first, and they had some trouble grasping the idea of the collage and getting started with making it. The other round, which was suggested by the teacher, went considerably better.

In the group interviews after the project, the children were asked about each of the participation sessions (except for the idea map creation, as these children were not yet in the partner class at the time of that session). Many of them pointed out that collage creation had been the least interesting method in which they had participated in the course of the project. As seen above, immediately after the collage creation session they gave principally positive comments about the activity, but in hindsight this session appeared to have been overshadowed by other activities. One group talked about why it was so, and it turned out that they did not like it as much as some other methods because it was the least concrete activity. They felt that they did not really get to *do* anything. For the same reason, children in another group felt that the collage creation had been the least useful method: they stated that the things planned with the aid of the collages were very basic and did therefore not have much effect on the development of Virtual Peatland in practice. This issue manifested already during the session: it was clear that the children wanted to see and do something more concrete, as some children asked when they would get to do something more “real” for the website and when the site would be finished.

> One could clearly notice that the students would like to see something concrete as soon as possible (they were, for example, especially interested in knowing when Virtual Peatland will be finished and when they will get to make something for the website 'for real'). (HCI specialist in the field journal)

Interviewer:	What about the… most boring or least interesting phase out of those?
Student 1:	The planning…
Student 2:	Yeah. Or it wasn't actually boring but it was, like, least interesting.
Interviewer:	You mean the one at the very beginning?
Student 1 & 2:	Yeah.
Interviewer:	Well, what was it that was least interesting or difficult about it?
Student 1:	Because you kind of didn't really get to actually do anything.
Student 2:	Yeah.
Student 3:	Mm.
Interviewer:	So it was kind of like playing around with the ideas, but it wasn't yet anyth- ?
Student 2:	Mm.

In the feedback questionnaire after the session, the children were also asked what they thought had been the purpose or the goal of the session. The children's views about this issue could be categorized into those on a broader level (the purpose of the session in terms of the whole Virtual Peatland project) and those on the level of that specific session (the goals to be accomplished during the session, such as "to arrange those snippets onto the paper"). Most of the answers dealt with the broader perspective (21 as opposed to four dealing with the one particular session), and they were further categorized into answers related to 1) planning what information the site will include and in which ways it will be presented (this was the most frequently mentioned goal or purpose), 2) general designing and proceeding in the project, 3) designing interactive tours, 4) learning to understand what Virtual Peatland is, and 5) making a basis for future sessions.

> [The purpose of the session was] to think about all the things that there could be on the Virtual Peatland website. What topics it deals with and how they are dealt with.

> [The purpose of the session was] to learn to come up with ideas for making a peatland into a virtual peatland…

Also the researchers remarked the difficulties at the beginning of making the first collages and acknowledged that there were issues that could have been improved. In an attempt to give the children as many items as possible to choose among, there ended up being too many of them, which slowed down the process of creating the collages and made it more confusing. The teacher's role was considerable in this session; the making of the other collages (about unfamiliar elements and species) was initiated by the teacher, whose experience was valuable in that she was able to read the situation and respond to the children's difficulties better than the researchers. Both of the researchers who participated in the session noted that both the children and the teacher had a great deal of ideas.

As regards the usefulness of the outcomes, it was rather straightforward to count the frequencies of the elements that appeared on the collages. Thus the goal of easy analysis was accomplished well. The elements and their frequencies were presented to the children in a later session, in order to avoid the "black box" that hides the collective results from the participants. Moreover, the collage creation served as a way of introducing different presentation forms to the children and prompting them to think about not only those with which they were already familiar but also the potential of such presentation forms that they did not know before the session.

> Working on the first [collage] was a bit hesitant, the making of the other [collage] went noticeably better. As a whole, the whole class (both the students and the teacher) got very well into the design of the Virtual Peatland environment and understood their role. Both the students and the teacher had many ideas for the implementation of the contents. […] We could have planned especially the [collage] creation better beforehand. There were a great deal of both different species and media elements. The topic areas of the [collage] should have been narrowed down more. On the other hand, the most popular species and elements in the [collages] can be selected and worked on in the future to be included in the interactive tour of Virtual Peatland. (Project coordinator / educational specialist in the field journal)

The next session took place in the school computer lab: the goal was to show the children some **existing web-based learning environments** to be used as points of reference, to allow the children to evaluate and comment on those, and to discover what kinds of elements and solutions were deemed successful and interesting by the children and which were not. Use of existing technologies akin to that being developed has been widely used in user-centred technology design projects with both adults and children. It is, for example, a general constituent in Druin's Cooperative Inquiry method (Druin et al. 1999), and it can be a great aid in exposing problematic issues and preferences, as well as understanding how children interact with the particular technologies (Jones et al. 2003).

Apart from these reasons, existing web-based learning environments were presented to the children in order to make sure that they understood the concept of a web-based learning environment and saw how different types of presentation forms were used on these sites in practice. Based on a web search conducted by the educational specialist, the researchers had chosen three learning environments for the children to browse. These particular websites were chosen because each of them had a somewhat different way of presenting information. One, which was related to Indians, was heavily based on quizzes and other types of interactive tasks. Another one dealt with archipelago nature, culture, and lifestyle; this site was structured as "paths" related to different themes, consisting of small stories and tasks. The goal of the third site was learning to identify plant species, and the presentation forms consisted mainly of pictures and short informative texts. To guide their browsing, the children had a note sheet, which included a few prompts about each of the websites (Appearance, Tasks and content, Navigation, Pros and cons, General comments, Ideas for Virtual Peatland). Finally, they were asked to choose the best one out of the learning environments they had browsed and to specify why they preferred just that particular site.

Due to the limited capacity of the computer lab, the session was carried out in two turns, sixth-graders first in one group and fifth-graders then in another. The sixth-graders worked in pairs, browsing the sites at their own pace. The idea was to answer the questions together but – in order to make the task as smooth as possible – one of the children was responsible for using the mouse and keyboard for navigating on the site, while the other child was responsible for writing down their comments. However, the setting of the task turned out to be too complicated for such a short period of time: there were too many questions and too many things to address, which confused the children. Therefore with the fifth-graders the session was carried out a bit differently: instead of independent pair work, the researchers guided the session, and all pairs went through the websites one by one in the same order. The children were asked for comments after browsing each website, before moving on to the next one, and the researchers gathered their comments on the chalkboard. The issues that were addressed included the appearance of the websites, their pros and cons, and how the elements of each site could be used to guide the development of Virtual Peatland. The answer sheet was used only to write down ideas about how to learn from these websites in the design of Virtual Peatland. After both of the groups had been to the computer lab, the whole class gathered in their classroom to sum up the session. The children talked about what they remembered the best about the websites and what had been the most interesting things in them.

The results from the children's point of view suggested that the children did not consciously get very many ideas for the design of Virtual Peatland from the website browsing. In the answer sheets the children filled out while browsing the sites, one question dealt with "using [ideas from website X] in the design of Virtual Peatland". When analyzing the answer sheets the children filled in, it was noticed that out of the 14 answer sheets returned, this question had been answered in only six of them. Moreover, out of these six answers, only three included a specific suggestion (animal names, navigation, quizzes), the rest were more vague ("It would be good to take inspiration from it", "By stealing ideas" etc.). Hence, it appears that it was difficult for the children to think about the websites in terms of potential ideas for the learning environment to be developed. However, the other questions they answered (e.g. pros and cons of the different websites; the questions related to the navigation, appearance, and the content; and the prompt to choose the best one of the websites) provided interesting information about their preferences regarding the elements of websites. One interesting observation was that having much empty space on a page was a negative thing in the children's opinion. Instead, the children wished to have a great variety of content – and the desire to have plenty of visible elements concerned navigation as well: the children did not want to move back and forth much, they preferred having as direct access to all the parts of the site as possible. Their preference for some specific content types, such as quizzes, was also confirmed again.

The children were not given a separate feedback questionnaire to fill out after the evaluation of the learning environments, because the session in itself entailed much written answering of questions. In the final interview after the project, the children were asked for comments related to each of the participation methods, including the evaluation of the websites. However, the same problem which manifested in the data gathering in the Talarius project came into play there; much time had passed since the activity and the children did not remember it in detail anymore. Hence, it would have been better to have an intermediate interview or questionnaire already when not so much time had passed after the idea generation sessions. Nonetheless, what the children stated in the final interview was rather consistent with what could be seen when analyzing what they answered to the questions sheets about the websites. In the interviews, it appeared that the children did not remember very well whether they had obtained any ideas for Virtual Peatland from the websites, but as far as they remembered, their answers were more on the negative side: they had not acquired much inspiration from the sites. The following excerpt from one group's interview illustrates this.

Interviewer:	Do you remember if you got any ideas from [the websites] to help you think about what kinds of quizzes there could be there, or what it could be like? The Virtual Peatland site?
Student 1:	I can't remember…
Student 2:	I don't think so…
Student 3:	No, we didn't really.

As to the evaluation session as such, there was some trouble with the task. The material (several different question sheets) was too complicated and the task in itself was too extensive for the period of time available (45 minutes per group). The first group, the sixth-graders, was puzzled with the questionnaires and did not have enough time to complete the task, i.e. browse all of the websites that were intended to be evaluated. Moreover, it was noted that the goal of the session remained unclear to the children; they did not really think of the task from the point of view of how it could benefit the development of Virtual Peatland. In the evaluations, they emphasized the content areas of the websites somewhat more than expected and did not seem to pay much attention to how the different games, quizzes etc. used on the websites could be applied in the design of Virtual Peatland.

As mentioned, the researchers who were present decided to change the procedure with the other group (fifth-graders) so that the browsing of the websites was carried out collectively and the researchers asked the children for comments verbally, writing them on the chalkboard. The change of procedures helped to avoid confusion but, on the other hand, it was more difficult to elicit comments from all of the children when the opinions were gathered verbally, as some children voice their opinions more readily than others. However, in this session this did not present a great problem, as verbal presentations and discussions had been held with the children already before in the project and they were thus used to voicing their peatland-related ideas to the researchers as well as to the other children. This approach also helped with emphasizing the goal of the evaluation, i.e. to apply ideas from the existing sites to Virtual Peatland.

> The evaluation session with the 6th-graders didn't go very well, because the session should have been directed more. The websites were too complicated to browse in such a short time. There were too many questionnaires and other papers. There should have been only one sheet that would have included all the things related to the topic. […] At the beginning, we should have stressed the connection between Virtual Peatland and the websites, in other words that the sites serve as examples of [navigational] tours and activities. […] The 5th-graders' evaluation session went better because the browsing of the sites was guided. With the help of the guiding, the students also got a more comprehensive notion of the purpose of the evaluation and the connections to Virtual Peatland. Because questionnaires were not used and instead the questions were discussed orally, part of the children did not answer the questions while some students stated their opinions all the time. […] On the other hand, the failure of the learning environment evaluation session also shows that the researchers did not have the competence/skill to teach elementary school aged children – the session should have been organized so that different applications would had been presented to the class and the [browsing of the websites in pairs] would have been left out. (Project coordinator / educational specialist and HCI specialist in the field journal)

Another form of idea creation was related to the **ideas for the game** to be included in the Virtual Peatland environment. There were game-related activities in several different sessions. In the first of these sessions, the whole class wrote down individual suggestions about what the game could be like. In the next session, general game ideas were first brainstormed and collected on the chalkboard together, and then the children wrote individual ideas on paper about the beginning and the ending of the game, the goal of the game, and the plot of the game. In the third game-related session, the children formed different theme groups according to their interests, one of which was related to the game idea. One of the researchers had categorized the game-related ideas collected in the previous session and presented them now to the children in the game idea group. Together, the researcher and the children discussed the ideas, and the children started planning and creating a collective drawing of the game idea (Figure 33). The game drawing depicted the beginning and the end of the game, the path and the sub-games along the way, the means of proceeding in the game, as well as other topics related to the game idea. The teacher also commented on the children's game plans, and the researcher was actively involved in the creation of the game drawing. The children continued the game idea drawing independently in the following week, and they also planned the general plot of the game and drew suggestions for different game characters. After this, there was a session in which the ideas for the games were reviewed together. More game character drawings were made also later on in the project, in the second prototype evaluation session. Some examples of the children's game character drawings are presented in Figure 33 together with the game idea drawing.

FIGURE 33 The game idea drawing and examples of the characters drawn by the children

The aim was to give all the children a chance to express their ideas regarding the game but at the same time avoid big disparities between them by integrating them into one collective game idea drawing based on the ideas. As Hart (1997, 162) has pointed out, through the creation of collective drawings children can both express their individual ideas and place them in a shared context. As seen in the Talarius project, the large number of individual drawings caused problems to the children with recognizing their ideas, as the analysis, merging, and extraction of ideas were conducted by the developers largely in isolation from the children. Therefore it was seen as essential to provide the children with a possibility to have an active role in the interpretation, filtering, and merging of ideas.

After all the sessions that were related to the game (and interactive quizzes, which are discussed in more detail next, as part of the content creation activities), the children were asked about all these issues in one joint feedback questionnaire. As a general question they were asked whether the whole set of design activities had been easy, to which sixteen children agreed and six disagreed. When asked to specify the most difficult subtasks or aspects of the activities, the single most frequently mentioned issue (mentioned by six children) was the planning of the plot and the rules for the game. The activity enjoyed by the children the most, on the other hand, was the drawing of game characters. To get confirmation and to specify reasons for preferring or not liking a particular activity, the questionnaire entailed also a question in which the children were asked to choose the most enjoyable as well as the most difficult activity from a list and to explicate their choices (they were allowed to choose more than just one). The drawing of characters was mentioned as the most enjoyable activity by 13 children, quizzes by eight children, and information texts as well as game plot both by five children. Character drawings were popular because the children could use their imaginations, liked to draw, or considered themselves good at drawing.

Information texts – which were not directly game-related but served as background material for several other creations – were seen as the most difficult activity by seven children, mainly because there had been difficulties with finding information: searching was boring or difficult, or different sources had different information which made the task more difficult. Planning the game plot was mentioned by five children as the most difficult activity as it was hard to come up with a plot from scratch. Quizzes were mentioned by three and character drawings by two children. However, despite the difficulty of the game plot creation, the children saw the game idea and plot as the most important thing among all the activities related to the game and the interactive parts. Other views about the most important things entailed the characters and the rules. The less directly game-related tasks – information texts and quizzes – were also mentioned by the children. Interestingly, several children brought up also more abstract issues about the design tasks, such as good atmosphere in the design sessions, understanding the tasks, and the ability to use their imagination.

> [The most important thing is] that there's a good work spirit so that everyone's not quarrelling all the time.
>
> [The most important thing is] to finish the game, with care.
>
> The designing of the rules of the game [is the most important thing].

In the final interviews, the creation of the game idea was among the activities that the children considered the most enjoyable in hindsight, along with testing the game and making the quizzes. Game idea creation was mentioned in two of the three groups being interviewed.

The researcher who worked with the children in the sessions in which they did game-related things (i.e. brainstormed about the game ideas, drew game characters, and, as a smaller group, made the game idea drawing) felt that the children were very interested in the topics related to the game and participated in a motivated way. However, she regarded it as necessary to be strongly involved in the game design group to guide the work and to ensure that the planning advanced along the lines of the ideas that had earlier been brainstormed by the whole class. As the children brought up, the planning of the plot was a challenging task.

> The game design advanced well. The children (N=5, three girls and two boys) were enthusiastic and interested in planning the game. I participated strongly in the design myself: I asked the children different questions and asked them to write down their ideas about the playing of the game. I tried to make sure that the ideas presented last week were included in the game. Probably the game would not have advanced if the children had been allowed to design the user interface among themselves. Also some comments and ideas of the teacher were very good. (Project coordinator / educational specialist in the field journal)

However, as a side note it is worth mentioning that at the time of the game design task, the whole Virtual Peatland project was going through fundamental changes, and the goals and the ways of carrying out the project were being re-examined. For example, biological expertise had been lacking in the project, and at this point the developers became worried about the game not meeting its pedagogical goals adequately. There was no straightforward plan as to how to link together all the materials made by the children, the work related to the game idea being the culmination point of these uncertainties. An interesting observation from the analysis of the field journal is that after the game design sessions, there was suddenly a great deal of general reflection in the journal regarding the state of the project, all of which was not directly related to the field sessions.

> In the future, we will have to think about narrowing down the game environment and the [theme] tours of Virtual Peatland to one tour/topic/theme. Based merely on the material produced by the school, the game will become incoherent, if the theme is approached with a few short quizzes at specific points. Therefore we have to think if it is rational to narrow down the game in Virtual Peatland only to e.g. the ecosystem of peatland nature. Here we need a natural scientist's expertise regarding how to move from one topic to another and how the different contents are linked to each other. (Project coordinator / educational specialist in the field journal)

Content Creation

The development project of Virtual Peatland entailed one completely new category of methods, namely content creation. In addition to providing the developers with ideas and suggestions on which to base their work and with feedback from prototype evaluation to guide the improvements to be made to the application, the children produced concrete material to be directly included on the website. The growing popularity of different forms of user-created content in games and on the web is an indication of people wanting to see their creations published for others to see and use (e.g. OECD 2007). In this project, the materials created by the children included, firstly, photographs and video clips they shot on a peatland excursion, and secondly, a variety of quizzes and puzzles about peatland flora and fauna.

One of the most important events in terms of content creation was the children's school **excursion to the peatland** in the nearby National Park (Figure 34). The purpose was to gather material, such as photographs and video clips, for the Virtual Peatland website. Another goal was to support the children's understanding about peatlands and to help them form a connection between the virtual learning environment and the physical peatland. In independent (as opposed to researcher-led) sessions before the excursion, the children had made preparations e.g. by searching for information and writing informative presentation texts about different peatland species.

FIGURE 34 Children of the partner class on the peatland excursion

The whole school participated in the peatland excursion. Each class had different tasks to do during the visit; the Virtual Peatland project was the fifth- and sixth-graders' theme for the day. The visit was divided in two parts. For the first part of the day (two hours), they recorded video presentations of different peatland plants. In small groups, the children had chosen one of the species which appeared in the collages, taking also into account which of the plants were likely to be found in the National Park in the autumn, and prepared presentations about them. In the National Park, they set out to find their respective plants. Once they found their plants, they first rehearsed their presentations and then recorded video clips in which they showed what the plant looked like and read their presentation texts. The researchers accompanied the groups and assisted them with the video cameras.

The second part of the day (two hours) entailed photographing and more casual video shooting. The whole group walked a specific route together, and the children were given digital cameras to document the visit. There was one digital camera per a few children; some had brought their own, and some used cameras provided by the researchers and the teacher. The purpose was to take photographs to be used as general illustrations and/or as digital postcards on the website (Figure 35). Another goal was that some of these photographs could be submitted to an art competition related to the National Park. As regards the video, the children were shooting clips that might be used on the website e.g. as introductory video sequences. The children were given a background story to help them focus their work: they were asked to imagine what an elk would see when walking around the peatland.

FIGURE 35 Examples of the photographs taken by the children on the excursion

In the next session, in the following week, one of the researchers showed all the pictures and video clips to the children. The whole class gathered in the school computer lab, and the researcher went through the pictures and video clips one by one, projecting them on the wall. The videos were watched twice: first with sound and then without sound (in order for the children to focus on the visual quality of the video material). On the second viewing, the video was paused after each presentation, and the presentation was discussed together. The discussion touched on topics such as how well the video clip had succeeded and why, and whether the plant was recognizable in the clip. The researcher wrote down the general comments for each video clip. After this, the children viewed the pictures once more on their own computer screens (in pairs or in small groups) and voted for their favourites to be made into virtual postcards. They chose three favourite pictures, giving points to them (three to the best, two to the second best, and one to the third favourite), and wrote their choices on paper. After this, the class moved back to their own classroom, where another voting was held, this time about the videos. The voting system was similar: each child had three points to give to one clip, two points to one, and one point to one. The researcher wrote the standings on the chalkboard. Some literature suggests that voting be avoided in participatory design sessions altogether (e.g. Muller 1992), but in this case it was considered a good way to decide the best photographs and videos to be included on the website, as it gave each child an equal chance to influence the outcome and as there were so many items to choose among. With such a large group, other ways of negotiation might have fallen short. Voting was suggested by the teacher of the class; it was a common practice in comparable situations in the classroom.

In this session, the children were also asked for suggestions or ideas as to how they would like to further work on the material. The aim was to give them a chance to have a say in the ways of participation – in a similar way as in the very first idea map session when they were asked about which aspects of the Virtual Peatland environment they especially wanted to influence. However, this question turned out to be too difficult, or alternatively the way of presenting the issue was not successful. Only one of the groups that were presented the task returned the sheet of paper on which they were asked to write down their ideas.

In the Talarius project, the children had been somewhat unhappy with the extent to which their input was concretely visible in the outcome. This was one of the reasons why content creation was included as one essential part in the Virtual Peatland project. Some children voiced at the end of the Talarius project that they would have liked to create pictures and other such material to be used in the application. Fortunately Virtual Peatland provided a great deal of opportunities for concrete material creation, photographs and videos being one of the key elements in it. These practices were also designed with the aim of being pedagogically feasible, as they were intended to support and deepen the children's knowledge about peatlands and to give them personal experiences of peatland nature.

The peatland excursion was commented on in a positive tone in the children's final interviews. Due to being different from all the other participation activities, the excursion stood out. For example, in one group of interviewees the excursion came up at several different points in the course of the interview. First the children talked generally about what they had done on the excursion, later it was mentioned as one of the most enjoyable and fun ways of participation, and finally it came up as something that the children would like to do again. As pointed out earlier, in the more abstract design sessions the children were looking forward to some hands-on activities, which is what the peatland excursion was. Instead of merely planning things, they got to do something concrete, i.e. take photographs and record video clips. Moreover, the excursion was not as firmly structured as the other sessions, and if there was extra time left after finishing a task, lack of things to do was not a problem on the peatland. Especially some of the boys in the class, as exemplified by the interview excerpt, took the opportunity to goof around and have fun in their own ways amidst the more task-oriented activities.

Interviewer:	What about this trip… what stuck on your minds?
Student 1:	I think we were messing around there a bit.
Student 2:	Maybe a little.
Student 3:	Didn't we take those pictures there?
Student 1:	Yeah, we shot the clips first and then it got a little... something else.
Student 3:	But didn't we take those pictures too, really…
Student 1:	Yeah.
Interviewer:	Pictures and videos, yeah.
[…]	
Interviewer:	What if… if this project started now all over again and you would know how you've been involved in it now, so would you do something differently, or would you like this project to be carried out in some other way, would you want to participate in some other way? What would you like to improve or fix now?

Student 1: At least I can't think of anything.
Student 2: Me neither.
Student 3: Only that… [we could] again, just for fun, [go and] shoot those clips.
Student 1: Mm, only different ones.
Student 3: Yeah.

The researchers made a note of the children's motivation as well. The class took photographs and recorded videos enthusiastically, and despite having their moments of non-task-related fun, they commendably carried out all the tasks they set out to do. The only problem was the lack of planning at some occasions; especially the video material ("elk's perspective") to be recorded during the latter half of the excursion was filmed rather carelessly and spontaneously without putting much thought in the process. The quality of the rest of the material was good, however. The digital photographs were very well suitable to be used as website material, as were the video presentations about the plants, apart from some problems with sound quality that could be fixed by editing or re-recording the speech.

> The students, in general, appeared to work enthusiastically. They were motivated to find different plants and they observed the nature with interest. However, especially in the video recording, lack of planning appeared as a problem. (HCI specialist in the field journal)

> The material collected during the day yields a great deal of content to the Virtual Peatland learning environment. The photos taken with digital cameras turned out good. Video recording, for its part, didn't go very well. Probably the video cannot be used because the quality is not very good; the sound is poor and the picture moves a lot (= sudden movements and angle switches). Potentially, short clips can be included in the learning environment and the talking will be re-recorded later. The video yields still pictures, however. (Project coordinator / educational specialist in the field journal)

When one of the researchers presented the children's material to them in the next session, the children were excited to see their own creations. When the researcher projected pictures on the wall, the children recognized their own or their classmates' photos and commented cheerfully on each other's shots. They also concentrated very well on the evaluation of the videos, giving constructive criticism about each clip and pondering which of them would be the best ones to be included on the website.

> Watching the photos and the videos was very interesting to the children; it appeared that they were excited about seeing their own creations. [...] It was noted that there were a great deal of good shots among the digital photos, and in terms of picture, there was some usable clips among the videos as well. We came to the conclusion that with some editing they could become good presentation videos. (HCI specialist in the field journal)

Besides the pictures and video clips, another form of concrete content creation was the **creation of interactive tasks** for the website, which was briefly touched upon in relation to game design activities. Based on the information texts they had created and additional information they had searched for, the children created pop quizzes, crossword puzzles, anagrams, and other types of small games or activities (Figure 36). The children started the making of the quizzes during an independent session, and in the next session they presented their creations to the researcher who participated in this session. The researcher took copies of the children's sketches, and they were reviewed and commented by a content-area specialist. In a later session, the children made modifications to the puzzles based on the comments. At the time of these sessions, it was still unclear whether the quizzes would be used as subtasks in the game or as separate activities elsewhere in the learning environment.

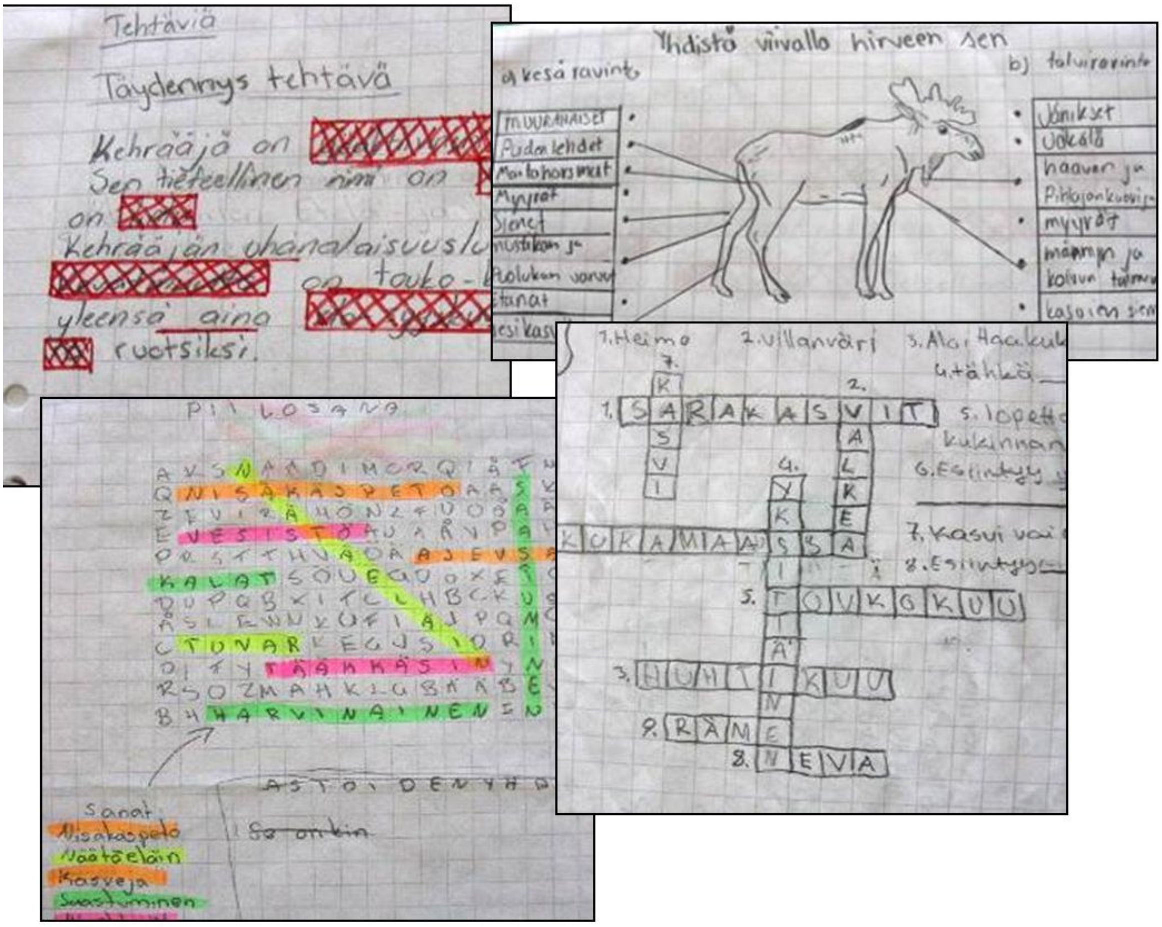

FIGURE 36 Examples of the children's puzzles: a fill-in task, a picture based connection task, a word maze, and a crossword puzzle

Similarly as with the photographs and the videos, an important goal of the quizzes was to give the children a hands-on feeling of their participation and contribution in the final outcome. In the creation of the quizzes, the teacher had again a considerable role; it was on her initiative that the class had already started making the puzzles independently, to supplement the game drawing and other game-related ideas the children had provided. In light of the experiences obtained from the Talarius project, the quiz creation was also expected to have a significant meaning for the children. As pointed out in the Talarius results, the children of the partner class were thrilled to recognize their own questions while playing a Talarius game. Similarly, the quizzes, as well as the photographs and videos, would potentially cause similar joy in the children participating in the Virtual Peatland project, upon seeing them on the finished website.

The gathering of children's experiences about the creation of the quizzes and the compilation of the information texts was conducted on the same questionnaire as the experiences from the game-related activities. As the quizzes were based on the information texts created by the children about different peatland animals and plants, therefore also the compilation of information texts is dealt with here, together with the puzzles.

As brought up above when discussing the game-related activities, the making of the quizzes was the second most interesting activity (after game character drawing) out of those that dealt with the game or the interactive puzzles. The reasons for enjoying the quiz-making were categorized in four groups: a chance to do something, an interesting activity, an easy task, and learning by making the quizzes. It has been brought up at several points that the children were looking forward to doing something concrete, and the quiz-making responded to this wish. The final interviews brought up several points related to the making of the puzzles; besides that it was seen as one of the most motivating activities, it was also considered by the children as the most useful contribution they made to the project, and related to this, the quizzes were seen as the contributions that were seen the most clearly in the final outcome.

Student 1:	Those quizzes were nice in that you could kind of really design them yourself.
Student 2:	That's right.
Interviewer:	So you mean you could in a way plan them yourselves, all the way from the start?
Student 3:	Mm.

Making the puzzles was seen as challenging, yet not too difficult: only three children mentioned having some problems with quiz-creation. Those were related to difficulties with getting an idea about what to do, realizing an idea based on the information available in the information texts created earlier, or the rather laborious nature of the task. The amount of work required by the quiz-making was mentioned also in one of the group interviews at the end of the project.

Interviewer:	What about these phases, what do you remember about them? […] The puzzles and the game characters?
Student 1:	Well, the puzzles took an awful lot of time to make at least.
Student 2:	Yeah, you had to come up with them...
Student 1:	Mm.
Student 2:	And then at the same time we had those…
Student 1:	Were they at the same time?
Student 2:	Those… animal presentations, or the quizzes, when we made those.
Interviewer:	The info texts? Yeah, you made those too...
Student 3:	Yeah, those.

As regards the information texts, their creation was seen as the most difficult of the game- and quiz-related tasks. Reasons were categorized into problems with finding or searching for information, the time-consuming nature of the task, the boringness of searching for information, and the difficulty of estimating the reliability of information found. On the other hand, enjoyable aspects in the task included learning, teamwork, challenge, and the possibility to use computers for the task.

> There were differences between information found in different books.

> Typing the info text on the computer was fun.

After the creation of the information texts, there was also a separate questionnaire that concentrated solely on the text creation. This questionnaire shed more light on the children's views on the activity by providing somewhat more detailed feedback. As regards the most interesting and fun aspects of the task, two specific categories emerged, namely writing and searching for information. In terms of writing, what was considered fun was either writing in general or specifically typing with the computer. As regards information-searching, both the activity of searching as such and learning about the topics while searching were brought up. Teamwork and computer-related activities such as printing and the already mentioned typing of the texts were mentioned as well. However, many of the same issues came up in the question about the most boring or the least successful aspects: writing (writing in general and, specifically, handwriting), searching for information (its boringness), and teamwork (difficulties with sharing work within the group). Thus, the children's preferences were rather divided in terms of the information text creation.

Issues related to children's motivation to work on the texts were addressed also by three "yes/no" questions related to the ways of working. Eighteen children felt that they had been able to work on such a topic that they were interested in, while six felt the opposite. The children were allowed to choose freely the peatland species to which their texts were related, hence most of them were satisfied with their topics. Teamwork went well in the children's opinion, twenty children stated that they had been allowed to form a group with those classmates they wanted to work with (three children felt that they had not). Teamwork was also strongly preferred over individual work; consistently with the previous question, 21 children preferred teamwork while two liked individual work more – potentially because their group did not function well.

The children were also asked about their views on the purpose and the goals of the information text creation task. Their thoughts about this issue were categorized into those related to information and those related to text production. The "information" category entailed both directions knowledge-acquiring: getting information about the topics of the texts on the one hand, and passing on information to others through the texts on the other hand. In terms of the text production, the effective finishing of the texts and their quality were emphasized (the children felt that the texts needed to be accurate as they would be put on the Internet).

> [The goal of the task was] to give others information about animals.
>
> [The purpose was] that we write as much information as possible.
>
> [The goal was] to obtain information. Correct information, because [the texts] will be on the Internet.

As the children's questionnaires and interviews have suggested, quiz creation was one of the children's favourite tasks in the Virtual Peatland. This was remarked also by the researchers who worked with them. The quiz creation did not need to be led by the researchers; instead, the class had taken the initiative of starting to work on them independently beforehand. It was pointed out above that the children considered the puzzle creation motivating because it gave them something concrete to do. The concreteness was aimed at from two points of view; firstly, to give the children a hands-on activity to participate in, and secondly, to obtain outcomes through which the children would see their input concretely once they would be on the website. Also from the developer perspective, the quizzes were concrete: they could be included on the website as they were. There was no need to analyze, interpret, elaborate, or further refine the outcomes of this activity. However, at this point, the expertise of a natural scientist was needed. In order to ensure the accuracy of the information texts and the quizzes based on them, the teacher of the class expressed a wish that they be reviewed by an expert.

> I also think that through working on the game idea and the quizzes the class will be able to do something concrete. Moreover, the different parts will come together gradually. (Project coordinator / educational specialist in the field journal)
>
> Making quizzes was very interesting to the students, as they had independently been working on quizzes related to different topics. […] The students are especially interested in designing, such as the design of the quizzes. (Project coordinator / educational specialist in the field journal)

Evaluation

There were four evaluation sessions altogether in the course of the project, three of which were related to the game included as one part of the Virtual Peatland environment and one to the other parts of the learning environment. In the first evaluation session, the children evaluated an initial game idea produced by a multidisciplinary multimedia student group who had been assigned to sketch ideas for a peatland-related game based on a variety of background material, including the outcomes of the school sessions. They created a simple computer prototype, "Peatland Game" (Figure 37), demonstrating the basic idea of the game. The aim of the evaluation session was to give the children an impression of how the game idea had evolved and how their ideas had influenced it, as well as to gather feedback from the children, based on which the game prototype would be developed further. One of the researchers demonstrated the prototype to the children, and there was a discussion related to it with the class. The discussion dealt with the following issues: the development and implementation of Virtual Peatland in general, the connection of the children's quizzes and game drawing to the whole, and the correlation between the game prototype and the material and ideas created by the children. Once the game prototype had been demonstrated and initially talked about, the researcher showed the children the game drawing they had made, with an intention to bring it back to mind for the children and enable a more concrete comparison of the current prototype and the ideas represented in the children's drawing. Each child gave orally his/her comments about the game prototype and ideas for its further development, and the researcher wrote them down. At the end of the session, the most important issues of further development were written down on the whiteboard.

FIGURE 37 The main view of the Peatland Game prototype

The second evaluation session took place some months later. Meanwhile, there had been extensive changes in the prototype, as a new game project group had been established to develop it and pedagogical goals were used as the starting point of this project. The objects of evaluation in this session were the first sketches of the Peatland Adventure game. One of the researchers, who was also a member of the game development group, presented the general plot of the game, some visual ideas of the game, and four game characters. Moreover, the researcher presented the ideas of other characters (some of whom were based on Finnish mythology) that would appear in the game, and the children were asked to draw ideas of what they thought these characters could look like. It was also settled that the prototype of the game would be presented to the children later.

After the first (the Peatland Game sketches) and second (first version of Peatland Adventure) evaluation, the children were somewhat disappointed with the prototypes. This was remarked both by the researcher who was present and the teacher of the class. There are several reasons leading to the disappointment. Firstly, the game prototypes included some ideas from their game drawing but did not correspond directly to it. Hence, the problem was similar to that observed in the Talarius project, even though in this project there was only one drawing to inspire the development of the game. The main source of the problem in the case of this project was the fact that the game plans changed significantly at a relatively late stage of the whole project. The game development team wanted to alter the game plan towards such an idea that would be more fundamentally based on scientific contents, all the way from the basic plot to specific subgames. Hence, in this sense the project fell into the same trap as the Talarius project; the children's suggestions became separate from the actual development work and they were only used vaguely as "inspiration" to the actual game.

> I think that the children and the teacher alike were disappointed with the game proto. They were expecting a more finished or a [completely] finished game proto. The children commented on and asked about e.g. the characters and points as well as the information texts etc. several times. The students were not sure at all about the visibility of their own contribution in the game proto, rather they thought that actually none of their ideas had been implemented. (Project coordinator / educational specialist in the field journal after the first evaluation)

> The current game proto does not correspond to the suggestions presented by the children. Both the teacher and the students were disappointed because of this. It was emphasized to them, however, that their work has not been in vain, and that the materials they have produced will be used in other ways [, in the Children's Peatland]. (Biology specialist in the field journal after the second evaluation)

One of the researchers pondered that one reason for the disappointment might be the fact that the appearance, versatility, and other elements of a learning game that is intended as one part of an educational website do not compare with the high-budget products of the game industry. She pointed out, therefore, that the children's expectations should have been shaped accordingly. On the other hand, the children did evaluate some existing learning environments early on in the project, which was expected to give them an idea about what learning environments can be like. None of them included a game, however, so they did not get an example of a game integrated as a part of an educational website.

> The students are experts of playing and gaming culture. It is difficult for the students to understand that the game will not be like those [created by] commercial firms but a learning game for the use of schools and the national park. The students imagined the graphics and other elements of the game to be more like industry games. In the course of the spring, it would be good to 'shape' the students' attitudes towards a learning game. Now that there is something concrete to show, the students are better able to follow the development phases of the game prototype. It must be demonstrated more clearly to the students, what has been done and what had been accomplished and how their own ideas have affected the development of the game prototype and the quizzes. (Project coordinator / educational specialist in the field journal)

Next, the game prototype was evaluated with the children in the following autumn. As there were new fifth-graders in the class again, the class consisted both of those children who were already very familiar with the project (the sixth-graders) and of those who had not been involved in it before (the fifth-graders). It was decided together with the teacher that only the sixth-graders would participate in the Peatland Adventure evaluation session, but also the fifth-graders would participate in the evaluation of the whole Virtual Peatland environment in the following week. This decision was made partially because of certain time limitations in the school at that time and partially because there was a desire to allow the fifth-graders to form a comprehensive picture of the whole Virtual Peatland environment first, instead of asking them to concentrate merely on the game application right away.

With the sixth-graders (12 children), the session proceeded as follows. First, the class gathered in a classroom to once more go over the different activities that had been carried out in the course of the project and the ideas and items that resulted from them. There were two researchers present, and they recounted the different project activities with the aid of the outcomes of all the different design sessions. The idea map, some of the collages, the existing websites, material from the peatland excursion, the game drawing, and some character drawings were used as concrete representations exemplifying the different participation methods. The children were encouraged to participate in the summing up of the project phases: they could comment on the methods and activities and they were asked what they remembered of them. Directly after this, the group went to the computer lab where the researchers presented the current version of the Peatland Adventure game (Figure 38) and the children preliminarily familiarized themselves with it. After a break, the children started playing the game in pairs. They played at their own pace, and the researchers helped them with proceeding in the game if necessary. After playing the game for a while, the children were given brief question sheets about the functionality and appearance of the game which they then answered while playing. At the end of the session, when the children had played the game approximately for one hour, they answered questions related to the story of the game and to learning with the aid of the game. This was carried out in a child-to-child interview setting (cf. e.g. Bekker et al. 2003). The children were in the same pairs as they had been while playing. First, each child answered his/her questions in writing (one answered questions about learning, and the other answered questions about the story of the game). Once they had answered their questions, the children – each in turn – interviewed their partners using the same questions they had first answered themselves, and wrote down the answers on an empty answer sheet. The aim of such a setting was to make the feedback-giving less monotonous: instead of merely writing down their own answers, they asked the same questions from their partners as well. This was another implication of the experiences obtained from the Talarius project, where the very similar testing sessions (consisting of first using the application and then answering a questionnaire) were criticized by the children. Child-to-child interviews, which have been used in technology design projects before (e.g. Bekker et al. 2003), were seen as one way of making the evaluation session slightly different from the ordinary pattern.

FIGURE 38 Peatland Adventure

The final evaluation session took place one week after the previous one. In this session, both the sixth-graders and the fifth-graders participated. The goal of the session was to evaluate the other parts of the Virtual Peatland environment than merely the Peatland Adventure game – especially the Children's Peatland section (Figure 39) which included quizzes and activities created by the children as well as the video presentations recorded by them during the peatland excursion. The evaluation took place in the school computer lab. The children worked in pairs or small groups, playing with the puzzles in the Children's Peatland section and browsing the website in general. In the latter half of the session they also played the Peatland Adventure game – the sixth-graders continuing from the previous session and the fifth-graders trying the game for the first time. At the end of the session, the children answered some questions in feedback sheets which included prompts for giving comments on the application.

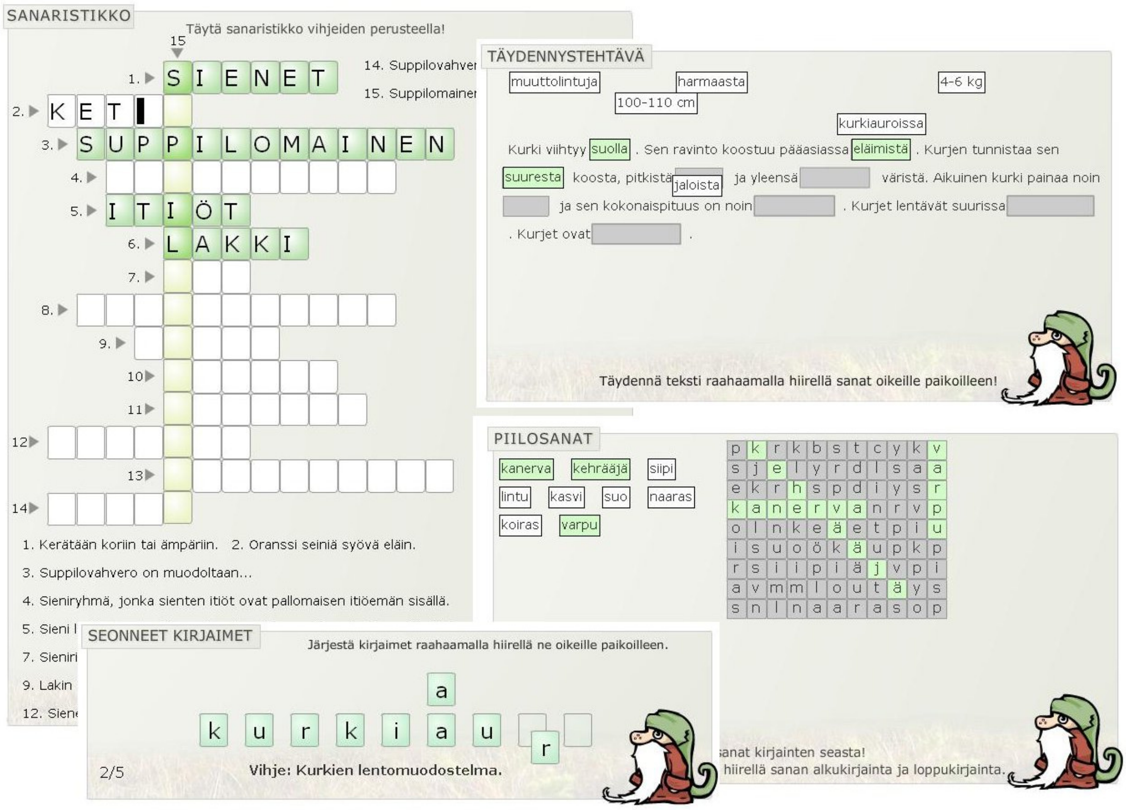

FIGURE 39 Quizzes in the Children's Peatland section

Moreover, the sixth- and fifth-graders, respectively, had also other, separate question sheets. The sixth-graders' questions dealt principally with their participation in the project, whereas the fifth-graders (who had not been involved with the Virtual Peatland project before) were asked more specific questions about their opinions regarding the website. After the children answered their questionnaires, the whole class moved back to their own classroom, where a concluding discussion was held. The topic of the conversation was Virtual Peatland in general and the participation in the project. The children gave feedback on the learning environment (each child in turn mentioned one feedback comment or suggestion for an improvement), and the researchers wrote the issues as a list on the chalkboard. Finally, the children were thanked for their participation in the project and their feedback on the outcome.

As discussed above, the evaluations of the two previous prototypes yielded rather disappointed feedback from the children. The final version, however, obtained much more positive comments. One possible reason is that in the previous evaluation sessions the game prototypes were only demonstrated to the children, and they did not get to play them themselves. When, in the final session, they got engaged in the game, they obtained a better understanding of it and potentially also recognized some of their ideas in it as well. This assumption is supported by what was said by the teacher; she admitted having been somewhat disappointed with the prototypes which were demonstrated to the class previously, but upon a bit closer inspection of the final version, her opinion had changed.

> In general, the evaluation session went well in my opinion. Beforehand I was a bit afraid of the student's possible disappointment, especially since they had been slightly disappointed with the first prototype of Peatland Adventure. […] Their comments were, however, much more positive this time. This could have been at least partially due to the fact that the students had plenty of time to engage in playing, and they had the chance to really solve different kinds of challenges and think about things. A quick glance does not reveal all the aspects of a game. (HCI specialist in the field journal)

> The teacher had taken a look at Virtual Peatland and Peatland Adventure briefly beforehand. The teacher told that when Peatland Adventure had been demonstrated at the school in the spring, both she and the students had been slightly disappointed with it, because it was so different from the students' idea about the game. Now she said, however, that she had liked the game and believed that the students would be excited about it too. (HCI specialist in the field journal)

As a participation activity, evaluation was one of those that the children regarded the most positively. This result was expected, as this was the case also in the Talarius project. Games are a generally interesting topic for children, and the playing and evaluation of a game can also be seen as a more hands-on activity than, for example, the creation of an idea map. In the final interviews, evaluating (i.e. testing) the game was mentioned as one of the best activities in all three groups of interviewees.

> Interviewer: What do you think was the most fun [activity]?
> Student 1: Testing the game and making those quizzes.
>
> (Another group:)
> Student 1: The most fun thing was maybe the making of the game.
> Student 2: Yeah, or maybe when we got to test the game.
> Student 3: Yes.

From the developer perspective, the different evaluation sessions yielded ideas and suggestions regarding the game. Similarly as the existence of a prototype concretized the game for the children, it also concretized the feedback that was obtained and made it easier to make improvements based on the comments. The feedback was related to specific playability or usability issues, the realization of the children's ideas, and more general opinions about the game. According to the researcher who was present at the first evaluation session, one issue being discussed was also the interplay between how fun the game is to play and to what extent it enables the teachers to use it as a tool for monitoring the students' learning. The conclusion in the session was that the monitoring possibilities were secondary to the fun aspects of the game: the main thing is that the game engages the children, and tools provided to teachers should not be implemented at the expense of the flow of the game.

> The game must have tension and challenge. This motivates and engages especially boys to play and upholds the student's interest toward the game. The starting point in the game is the game itself and playability, not how teachers get information about the results of the game or the progress of a student. The quizzes designed by the students for the game are not such that would directly benefit the teacher or teaching. Immediate rewards and experiences that motivate the player to keep playing must be implemented in the game. (Project coordinator / educational specialist in the field journal)

Releasing the Learning Environment

Finally, after the actual design and evaluation activities, the final session of the participation of the partner class in the project was the release event of Virtual Peatland. The event was held at the university in January 2007, and the sixth-graders were invited to participate in it. Their attendance in the event was intended as a thank-you gesture for their participation in the project and as a chance for them to see Virtual Peatland being officially released. In the event, the developers and researchers first generally presented the website for the attendees, and the actual opening of the website was conducted by the Finnish Minister of Trade and Industry together with two children whom the partner class had chosen among themselves to represent the class. The children showed e.g. the quizzes and the Peatland Adventure game to the Minister, and after the event they were interviewed for a newspaper article about their participation.

Field Trials

The field trials (see Figure 30 in Section 5.2.2) were conducted with 57 students aged 13-16 years from grades 7-9. There were 12 seventh-graders, 32 eight-graders, and 13 ninth-graders. The goal was to study the immediate learning effects of the use of Virtual Peatland, with the main focus on the use of the Peatland Adventure game. The trials were designed, conducted, and the results analyzed by the biology specialist in the research group and the game development group. The results of the field trials have been published and presented previously (see Nevanpää 2007 and Nousiainen et al. 2008). The following summary of the results is wholly based on the aforementioned sources.

The procedure during a field trial session was as follows. Two hours were allocated for the research in each class. At the beginning of the sessions, the students answered a pen-and-paper questionnaire consisting of multiple choice questions and "yes/no" statements about peatland ecosystems. The issues addressed included the formation of peatlands, peatlands as habitats, and typical animal and plant populations on peatlands. After answering the initial questionnaires, they played Peatland Adventure either individually or in pairs. While playing, they were able to discuss and negotiate with others and ask for tips from their classmates in case they came across some problems. The researcher was present throughout the sessions, making observations and taking notes about the difficulties the students encountered while playing, and about their discussions and comments. After approximately an hour, the playing session ended and the students returned to their questionnaires. They were asked to critically consider the original answers given before playing the game and to change their answers if necessary. The original answers were given by using a pen so students were not to change them but to make new marks to the paper with a different-coloured pen. The qualitative data was analyzed using the SPSS software. The main results of the field trials are presented next.

Before the use of Virtual Peatland, the students' knowledge about the environmental conditions required for peatland formation proved to be moderate: only approximately half of the students knew that it typically requires moist and cool habitat for peatlands to form. This topic was one of the central contents in the Peatland Adventure game. However, it was noticed that despite this, the students' knowledge about the prerequisites of peatland formation was not improved after the playing session. They were also asked about different ways in which peatlands can form. Half of them believed that low-lying forest (54%) or alluvial regions (49%) can change into peatland. Different formation types were better understood after the session, as low-lying forest was then recognized by 70% and alluvial regions by 75% of the students. Also, after playing, fewer students thought that forests in mountains can change into peatland.

Peat is an integral part of peatland ecosystem. Prior to using the Peatland Adventure game, nearly half of the students knew that peat is formed by incomplete decomposition of plant material. The amount and diversity of decomposers is closely linked to the decomposing process and its rapidity. However, only 19% of students knew that there are only few species of decomposers in the peatland ecosystem and their numbers are few. After playing, 61% recognized peatlands as ecosystems with few decomposers.

In summary, the students' knowledge about peatland ecosystems and their special characteristics was shown to be somewhat inconsistent, as some characteristics were well recognized and others were ignored. There was also some faulty knowledge as many students answered, for example, that fauna of decomposers is rich and abundant in peatland ecosystem. Although the use sessions did not improve the students' knowledge in all topics, even these short sessions helped them change some of their incorrect presumptions and elaborate their understanding about peatland ecosystems. Moreover, according to their comments, it was a motivating and interesting way to learn. Thus, adventure-type games potentially are good learning environments for supporting knowledge construction in science. Moreover, as the Virtual Peatland environment includes extensive text-based information sections, the users can draw upon them if they need further information on a specific topic.

During the sessions, the students shared ideas and gave hints to each other about how to proceed in the game. They were also very interested in how others were doing and who had proceeded furthest – the same observation was made in the evaluation session with the partner class as well, as discussed above. Hence it is evident that social interplay and cooperation must be included in a game, as communication about the topics to be learned further enhances the explicit expression of one's own ideas and thus supports learning (see Phillips and Klawe, 1995).

5.2.3 Functioning of the Team

Above, the different phases of the project and the methods used in user involvement were discussed. This subsection will deal with the issues related to the functioning of the team and the successfulness of the collaboration. It is structured in a similar way as the corresponding subsection in the chapter dealing with the Talarius project: the themes discussed include roles, motivation, and scheduling and time constraints.

Roles

The roles of the different participants in the Virtual Peatland project include, firstly, the children's role; secondly, the researchers'/developers' role; and thirdly, the teacher's role. The question of the roles between all these groups was less straightforward than it was in the Talarius project, in which each of these parties was rather distinct from the others: the developers gathered opinions from the children, the children provided requirements and feedback to the developers, the teacher provided ideas and feedback from the pedagogical perspective, and the researchers observed and monitored the project without very profound involvement. In the Virtual Peatland project, however, some of the researchers were in a double role, representing the developer group as well. Moreover, the researchers were in a more active role in the design sessions, both before (i.e. planning) and during them. Similarly, the teacher was an active participant in most of the design sessions, and also took part in directing the course of activities with her suggestions of how the events could proceed. Therefore, the following will entail discussion of the roles of all the different groups, both on the level of the whole project and within single sessions.

Children's Role: As the previous subsection demonstrated, there were several different types of participation methods and activities in the project; in addition to idea generation and evaluation – which were also present in the Talarius project – there were content creation activities. The diversity of ways of contributing was reflected on the children's views about their role in the project. To find out how the children saw their own role in the project, in the final interviews they were asked to imagine what they would tell about their role in the project to someone who was not familiar with what they had done and how they had participated. In each group being interviewed, several different things were mentioned as issues defining their role: the designing of the game and the general structure were mentioned by every group, as were the video clips and the quizzes. However, as the excerpt below illustrates, they were also able to see their role in a more comprehensive way, seeing it in terms of participation in the planning in general.

Interviewer:	What about… What if, say, one of your relatives has heard that you've been involved in a project like this and then asks that… 'what was your role in that project again?' and 'what did you do in it?', what would you tell them?
Student 1:	Well, that we were kind of like planning the whole thing and…
Student 2:	And then we made those quizzes to it.
Student 3:	And videos.
Interviewer:	Mm. What if you had to say one thing, your most important input to this project, so what do you think it would be?
Student 3:	Hmm… Maybe the planning.

Moreover, in the final questionnaire, the children were asked to recount how they had participated in the project. Answers to this question implied that the activities related to content-creation had clearly been the most defining activities in the project: the creation of quizzes and the making of the video presentations were mentioned eight times altogether, each of the activities being brought up by four children (out of 12). General planning and designing were brought up by three children, while other issues had only single mentions. For example, testing the game – which was clearly the most essential aspect for the children in the Talarius project – was mentioned only once. This was interesting, because as we saw in the previous subsection, evaluation sessions were generally liked by the children. On the other hand, the first two evaluation sessions were also somewhat disappointing to the children, which may have had an influence on how significant a part of the project they considered the evaluation tasks to be. It appeared that the activities in which they were able to create something concrete – and something that would end up on the website as it is – were the most memorable phases of the project and had a significant role in defining the children's view of their role in the project.

> I have gotten to design different things, such as quizzes, and we also got to be guinea pigs in the testing.
>
> When we made/designed the game, we told many ideas.

It took time for the children to get an idea of their roles in the project. It was pointed out in the field journal that in the evaluation session of the existing learning environments, it was still unclear to the children what the idea of their participation was. The children's opinions about the helpfulness of their participation for the developers were rather divided as well; five children (out of 12) felt that their contributions had not been very helpful to the developers while three felt that they had helped the developers (Figure 40). Here, as in the following subsections, the numerical results from the statements using the Likert scale in the questionnaires are contrasted against the corresponding results from the Talarius project. As there were different numbers of respondents in the two projects, the results are presented as percentages in the figures in order to illustrate the comparison between the two projects.

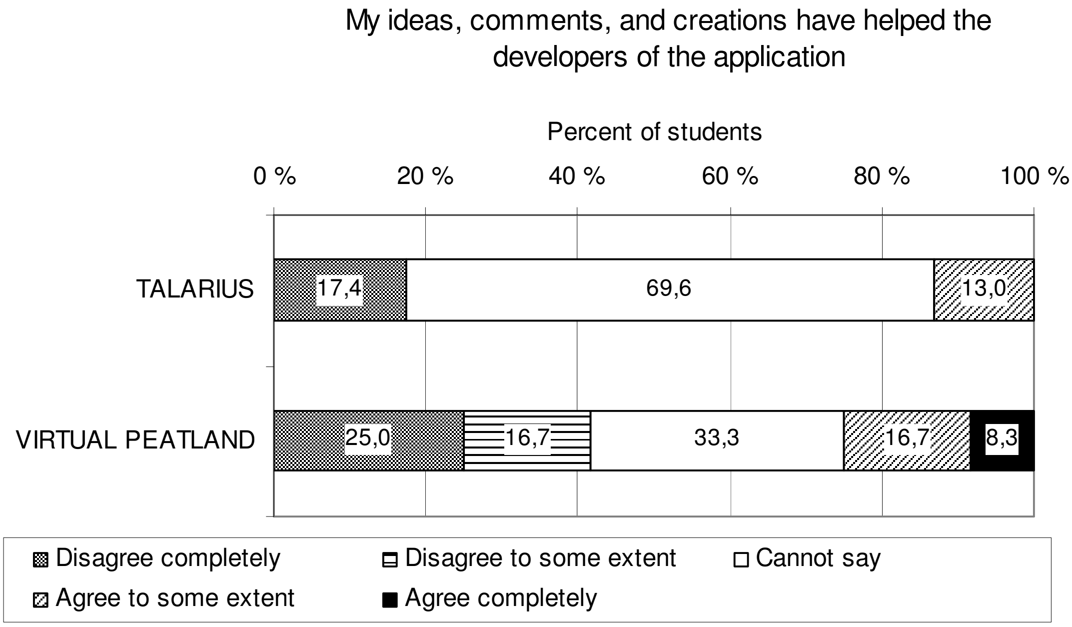

FIGURE 40 Children's views on whether their participation has helped the developers

As in the Talarius project, in this question the "cannot say" category was the single most frequently chosen alternative. However, in Virtual Peatland one third of the children could not or did not want to estimate the usefulness of their comments, while in the final questionnaire of the Talarius project, more than two thirds of the answers to this question were in the "cannot say" category. When asked to specify the ways in which they felt their comments had helped the developers, the children mainly brought up the general providing of ideas: the developers had obtained feedback and ideas from the children in many aspects of the design.

Similarly as in Talarius, more than half of the children (seven out of 12) felt that they would not have wanted to participate in the project in any other way (Figure 41). In the Virtual Peatland project, there were no affirmative answers at all. None of the children specified reasons for this in the final questionnaire, and hence it could not be said whether this was because they were satisfied with their role and the methods used as they were, or because they were dissatisfied with the participation in general. Therefore they were asked in the final interview whether they would have wanted to do something differently. In the interviews, as in the questionnaire, there were no specific wishes to have done something differently or to add or change any methods. One group brought up that there are so many different ways to design game ideas that, in that respect, there would have been possibilities to do something in a different way. They were not able to specify the issue in more detail, however.

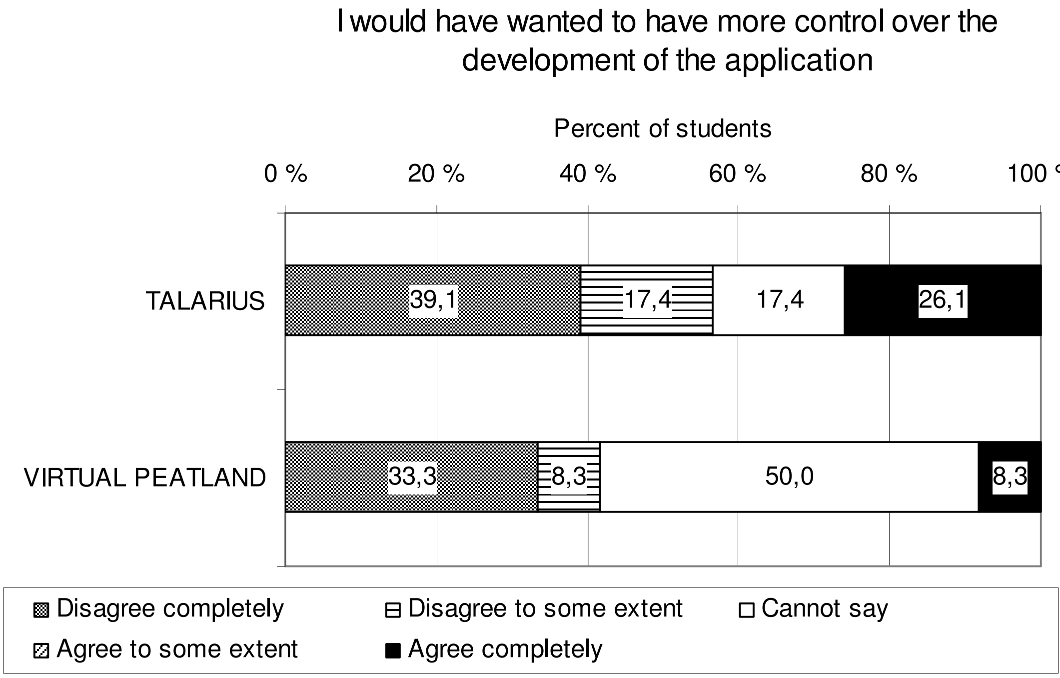

FIGURE 41 Children's wish to participate in the project in other ways

Looking at the issue from the researchers' and developers' perspective, the children's role was seen as being constituted of general idea creation, content creation, and evaluation. This was reflected in the phases of the project. As the document excerpts below illustrate, the ways of participating became gradually better defined. In the first version of a document aiming to define the children's participation, the description of their participation is formulated rather vaguely in terms of gathering information and testing prototypes. In a later version, the ways in which the partner class was going to participate were somewhat more specifically described in terms of the different activities they would carry out.

> The goal is to gather knowledge for the implementation of the content of Virtual Peatland and to bring out the visions of the future users. […] Later, [the project] will entail user-centred testing and carry it out. (Plan for carrying out user participation, Version 1)

> Ways in which the school participates in the design of Virtual Peatland: Planning the structure of the tours and choosing the media elements [i.e. presentation forms], producing contents for selected tours (nature trip). (Plan for carrying out user participation, Version 2)

However, the children's role in the project was somewhat unclear from the researchers' and developers' perspective as well. There were some conflicting views between team members representing different disciplines: on the one hand, the goal was to involve the children in the project as extensively as possible, while on the other hand it was pondered whether it would have been necessary to narrow down the aspects of the children's participation. The partner class was given a great deal of responsibility over designing the game idea, the quizzes, and other material, but it was not settled early enough what the role of this material would be in the final product. As it was seen in the previous subsection, this caused dissatisfaction with the first two prototypes.

> The proceeding of things has also been affected by the fact that the idea of Virtual Peatland has evolved during this autumn. I think that Virtual Peatland, especially the game-likeness and information contents, should be planned still more specifically. For example, the school children could have designed contents to the game prototypes […]. The role of the school, at the moment, is to design both a game and contents, which makes the work challenging. (Project coordinator / educational specialist in the field journal after the game idea creation session)

As pointed out earlier, in conjunction with discussing the game-related participation activities, there were significant changes in the project – especially in the goals of the game to be included in Virtual Peatland – after the children had already designed their own game idea. It was deemed necessary by the game development team to start the game design from a pedagogically more coherent basis. The difficulty to integrate the children's game idea as such to these plans, failures within the development group to communicate the children's ideas about the game to the development of the Peatland Adventure game, and the failure to work more closely with the children during the actual game development phase (as it, for reasons of project scheduling, took for the most part place during the summer vacation of the children) led to the diminishing of the children's role with respect to the game idea. At the same time, the creation of a specific children's section for the website, entailing the children's videos and quizzes, gave emphasis to their role as content creators.

> It must be taken into account […] that the starting point for the participatory design with the fifth- and sixth-graders was that they begin by making information texts; based on the texts, design different quizzes for testing knowledge; think about the characters and rewards; and design the game plot and the game board. This process was challenging and, for some part, even difficult for both the researchers and the teacher and the students. While the participatory design process was ongoing, also the Virtual Peatland project evolved. Hence the goals and aspects of the Virtual Peatland became slightly different compared to the plans and starting points [of the school]. Moreover, it has to be taken into account that the researcher(s?) originally presumed that the material [created by the school] can be implemented as such. Only later it transpired that the material produced by the school will not be used in its entirety. On the other hand, it also turned out that the material produced by the students is not of adequate pedagogical quality and that the quizzes, game and plot are not sufficient as they are, but they require […] further work. (Plan for structuring the participatory material)

*Teacher's Role***:** As already brought up, the teacher was an active participant in the project. The role of the teacher was significant both on a general level and in specific sessions. As regards the more general view, the teacher was very enthusiastic about the project and motivated to participate in it as well as to facilitate the process. This was one of the most important reasons for being able to conduct several design sessions in the course of the project and to use a large variety of different activities and to try new things. Secondly, the teacher's role was a supporting role to that of the children. She expressed concern if she felt that the researchers had misunderstood the children's ideas or if the developers had not taken them into account adequately. On the other hand, the teacher also wanted to make sure that the children's contributions were helpful to the developers, so that the process would benefit both parties.

> [T]he teacher was uncertain about the successfulness of the participatory design. She was worried especially about whether the participation of the school serves the development of Virtual Peatland. According to her, the students learn a great deal during the process, but their 'contribution' to Virtual Peatland is not necessarily as hoped for. We explained that the idea of participatory design was to proceed one step at a time and that the contents would shape gradually. (Project coordinator / educational specialist and HCI specialist in the field journal)

> [The teacher] was still worried to what extent their participation benefits [the development of] Virtual Peatland, and who else will be involved in the production of content. […] The teacher also hoped that e.g. a biology student would help them define which issues are especially important regarding their topic areas. (HCI specialist in the field journal)

The teacher also had a great deal of ideas regarding the Virtual Peatland environment and provided them during the sessions similarly as the children provided theirs. The teacher's ideas were useful, but it was also observed that they affected the children's ideas as well. The natural role of a teacher as an authority and a leader of the class could potentially have been one reason for this; the children started moulding their ideas according to those of the teacher. An excerpt from the field journal reflects on this question; the researcher who participated in the creation of the game drawing, in which the teacher was also actively involved, felt that the drawing (which was made by a five-member group of children) reflected the teacher's ideas more than the ideas that were created earlier by the children and used as the basis of the game drawing.

> The goal of participatory design is that especially the children's ideas and thoughts become visible. At some points, it felt as if the teacher's ideas and plans manifested in the game [drawing] better than those of the students. This is, in my opinion, an indication of 1) the interaction between the students and the teacher, and the role of the teacher as a leader of the class, 2) the teacher's view about the students not being able to direct their activities by themselves, 3) the teacher's enthusiasm to be involved in the game design, and 4) the initial info given by the researchers about their wish to have the teacher's expertise as a resource at different stages of the project. (Project coordinator / educational specialist and HCI specialist in the field journal)

On a single-session level, the expertise and experience of the teacher regarding the skills and preferences of the children was valuable. The collage creation session, for example, would not have gone so well without the teacher's input. Seeing that the children struggled with their first collages and knowing the children and their ways of working, she knew to suggest that they make another collage. She also knew that the children would benefit from making the second collage out of such elements that they were not familiar with beforehand.

> In the actual design session, the children formed (assigned by the teacher) five groups of ca. five people, based on the [desk] rows [in the classroom]. […] The teacher suggested that after [making the first collages] we could have another round in which the students would choose a topic which they don't know anything about, and think about how they would like to find out more about said topic. The teacher had, in general, lots of ideas in terms of the designing and she participated enthusiastically in the planning of future steps. (HCI specialist in the field journal)

Researchers' and Developers' Roles: The researchers were active participants in all of the sessions, instructing the children about the tasks, prompting them to voice their ideas, reacting to the children's ideas and elaborating them further, answering their questions, and helping them in the tasks if they had difficulties. The following field journal excerpt describes the participation of the researchers in the very first idea map creation session.

> We […] participated in the idea creation e.g. in the following ways: we gave instructions about what we would do at each phase, we helped in case the questions in the questionnaires were difficult, we thought about the things related to Virtual Peatland together with the students, and planned the idea map together with the students. (Project coordinator / educational specialist in the field journal)

> We participated actively in the idea creation and design session. We moved around among the groups, gave advice and instructions for making the [collages]. However, we didn't intervene in the making of the [collages]; the children got to choose the species and elements themselves, glue them [on the paper] in the way they wanted and write their own rationales. […] During the session we especially listened to the teacher's opinions and wishes regarding the proceeding and direction of the session. (Project coordinator / educational specialist in the field journal)

The atmosphere in the sessions was informal and relaxed, which encouraged the children to say their opinions. In the first idea map creation session, for example, the children were somewhat quiet at first, but started soon participating very actively. One of the children described the session in the following way: "It was pretty fun. The leaders were nice, and we got to say our opinions." However, the same questions that were related to the teacher's role were also related to that of the researchers. Unlike, for example, in Druin's design partnership projects which particularly strive for a completely equal setting and aim to eliminate the power imbalance between children and adults, the researchers in this project were clearly in the role of leaders rather than peers in the sessions. Therefore it is necessary to take into account the possibility that the children might have said things they thought the researchers wanted to hear, or in other ways attempted to adjust their comments to the researchers' expectations. The context of the sessions, namely school setting, also emphasized this possibility by increasing the risk of the researchers being seen as "teachers" by the children.

Another related challenge was that the researchers had, unavoidably, certain preconceptions about the topics of the design tasks. This, in conjunction with the researchers' role as facilitators and leaders of different tasks, constituted a risk that the outcomes of the sessions (and/or the results of the analyses of the outcomes) were formed according to the researchers', and not the children's, ideas and models. One example of this concern was the creation of the collective idea map.

> At some point I was wondering whether we directed the students' thoughts and opinions too much. I don't know if the idea map was made too much according to our model. Maybe, because we started constructing it based on our view. On the other hand, we asked the students which three things they thought were the most important ones, and they were placed in the idea map first. We could, however, have asked their visions/ideas about how we should start working on the idea map. (Project coordinator / educational specialist in the field journal)

However, as mentioned, the atmosphere was good in the sessions, and also the teacher was satisfied with the researchers' input. She saw completely independent work (led by the teacher without the researchers' presence and aid) as the alternative to the researcher-led approach, and stated that the role of the researchers in planning how the activities proceeded and what needed to be done was invaluable for the successful accomplishment of the design tasks.

> The teacher felt that the school and the class had got plenty of help with working on the game idea and the quizzes. According to her, it was good that the class has not had to make contents or proceed with the design completely independently, without any help or planning, at any point. (Project coordinator / educational specialist in the field journal)

The above points have dealt with the roles of the researchers who participated in the collaborative sessions with the children, and particularly with their roles during the sessions. However, as seen previously, the children's ideas were not transferred to the final outcome adequately even though it appears that the participatory sessions as such were rather successful. At the time of the development of the Peatland Adventure game, there were also personnel changes in the project, and it was at this point when the children's ideas moved from the foreground to the background. The game development group was a specific sub-team within the whole research group that was carrying out the project. The principles of taking the children's perspective into account were not adequately communicated to the members of the game development group, and no common understanding of the role of the children's contribution was formed. In the game development group, each member had a rather specific and well-defined role according to his or her expertise (game design, technical development, content area knowledge, educational expertise, narrative design, graphic design), and while the members of the team managed very well to merge their respective expertise areas together, it happened at the expense of the children's views. One of the researchers who had been participating in the school sessions was a member of this team at the beginning, but as said personnel changes took place and this researcher left the project altogether, there was no such active advocate within the game development group any longer to ensure adequate consideration of the children's perspectives when designing the Peatland Adventure game.

Motivation

In the following, the children's motivation related to participation will be examined, both as reported by the children themselves and through the researchers' observations of the children's behaviour in the collaborative sessions. As already touched upon with regards to certain single design sessions, to the researchers the children's behaviour had manifested as enthusiastic throughout the project: they focused on their tasks and participated in the collective activities actively. However, there were individual differences between children and between tasks. The children's preferences were rather different from one another; someone could show signs tiredness or boredom especially in certain tasks (s)he did not like and be among the most enthusiastic children in another task.

> The students participated enthusiastically in the design and they understood the meaning of the design session. […] The children who had participated [in the idea map session] in the previous year remembered well what Virtual Peatland was all about, and the new students seemed to grasp the idea fairly quickly as well […] [After the first collage,] some of the children seemed excited about the planning, while some would not have wanted to have another round. (HCI specialist in the field journal, about the collage creation session)

One especially fruitful occasion for observing the children's behaviour was the peatland excursion day. Despite having the opportunity to be quickly over with their first task (the video presentation) and spend the time doing something irrelevant, they took the task seriously and concentrated on it, looking for a good individual plant representing their selected species and rehearsing their presentations. Only after the task had been accomplished, it was time for other things. Similarly as it was observed in the Talarius project that the children were especially enthusiastic when they visited the university, this can be an indication of one of the issues often mentioned by the children in both two projects: that they were particularly motivated by the activities that differed from regular school work.

> The students, in general, appeared to work enthusiastically. They were motivated to find different plants and they observed the nature with interest. However, especially in the video recording, lack of planning appeared as a problem; they shot material a bit carelessly at times. (HCI specialist in the field journal, about the peatland excursion)

However, as noted in the part dealing with the peatland excursion, the latter half of the day was less successful in this respect. The children's concentration started to wane and their activities lacked a clear goal and a meticulous approach. In an earlier session, the researchers had noted that one 90-minute session was a suitable time for the planning activities because the children stayed focused the whole time. This seemed to be the case also in the peatland excursion – especially because, in that context, there were many distractions to divert the children's attention away from their own task.

> One double lesson [90 min] was a suitable time for the planning activity. The children did not get tired and they stayed interested in the topic throughout the whole session. The children participated commendably throughout the session. (Project coordinator / educational specialist in the field journal, about the idea map creation session)

While doing computer-based tasks, the class was more restless than during the non-computer-based tasks, but on the other hand, the interaction between children was also especially rich during the computer-based sessions. In the evaluation of the final prototype, for example, they helped each other and exchanged tips for getting ahead in the game, both within and between groups.

> In general, working on a computer is experienced as exciting, which for its part plays a role in the children's lack of concentration. (Project coordinator / educational specialist and HCI specialist in the field journal, about the evaluation session of existing learning environments)

> The testing of the game itself appeared to go well for the children; the students absorbed enthusiastically in the playing and seemed to be motivated to solve challenges they came across in the game. (HCI specialist in the field journal, about the evaluation session of the final prototype)

As seen above, when discussing the children's experiences related to the different methods used during the project, most of the methods received positive feedback from the children. The reasons for liking the activities were to a great extent the same ones that had manifested as the main motivating issues in the Talarius project. The idea map task, for example, was liked because it was considered generally interesting, it was different from normal school activities, and it allowed the children to have a say and voice their opinions.

In the final questionnaire, however, it appeared that the children's interest in the process of participation as a whole had not always been so great. In the statement *"It has been interesting to participate in the project"*, the children's opinions were strongly divided: one third felt that it had been interesting, one third that it had not, and one third could not say (Figure 42). Interestingly, when compared with the results from the Talarius project, the Virtual Peatland project appears to have been considerably less interesting: more than three fourths of the Talarius participants considered it very or somewhat interesting to participate in the project.

At least one reason for such results can be found from the question which asked the children to specify why the project had or had not been interesting. Again, it was the topic of the project that divided opinions. Peatland, and nature in general, was mentioned by some children as the reason why it was interesting to participate, but at the same time it was also a cause of negative opinions for those who were not particularly interested in the topic. In comparison to Talarius, there is a difference between the topics of the two projects. Unlike in the Virtual Peatland project, the application was not content-specific in the Talarius project. Instead, the focus was merely on the design of the features of the application, and therefore in most of the sessions (except for the field trials) the children could use any topic as the "test content" of the

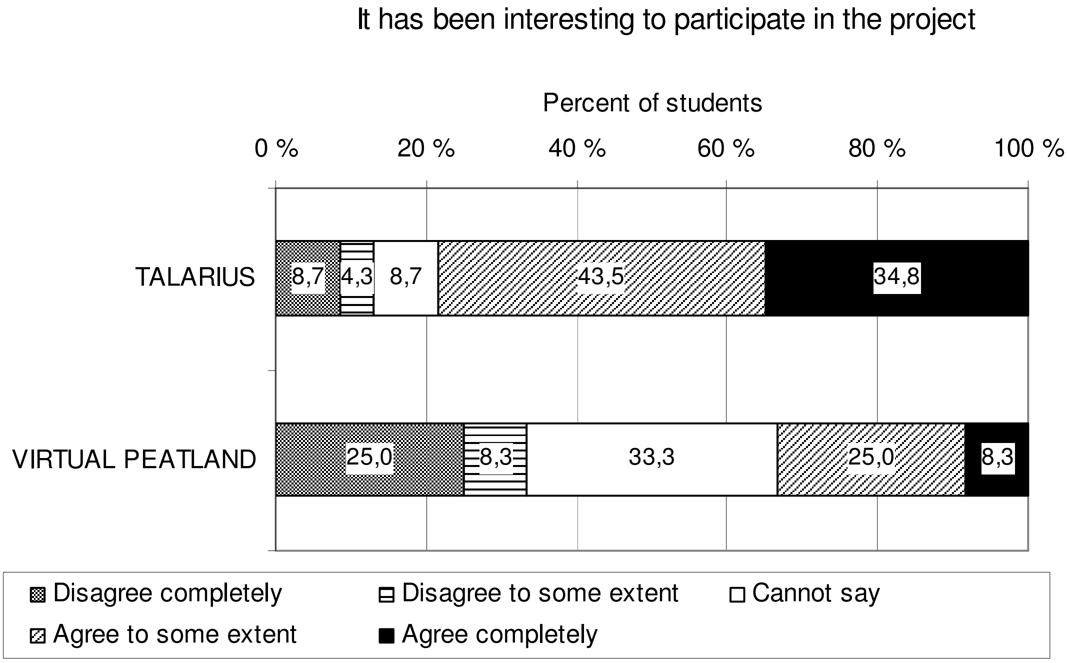

FIGURE 42 Children's views on the interestingness of participation

games they made with the application. In Talarius, too, it was mentioned by some children that making a *learning* game was not very much fun. It is a challenge to motivate children if the topic is not at all interesting to them. Similarly, the different types of activities played a role in dividing the children's attitudes; not all children liked the same activities.

> We got to do all kinds of fun things and spend more time in the nature.
>
> Team work tasks were interesting.
>
> It was boring, because we [were working on] a topic related to peatlands.

Scheduling and Time Constraints

In the Talarius project, schedule-related problems were significant. The Virtual Peatland project faced some difficulties in this respect as well, but the types of the issues were rather different between the two projects. Whereas it was a struggle to fit together the schedules of the school and the developers in the Talarius project, in this project there were no such problems. A specific time slot was reserved for the project on an almost weekly basis for one term, and also for the rest of the duration of the project it was easy to schedule a session when necessary.

> The school has reserved two hours on Tuesday afternoons each week for activities related to Virtual Peatland. In some of these [sessions], people from the research group will be present, some will take place as classroom work carried out in the school independently. (Plan for Carrying out User Participation, Version 2)

However, what was problematic – especially when thinking about the extent to which the children were able to monitor the development process and the realization of their ideas and creations – was the fact that the project was stretched over three different school years. Therefore no child was able to participate in it from the beginning to the end, and additionally, some technical development phases took place during the summer – i.e. vacation time of the school – for which reason the class could not see the development closely all the time.

Another issue was the coordination of the outcomes obtained from the different parties involved in the project. In addition to the elementary school, contents were created by two upper secondary schools as well as different content area specialists. All this was ongoing simultaneously. Moreover, the user participation was rushed to start too early – before there was a coherent pedagogical manuscript for the learning environment – to coincide with the start of the school year. As all of the different areas and perspectives kept progressing and evolving simultaneously, the coordination of the project became difficult.

> A big difficulty has been the fact that the schools [the elementary school and two upper secondary schools] produce material each in its own pace, [and] the plans for the Virtual Peatland project (the game project and the user interface alike) progress and evolve at the same time. As a whole, both the peatland game and the user interface would be easier to implement if the pedagogical manuscript was completely finished and it would be implemented. Now the problem is that the design and the material production proceed simultaneously. (Document on the progress of Virtual Peatland: participatory design and its progress)

A final point related to scheduling and time constraints is the scheduling of single participation sessions. Most of the sessions were right in length, but as brought up above, the evaluation of the existing learning environments was too extensive a task to be carried out in one 45-minute session. This caused some frustration in the children, as there were so many questionnaires to answer in such a short time, and it also affected the quality of the results obtained from the session, as the children's answers to the question sheets were rushed and not carefully thought of.

5.2.4 User Expertise and Context

In the previous subsections, the theme related to the process of user involvement was addressed. First, the different activities and methods of the project were discussed, and then, issues related to collaboration and the functioning of the team in the design project were examined. Next, the focus will shift onto the goals of user involvement. In this subsection, the focus is on user expertise and the use context. The first part of the subsection deals with how the user expertise was brought into the process and how the children saw their own expertise in the project, and the other part discusses the addressing of the real use context.

User Expertise

Content creation and general providing of ideas were often mentioned by the children as the most significant elements in the project, as already seen above in relation to the children's view of their own role. In the final questionnaire, they were asked about the visibility of their expertise in the outcome. Three fourths of the children (nine out of 12) felt that the Virtual Peatland environment would be different if they had not participated in the project (Figure 34). When asked to specify how they believe it would be different, the children mainly mentioned issues related to how fun the website was: if they had not participated in the project to bring child perspective to it, the site would have become more boring and been made from an adult viewpoint, there would be no games or quizzes – or at least they would be different –, and the site would not be as interesting.

> It would be too adult-like [if we had not participated].
>
> It would be a little more boring maybe.
>
> [Other] students would have suggested different things to put in the game.

In comparison to the Talarius project, there was considerably more confidence in that the application would have become different without the participation of the class. As Figure 43 shows, while three fourths felt this way now, fewer than half of the participants of the Talarius project did. In the Talarius project, approximately as many children felt that the application would have become different if they had not participated as that it would not have become different, but in the Virtual Peatland project considerably more children believed in the effects of their expertise in the development of the outcome.

As regards what they considered to be the most important contribution they had made to the website in general, the Peatland Adventure game, the quizzes, and the videos were mentioned. It was important to the children that there was a peatland-related game in general, even though it did not directly correspond to the game idea drawing. The children felt that their participation had had an effect on the existence of the game on the website; otherwise the website would have been too heavily concentrated on factual information or, as stated above, too adult-like.

Interviewer:	What do you think is the most important idea that has come from you, like what is the most important thing that [you wanted especially to] see there?
Student 1:	The videos.
Interviewer:	Why just those?
Student 1:	Well you kind of get information from them too, and then you see what [the plant] looks like.

(Another group:)

Interviewer:	What do you think, out of the ideas that you presented, what is the one whose realization is the most important, in other word the most important idea that you have given or come up with? […]

Student 1:	I don't know.
Student 2:	Pretty much all of them...
Student 1:	Mm.
Student 3:	Yes.
Student 4:	Maybe, after all, the ideas to the Peatland Adventure, so… it would have become, maybe, if we hadn't participated in it, so it would have become maybe a little more, kind of too much focused on the information, or like that… Now there is something to be played too.

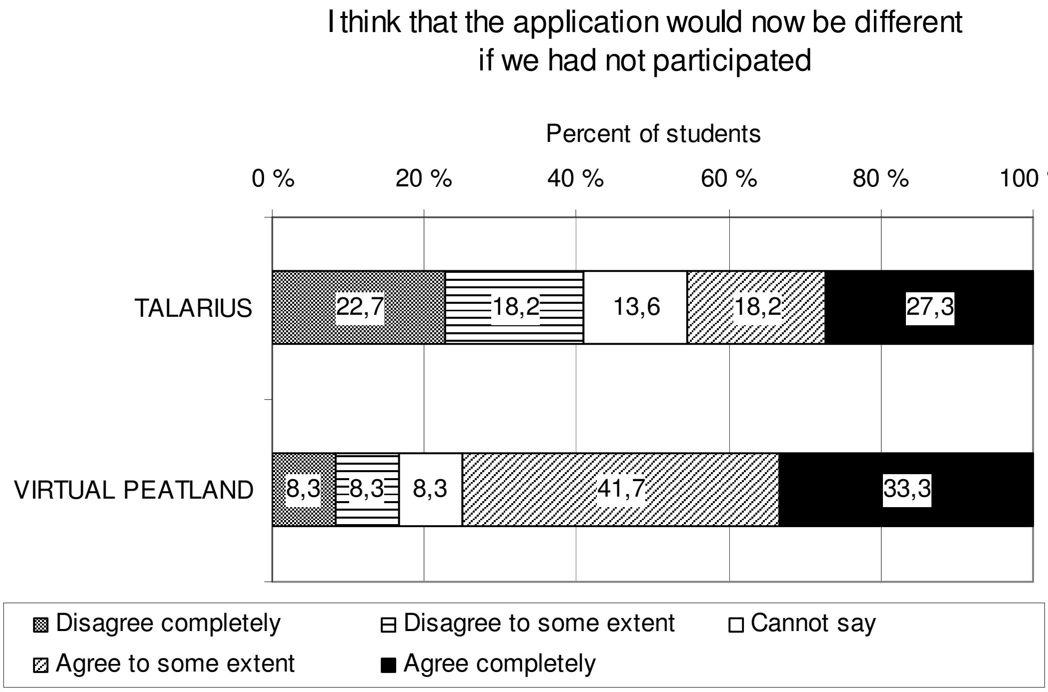

FIGURE 43 Children's views on whether they think the application would have become different without their participation

When asked if the children would have liked to have more influence on some specific features or aspects in the Virtual Peatland, half of the class chose the "cannot say" option and only one child agreed that she would have wanted to affect the development more (Figure 44). The case was somewhat similar in the Talarius project as well, where more than half of the children disagreed with the statement about wanting to have more influence.

However, in the accompanying open-ended question asking to specify over which issues the children would have liked to have more control, also some of the children who had chosen the "cannot say" category mentioned some aspects into which they would have wanted to bring more of their expertise. Similarly as fun and game-like aspects were the most often mentioned ones in Talarius, the game-related topics were emphasized here. The game in general as well as the game characters and story were mentioned, and one of the children also would have liked to have more influence on deeper learning with the aid of the website. The issues related to the game (characters and story) are an indication of the confusion related to the changing goals and purposes that plagued the game development part of the project, and of the consequent fact that their game idea was not implemented as such.

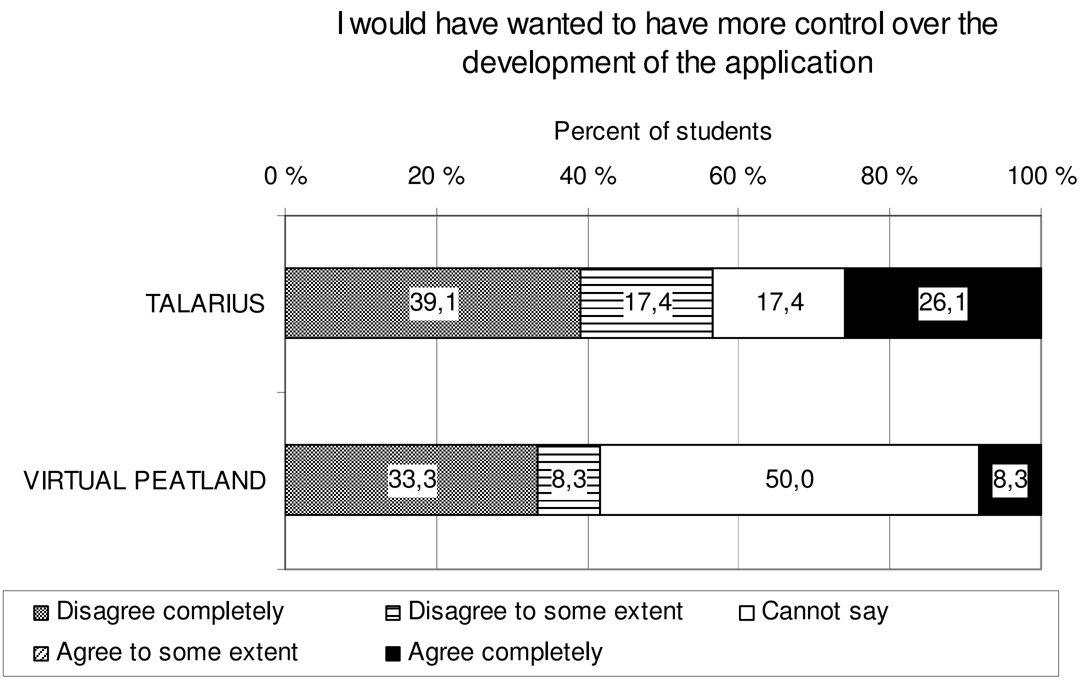

FIGURE 44 Children's views on whether they would have wanted to be able to influence the development more

Addressing the Actual Use Contexts

The Virtual Peatland project was, in the vein of the Talarius project, carried out in collaboration with a school class, the sessions taking place in the classroom. In order to disrupt normal school work as little as possible, it was suggested that the project be integrated to different school subjects and each activity be carried out during a suitable lesson; for example, drawing tasks in art class, stories in Finnish class, information texts and quizzes in e.g. Finnish or biology class, etc. Planning the collaboration to be carried out in this way was seen, in foresight, as a factor encouraging the school to participate and to benefit from the project.

However, upon discussing the conducting of the project with the school, it emerged that the school preferred to carry out the participation in a project-based fashion, reserving a specific, fixed time slot for it each week. One of the reasons was to enable the same teacher to be able to be involved in it throughout the project. This way of structuring the project was good in that there was a clear schedule, and a suitable time slot did not need to be sought separately for each activity. However, it was a risk regarding the students' motivation: the project took the slot of music and art classes for almost one full term, and even though there were no complaints about this, it is likely that someone's favourite lessons were affected by the project.

> We emphasized at the beginning that it might be good if the work on Virtual Peatland was strongly linked with school classes and their themes. This was not, however, the case; the school works on the project separately from other classes. (Project coordinator / educational specialist in the field journal)

> The class has spent a great deal of time with working on Virtual Peatland. For the students, every art and music class throughout the autumn has been spent with design activities related to the Virtual Peatland project. (Project coordinator / educational specialist in the field journal)

However, in terms of single sessions, there were very successful experiences related to addressing the actual context. The peatland excursion, for example, was useful in many ways. From the perspective of school work, the children obtained a great deal of material and experiences to draw upon in different school subjects – from biology and geography to subjects like Finnish and art. These materials can be used in the class not only in terms of this particular project but for many other purposes as well. On the other hand, the excursion to the peatland helped put the *virtual* peatland in real-life context: the children saw things they had been discussing, searching information about, writing about, and in other ways working on for some time. For example, the video presentations – and the experiences from the excursion in general – created a link between the virtual peatland and the real peatland, such as the idea that before or after going to the real peatland, more information can be learned by visiting the virtual one. Moreover, certain subtasks of different activities (such as searching for information to serve as source material for the writing of the information texts and the making of the quizzes) were learning opportunities to benefit the students in their future projects.

> [In the next session, t]he class makes preparations for next week's excursion to the national park. The goal is that they observe the nature from many perspectives. Student groups think about how peatland nature can be observed from the perspectives of different creatures (e.g. bird, ant, tree etc.). Moreover, the class thinks about how they should prepare for the trip and how different things can be observed on the excursion. The purpose is that the outcomes of the national park excursion can be utilized in e.g. Finnish, geography and biology, as well as art class. (Project coordinator / educational specialist in the field journal)

Another session in which context played a crucial role was the evaluation of the final prototype of Virtual Peatland, especially the Peatland Adventure game. It was already pointed out in the Talarius chapter how the evaluation sessions where the whole class was present informed the developers about the ways in which the application would be used in schools. Correspondingly, in the Peatland Adventure evaluation session, the children's behaviour provided indications of the actual classroom use of the game. Even though there was a large group of children present in the computer lab at the same time, the situation was not very restless; they focused well on the game, and when there were interactions between different groups of children, they were directly related to the game. The children were, for instance, asking for advice from another group, giving advice to others, and commenting and making remarks of what the game characters were currently doing.

> The students discussed the tasks of the game with one another: those who had advanced further in the game were asked for advice in problematic situations. While playing, the students also commented on their own game events and those of others, as well as the game characters and tasks. (HCI specialist in the field journal)

5.2.5 Empowerment of Users

As brought up in the subsections above, the children's experiences of their role and the influence of their expertise in the development of the application varied rather much between different areas of the project. This subsection will discuss issues related to their feeling of empowerment and ownership in more detail.

As regards their general experience of being able to be active participants in the project, the goal of involving them actively succeeded well: except for two students (out of 12), the children felt that they were able to participate either very or somewhat actively (Figure 45). This result was consistent with that obtained in the Talarius project. As seen in the section about the children's role, activities related to creating content were the main factors giving the children an experience of active participation, but the process of being able to design things in general was important as well.

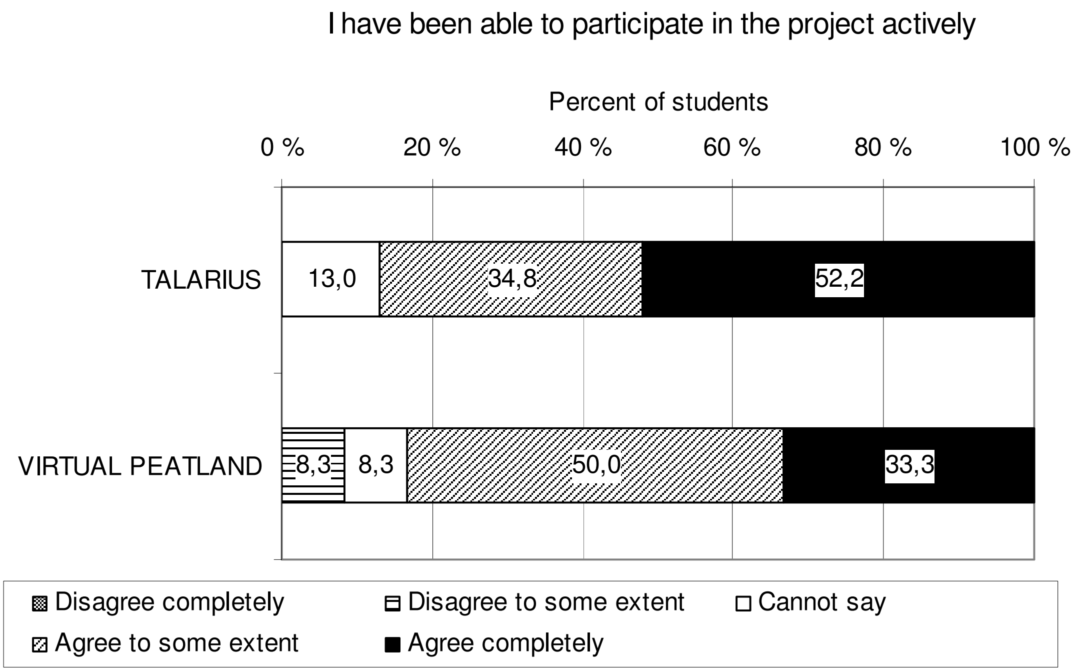

FIGURE 45 Children's views on being able to participate actively in the project

When asked whether the development of the application was visible in the course of the project, half of the children (six out of 12) felt that it was, either clearly or to some extent (Figure 46). Almost as many found it hard to estimate, however, and chose the "cannot say" alternative. The most significant difference in relation to the Talarius project was that there were more negative comments about the visibility of the development of Talarius than about the development of Virtual Peatland (only one negative comment). This is interesting, because in the Talarius project there were more evaluation sessions with gradually developing computer prototypes, while in Virtual Peatland there was heavy emphasis on non-computer-based tasks at first, and the three points of prototype evaluation that followed were rather far apart in time from each other. On the other hand, as mentioned, many children found it hard to assess whether they had seen the development clearly, most likely because of just these long intervals between prototype evaluations.

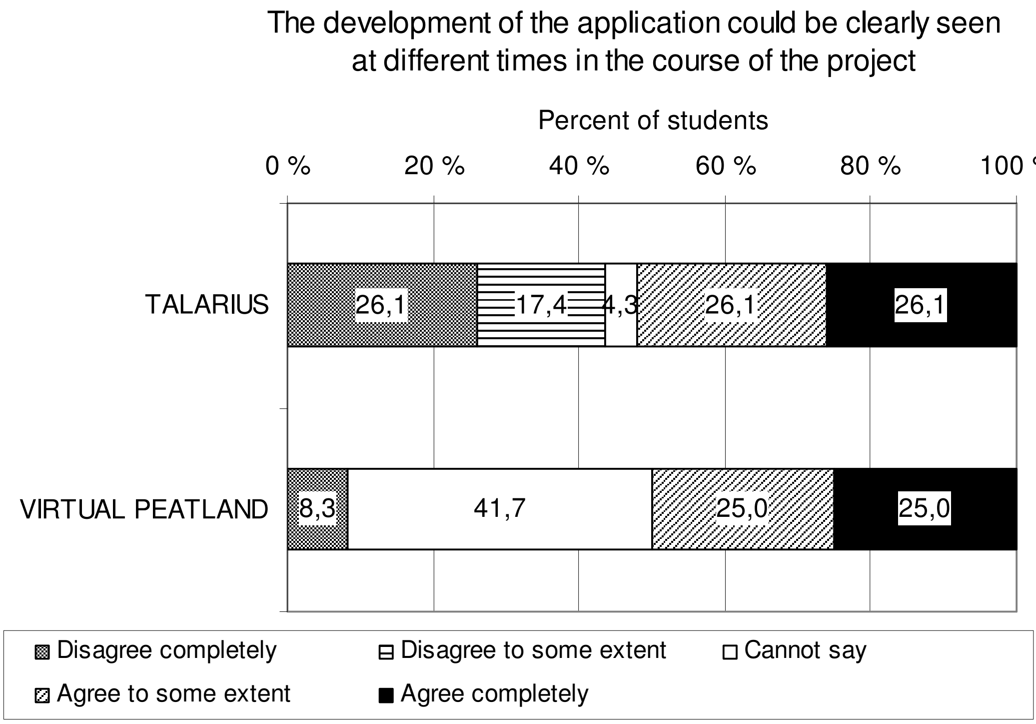

FIGURE 46 Children's views on being able too see the development of the website

In the Talarius project, the questions about seeing their own ideas in the final outcome (Figure 47) and whether they felt they had power over the development of the application (Figure 48) revealed that the children were not able to recognize their input in the product. In this respect, Virtual Peatland seemed to fare better. While in the Talarius project, there were more negative than affirmative answers to the statement *"My ideas show in the application"*, in the Virtual Peatland project it was vice versa. In the question about having power in terms of the directions of the development of the application, the difference between the two projects is also noticeable, although the opinions were rather evenly divided between all the categories in the Virtual Peatland questionnaire. To summarize, neither the Talarius nor the Virtual Peatland project managed to convey the feeling of empowerment in the best possible way, but the latter succeeded in it better.

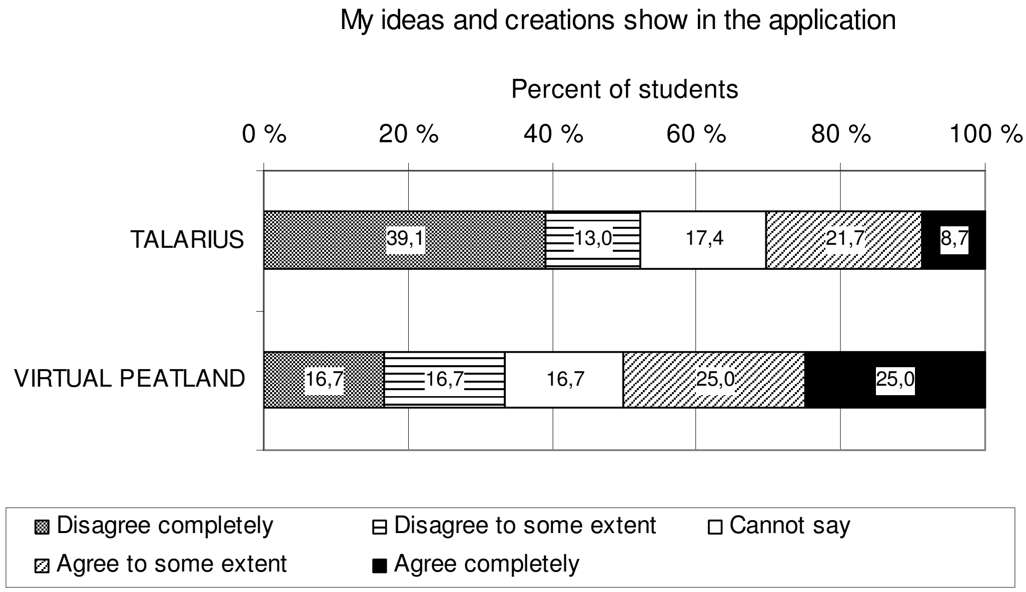

FIGURE 47 Children's views on seeing their creations in the application

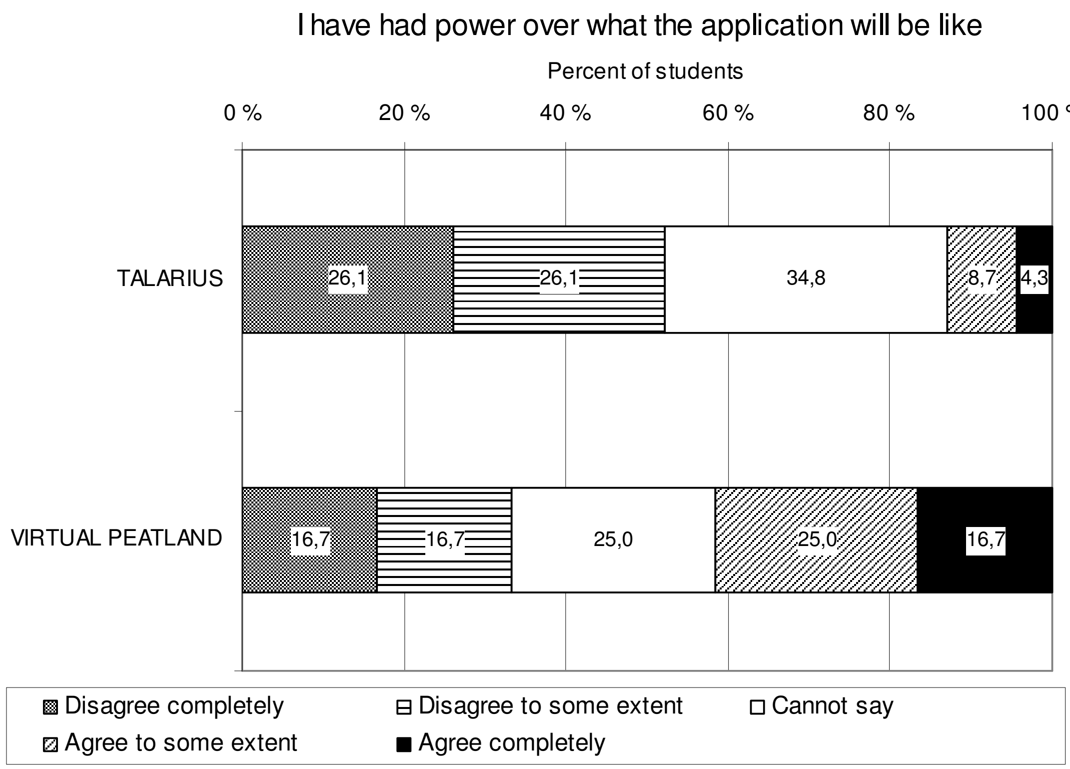

FIGURE 48 Children's views on having power over what the application will be like

In Virtual Peatland, the children felt empowered especially in terms of the quizzes they made and – despite the changes that were made to their idea of the game – in terms of the structure, ideas, and characters of the game. The video presentations were also mentioned, as well as certain more abstract effects: for example, one of the children stated that through her participation in the project, she had been able to promote respect for peatland nature.

> [My ideas show in the form of] the quizzes we made and the plant presentation videos.
>
> The quizzes are like I expected them to be.
>
> [I have been able to influence] the game in which you do different things (peatland game) and some quizzes.
>
> I have been able to promote respect for peatland nature.

The game idea drawing was created by one five-person group, based on the ideas provided by the whole class. It is possible that the children who were in the game group were able to form a more comprehensive picture of all the ideas related to the game and now saw them in the final game application, while those who were not in that group only remembered the ideas they personally had suggested, and if they were not found in the game as such, they did not feel that they had influenced the game development. The excerpt below presents a conversation from one of the groups in the final interview where three girls discuss which ideas were shown in the final outcome. One of the three had been in the game group, whereas the other two had not. The game group member was the only one that could name an aspect of the children's game idea that was found in Peatland Adventure. The other two children mentioned game-related issues as well, namely characters, which were created as individual drawings, but could not remember the collective game idea.

Interviewer:	How do these show in Virtual Peatland now, these three phases [of game creation activities]?
Student 1:	Pretty well.
Interviewer:	What shows best? What shows the least?
Student 1:	Maybe the quizzes show best.
Student 2:	Yeah, or those game characters.
Student 3:	Yes.
Interviewer:	Yeah, about the game idea… we just talked about it with the previous group, that there was… that some of those ideas were there but it wasn't exactly like you had thought there [in the drawing].
Student 3:	Mm.
Interviewer:	What is there in the game idea that you think shows, and what is there that is sort of different or what has changed since that game idea?
Student 3:	Well, there is kind of… those… that you collect things.
Student 2:	I can't remember anything about that game idea because I was… I wasn't there planning it.
Interviewer:	Yeah, that's right, there was one group there that made…
Student 1:	I wasn't there either.
Student 3:	Well, I was in it anyway.

5.2.6 Manifestation of the Users' Ideas in the Outcomes and Meeting the Children's Expectations

After discussing the children's views on their contribution in the outcomes, the focus will turn to the analysis of the design session products and the final outcome. First, the outcomes of the requirements gathering sessions are examined in relation to the final application. Secondly, the feedback the children gave on the first Peatland Game prototype is contrasted to the final Peatland Adventure game. The third part examines the extent to which the outcomes of the content creation activities were implemented in Virtual Peatland. Finally, it will be examined to what extent Virtual Peatland met the children's expectations.

Requirements Gathering and Idea Generation Outcomes vs. Final Product

In the following, the outcomes of the requirements gathering sessions will be examined in comparison to the final version of Virtual Peatland. The items to be analyzed include the initial idea map, the collages related to presentation forms and species, the outcomes of the evaluation of the existing learning environments, and the game idea drawing and characters.

Idea Map vs. Final Product: The main content areas highlighted by the children, and thereby included in the idea map, were animals, plants, and trees; and the most important presentation forms were games, pictures, quizzes, animations, and learning by seeing and hearing. The content of the final version of Virtual Peatland was analyzed to find whether, and how, these ideas manifested in it. Table 15 presents the comparison between the central elements of the idea maps and their manifestation in the final version of the Virtual Peatland learning environment.

As the table shows, all categories except for animations were represented in several forms. Animals and plants, especially, were addressed in a variety of different ways: the information texts and pictures in the Peatland Species section; the interactive quizzes created by the children; and the Peatland Adventure game, the second level of which was related to peatland animals and plants (the first one dealt with the origin of peatlands and their formation mechanisms). As regards games, the final version includes the Peatland Adventure game and the Peatland Boardgame. Pictures (including those taken by the children) have been used in the Virtual Postcard section and are included in plenty in the information section to liven up the text. In terms of quizzes, the final version entails several puzzles made by the children themselves as well as a crossword puzzle related to peat industry. Finally, related to the theme of "learning by seeing and hearing", the most essential elements include the children's own video presentations in the Children's Peatland section and the pictures used as Virtual Postcards and elsewhere in the learning environment to illustrate the textual contents.

TABLE 15 Central elements from idea maps in the final version of Virtual Peatland

Idea Map Elements	How do they show in the final outcome?
Content Themes	
Animals	Section "Peatland Species", entailing: Invertebrates Mammals Birds Quizzes Peatland Adventure: "Animals and Plants" level
Plants (+ trees as s specific category)	Section "Peatland Species", entailing: Peatland species in the National Park Medicinal herbs Peatland flora grouped by peatland type Peatland flora grouped by family Quizzes Video Presentations Peatland Adventure: "Animals and Plants" level
Presentation Forms	
Games	Peatland Adventure Peatland Boardgame
Pictures	Pictures on text pages Virtual postcards
Quizzes	Quizzes created by the children Peat industry crossword
Animations	-
Learning by seeing and hearing	Videos Plant presentations by children Peat layers Peatland sports Autumn morning landscapes Peatland services Pictures (see above)

Collage vs. Final Product: When the children made the collages about the species and presentation forms, the outcomes were analyzed by counting the most frequently chosen presentation forms. Table 16 illustrates which presentation forms were the most popular and how, according to the analysis of the contents of Virtual Peatland, they are represented in the final product. For spatial reasons, only the presentation forms that were mentioned more than ten times in the collages are included in the table. This is also consistent with the way the collages were analyzed in the project; when the results were presented to and discussed with the children after the analysis, those elements that were mentioned more than ten times were addressed in more detail, due to being the most popular ones.

Based on the analysis, all items but webcam are represented in the Virtual Peatland environment. The quizzes and crosswords as well as the videos include also contents created by the children themselves. As seen in the table, the children emphasized interactivity (games, quizzes, crosswords) and such elements that fall within the "learning by seeing and hearing" perspective that they pointed out already in the idea maps (photographs, videos, webcam). Traditional textual information was not discarded by them either.

TABLE 16 Most frequent presentation forms in the collages and their representation in the final version of Virtual Peatland

Collage Elements	How do they show in the final outcome?
Quizzes (incl. "questions", "question set", "multiple-choice")	Quizzes created by the children
Photographs	Pictures among text Virtual postcards
Games	Peatland Adventure Peatland Boardgame
Videos	Plant presentations by children Peat layers Peatland sports Autumn morning landscapes Peatland services
Textual information (incl. "factual info", "info box")	Information text in all the sections
Crossword puzzles	Quizzes created by the children (incl. crosswords) Peat industry crossword
Webcam	-

Evaluation of Existing Learning Environments vs. Final Product: The evaluation of existing learning environments was not completely a successful session, as pointed out in the subsections above. The goal (to evaluate the websites in order to obtain ideas related to what to do or what not to do on the Virtual Peatland site) was not clear to the children, and therefore their comments were rather vague. For this analysis, I narrowed the questions down to three: how the children would use ideas from each website for the design of Virtual Peatland, what was the best of the websites and why, and which presentation forms (out of those used on the sites) the children would like to see in Virtual Peatland. Table 17 presents these issues and the analysis of their manifestation on the final website.

TABLE 17 Ideas from learning environment evaluation and their representation in the final version of Virtual Peatland

Ideas / Comments	How do they show in the final outcome?
1. Ideas for Virtual Peatland	
Navigation (all navigational elements present at all times); Quizzes; Animals	Navigational column present at all times (the idea of path-like navigation was discarded); Quizzes; Animal presentation texts
2. Best elements of favourite website	
Site #1: Games and quizzes; Colouring task Site #2: Story; Quizzes Site #3: Clarity of presentation (plants organized in clear categories based on where they grow); Identifying plants	Games (Peatland Adventure and Boardgame); Quizzes; Plants and animals organized in categories e.g. by family or peatland type
3. Presentation forms for Virtual Peatland	
Quizzes; Nature-related information; Identifying plants; Games; Glossary; Short texts; Photographs	Quizzes; Information texts; Games (Peatland Adventure and Boardgame); Photographs (site illustrations and virtual postcards)

As pointed out, many of the comments were of very general nature, and therefore it is difficult to analyze their manifestation in the final product. Those, somewhat more traceable ideas that are included in the table, manifest in the final outcome in one form or another. Games and quizzes were mentioned several times, and as it has been seen, they are an essential part of Virtual Peatland. There were also a few navigational and structure-related issues mentioned by the children. Firstly, a navigational solution of one of the learning environments, where links to all the different sections were visible at all times was pointed out as a good way to structure the navigation. Secondly, the structuring of the actual content (e.g. information texts) has to be in made in a clear and intuitive way. An example of this issue was a website where different plants were categorized based on where they grow. A similar structure is used in the information sections of Virtual Peatland where the plants, for example, are organized in two alternative ways; either by family or by the type of peatland where they grow. A plant-identifying task was suggested as well. There are tasks related to the identification of species in the Peatland Adventure game, but there is no separate quiz for identifying plants. Other elements not found on the site are a glossary of terms and a story-based path along which to navigate.

Game Idea Drawing and Characters vs. First Prototype vs. Final Product: Finally, I will look at the similarities and differences between the children's game drawing (in which a five-person group merged the collectively gathered ideas of the whole class from the previous session) and the game. The children's game idea was a board-game type path along which the player (as an animal character) moved, stopping to do different tasks at specific "activity points".

For accomplished tasks, the player got rewards and points, and along the way the player might encounter various obstacles. The goal was to make it to the finish line and gather as many points as possible. In the analysis, this game idea was compared to the first version of the game (i.e. the Peatland Game prototype), and the largely different final game (Peatland Adventure). The categories for the framework of analysis were derived from the children's game drawing. They include the character, the game settings, the number of players, the background or environment of the game, the ways of proceeding in the game, the subtasks, the rewards and the obstacles, the general goal of the game, and other possible issues. The results are summarized in Table 18.

TABLE 18 Comparison of the children's game idea to the prototypes

Game idea	Peatland Game	Peatland Adventure
Character		
Animal (5 different ones: hare, hedgehog, woodpecker, owl, mole)	Human	Animal (four different ones: hare, crane, snake, frog)
Settings		
Adjusting level of difficulty Choosing character Choosing character name	Choosing character	Choosing character Choosing level
Number of players		
Multiple	Single but entails some inter-player activity	Single
Background / Environment		
Peatland, boardgame-type	Peatland, isometric	Peatland, isometric
Ways of proceeding		
Moving from one "activity point" to another (in a board-game-like way) by: Diving A long, slow path Short cut Skiing Riding moped	Moving from one "activity point" to another: Clicking on an "activity point" the character moves automatically to the point clicked	Moving around on the peatland, coming across other animals who give the player different tasks - Two alternative ways: moving freely using arrow keys, or clicking somewhere and the character moves to that point by itself

(continues)

TABLE 18 (continues)

Game idea	Peatland Game	Peatland Adventure
Types of subtasks		
Crossword Word maze Anagram Species identification Moped rally	Card game Connect related words Composition (open-ended question)	Finding hidden items Info boxes Learning objects Multiple-choice Logical problems Dexterity tasks Composition Yes/No statements Species identification Food chain creation
Rewards		
For right answers: Points Food Shortcut Magnifying glass Bouncing shoes Character-specific rewards	For solving subtasks Talismans which can be used to buy elements (e.g. plants) for the player's own patch of peatland	For solving subtasks or finding hidden rewards in the field "Instrument rewards": Help accomplish subtasks (e.g. gold, pieces of map) Actual rewards: Advance the main goal (e.g. opening a dam to make the ground damp)
Obstacles		
Hunter (takes points) Boghole (takes points or rewards) Returning backwards	-	- (Only those related to the subgames)
Goal/Finish		
To get as many points as possible Finish line Hall of fame	Creating one's own patch of peatland Subgoals: Tasks at "activity points", give talismans for buying items for the patch of peatland	Different goals for each level and each character: First level – creating peatland (each character for different reasons); Second level – learning about peatland nature (each character for different reasons) Subgoals: Tasks along the way, related to achieving the main goal
Other		
Mentor who helps along the way	Mentor: owl	Mentor: gnome

The table shows that in the children's game drawing, there are five animal characters (which the children also drew); hare, hedgehog, woodpecker, mole, and owl. In the beginning of the game, the player chooses a character and gives it a name. The game resembles a board game in which players compete against each other, hence the game is a multi-player game. Peatland Game and Peatland Adventure are principally single-player games, in which the player takes the role of a character. In Peatland Game (from this point on, referred to as Game I), the character is a human being, while in Peatland Adventure (from this point on, Game II) the type of the character corresponds to that of the children's idea. As regards the animal species, however, hare is the only animal that is common to Game II and the drawing. The name of the character cannot be chosen in either of the games. Another setting made at the start of the children's game drawing is level of difficulty. In Game II the player can choose one of two levels, but they differ in terms of the main theme, not in the level of challenge.

The game environment in the drawing resembles a board game; the player moves along a visible path which is pictured from above. There are different ways of moving; one can "dive", "ride a moped", etc. At specific activity points, there are tasks to accomplish. In both Game I and Game II, the game is located in an isometric peatland environment. In Game I, the path is not visible but the activity points are, and the player moves directly to a specific activity point by clicking on the point. In Game II, there is no path; instead, the player can freely move around by using the arrow keys or the mouse. The activity points in Game II are encounters with various other characters, who give the player subtasks to perform. The main goal in the children's idea was, in a board-game-like fashion, to cross the finish line and gather points. There was also a hall of fame for the best players. In Game I, the main goal was to create a private patch of peatland by adding different items, such as plants, onto it. In Game II, the game has an extensive background story of animal families; in the first level, the goal is to turn a forest into peatland, and in the second level, an offspring of the character in the first level sets out to find out whether the peatland built by its ancestor would be a good place to live.

As to the subtasks, the children's game idea entails both information-based and more entertainment-driven tasks: crossword, word maze, anagram, species identification, and moped rally. Out of these tasks, Game I included none (it entailed a card game, a word connection task, and a composition task). Game II entails species identification. In addition to this, there is a variety of subtasks in Game II, both information-oriented (e.g. multiple-choice questions and learning objects) and entertainment-oriented (e.g. finding hidden items and solving logical problems). Each of the games awards prizes for accomplishing tasks or for other reasons. In the children's idea, the players got a reward for getting questions right or accomplishing tasks. The rewards included e.g. points, food, some helpful objects, and different character-specific rewards (for example carrots to a hare). In Game I, for accomplished tasks, the player acquired talismans for buying items for his/her patch of peatland. In Game II, there are "instrument rewards" that help the player accomplish a subtask (e.g.

look for pieces of a map or hidden gold) and actual rewards which advance the main goal. For example, for a successfully completed subtask, beavers may create an opening in their dam to let water through, which makes the ground damp and thereby takes the player closer to the goal of successfully forming a peatland. In addition to rewards, the children's game drawing had obstacles as well, such as hunters or bogholes that could take the player's points, for example. In Games I and II there were no obstacles per se, but in Game II, there are some subtask-related extra challenges such as having to pay another character for its help, which requires the player to go looking for gold. Finally, in all of the games there was a mentor who was available to help and guide the player in the course of the game. In the children's game idea, it was not specified what the mentor would be like. In Game I it was a wise owl, while in Game II the mentor is an old gnome.

However, when the other parts of Virtual Peatland (such as the Peatland Boardgame and the different quizzes and activities created by the children) are included in the analysis as well, there are some more connections to be found between the children's game idea and the final Virtual Peatland environment than when comparing the children's ideas merely to the game applications featured in Table 18. Firstly, the basic idea of a multiple player board game is how the Talarius-based Peatland Boardgame is constructed. The game entails a game path along which the players (as the same animal characters as in the Peatland Adventure game) proceed, stopping in question squares along the way (entailing multiple-choice and open-ended questions). Secondly, three of the quiz types suggested in the game drawing are represented in the Children's Peatland section which includes the quizzes made by the children; crossword puzzle, word maze, and anagram can be found there. Hence, as the species identification task is a part of Peatland Adventure, only the moped rally cannot be found in Virtual Peatland in any form.

In summary, the Peatland Adventure game was, in terms of its basic idea, rather different from what the children had suggested the game to be like. This was due to the game developer team's view that the idea would not have been able to adequately accommodate a sound biological background and a game story. Therefore it is not surprising that many of the children did not see their ideas in the game. However, as it was discussed in the empowerment-related section, some children did recognize certain more subtle similarities that were not so evident on the surface. Elements that were common to the children's idea and the final outcome entailed the role of an animal character, peatland background, moving around on peatland towards task points (although implemented in a different way), collecting different kinds of items, a species identification subtask, and a mentor helping the player. If the rest of the Virtual Peatland environment is included in the comparison, the abovementioned quiz types and board game were additional common elements. However, these more vague links were not conveyed to the children very well, especially not to those who did not belong to the five-member game design group that addressed the game-related issues somewhat more profoundly than the rest of the class.

Peatland Game Feedback vs. Peatland Adventure

This part examines the feedback the children gave about the Peatland Game (again referred to as Game I), and how the issues mentioned by them have changed in relation to Peatland Adventure (Game II). First it must again be noted that Game II differs greatly from Game I in terms of its main idea, as seen above in the comparison of these two versions with the children's drawing, and therefore not all of the issues mentioned in the children's feedback are applicable or directly comparable to Game II. The personal patch of peatland is one example of this. Table 19 presents the results. The categorization is based on the structure according to which feedback was collected in the evaluation session. The categories include the game environment or background, the tasks of the game, and the player's own patch of peatland.

In terms of the game environment, some changes are rather straightforwardly traceable. The game can be saved, the character can be moved with arrow keys, the area is wider, and the sceneries change as the character moves along on the map. Moreover, the player meets more animals during the game. As to the activity points and paths, there is considerably more variety but in a different way: there are not more paths to choose among, but instead the character can move freely on the map, without following any specific path. Despite moving is unrestricted, the order of the activity point is predetermined, as the children hoped. The activity points (i.e. sub-games) are presented differently, however. Related to the sub-games, there are rewards that can be taken advantage of in order to progress in the game. Gold, for example, is needed in order to be able to attempt to accomplish one sub-game. Challenges like these were requested by the children, as they wished to have small tasks or challenges continuously. Specific obstacles, apart from these extra challenges, have not been incorporated to the game, however.

The children wanted also to see their characters and rewards in the game. These creations have not been used as such in the game due to the change in the game idea, i.e. adopting a specific biological background on which the plot of the game was based. Instead, the children were asked to draw more characters (moles, beavers, and mythological characters) to appear in the game. The rewards originally drawn by the children are not a part of the game either, although there are, as a whole, more types of rewards in the game than there were in Game I. There are four suggestions about which it can be clearly said that they do not manifest in the game. First, the game area is an isometric map, similarly as Game I, and not seen from first-person perspective as the children hoped. Secondly, there is no background music yet in the current version, and thirdly, there are no campfires or resting spots. Finally, the game includes a backpack for collecting pieces of a map which is required in one sub-game, but animals' or plants' pictures are not collected during the game.

In the feedback regarding the different tasks or sub-games, the children hoped, firstly, the game to have a final test at the end of the game, before the whole game is accomplished. At the end of the level in which the player creates a peatland, there is a composition task asking the player to recount how the

TABLE 19 Feedback from Peatland Game and its manifestation in Peatland Adventure

Feedback on Peatland Game	Manifestation in Peatland Adventure
Game environment / Background	
1) Characters: Animals, choosing character, adjusting what the character looks like	1) Animal characters (not those made by the children), choosing character but not possible to adjust its appearance
2) Rewards and character-specific gear	2) More rewards (not those from the children's drawing)
3) Background: More peatland-like, more animals, fewer trees	3) More animals that the player meets
4) Wider area and changing scenery	4) Wide area, scenery changes
5) First-person perspective	5) Still isometric
6) Order of activity points should be predetermined	6) Yes (although the form of "activity points" is different)
7) Obstacles: Hunter, bogholes	7) No, except for the task-related challenges
8) Using rewards for proceeding to next point	8) Yes
9) Several activity points, several paths	9) Free moving on the map
10) Continuous little tasks and challenges	10) Task-related extra challenges (e.g. finding gold)
11) Steering the character with arrow keys	11) Yes
12) Background music	12) No (noted as one issue of further development)
13) Picture album for collecting pictures of animals and plants the player comes across	13) No (except for backpack for map pieces in one task)
14) Resting points, campfires	14) No
15) Saving the game	15) Yes
Tasks	
1) Information text and related questions	1) No
2) Quizzes: Background pictures related to topic	2) Yes and No (in some quizzes)
3) "Final test" at the end of the game	3) A composition task at the end
Patch of Peatland	
1) Discussion and comparison of peatland patches with other players	1) n/a (no peatland patch; noted as one issue of further development)
2) Patch should be bigger	2) n/a
3) Unexpected surprises: e.g. moving or disappearing items	3) n/a

peatland was formed and what was required. Another comment related to tasks dealt with the appearance of the sub-games; they should have a related picture as their background. There are topic-related illustrations in the Peatland Adventure sub-games. For example, in a task related to wader birds, the answer options are represented as being floating in the water, and in the final composition task there is a picture of Tapio and Ilmatar (forest spirit and spirit of the air) because in the story of the game, Tapio asks the player to help him present the forming peatland to Ilmatar. A third issue related to tasks was one particular type of task wished by the children: reading a text and answering questions about it. There is, however, no such subtask in the game.

In addition to the general feedback on Game I, the children were asked about the similarities and differences between their game idea and Game I. There were two main aspects they identified as similar: the way of navigating in the game – going from one activity point to another – corresponded to their idea, and secondly, there was a backpack for collectibles, but the collectibles were not those that they were in their game idea.

Content Creation Outcomes vs. Final Product

Finally, in the analysis of the manifestation of the children's ideas in the final outcome, I will have a look at the content items created by the children and their manifestation in the final version of Virtual Peatland. The children created quizzes, recorded video clips, and took photographs to be included on the website. Examples of the manifestation of the photographs and the video clips are displayed in Figure 49.

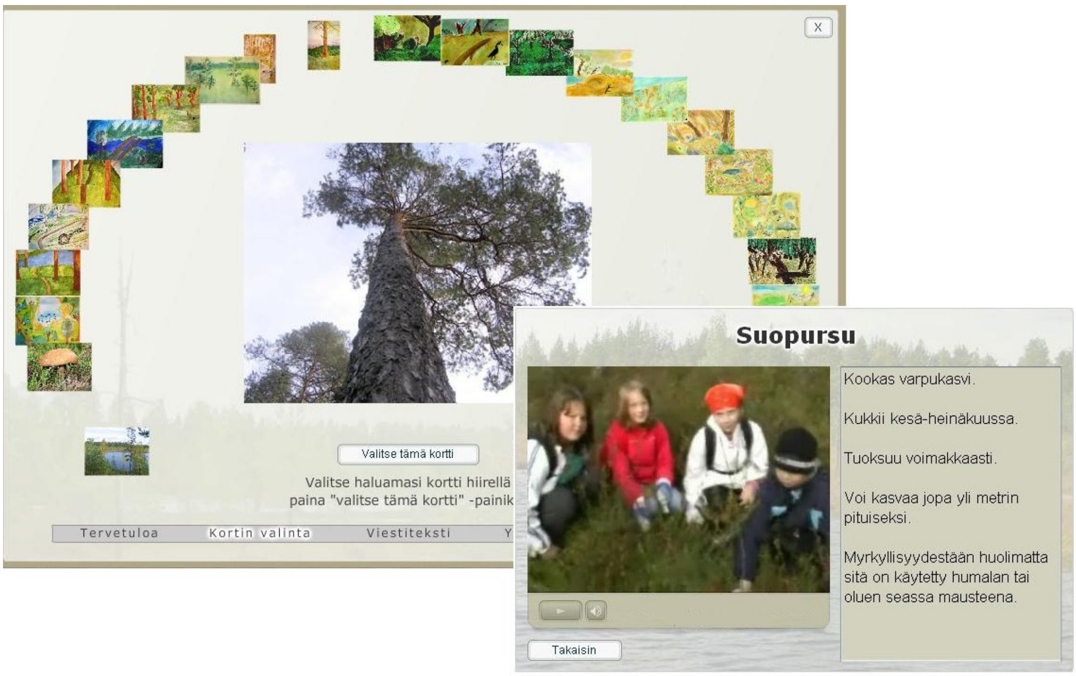

FIGURE 49 Virtual postcards and a video presentation on the Virtual Peatland website

Table 20 summarizes what the children produced and to what extent these creations have been implemented on the website.

TABLE 20 Content items created and contents included on the website

Creations	Manifestation in the outcome
Quizzes	
Word maze (n=7)	In the Children's Peatland section (n=1)
Multiple-choice quiz (n=5)	In the Children's Peatland section (n=1)
Text-filling task (n=4)	In the Children's Peatland section (n=1)
Yes/No statements (n=3)	-
Word connecting task (n=3)	In the Children's Peatland section (n=1)
Crossword puzzle (n=3)	In the Children's Peatland section (n=1)
Anagram (n=1)	In the Children's Peatland section (n=1)
Identification task (n=1)	-
Video presentations (n=7)	
Rufous Milkcap (51 votes)	In the Children's Peatland section
Cottongrass (22 votes)	In the Children's Peatland section
Heather (18 votes)	In the Children's Peatland section
Crowberry (9 votes)	In the Children's Peatland section
Marsh tea (9 votes)	In the Children's Peatland section
Bog bean (9 votes)	-
Cranberry (8 votes)	In the Children's Peatland section
Lingonberry (7 votes)	In the Children's Peatland section
Photographs (n=74)	
Boletus (25 votes)	As a Virtual Postcard
Pine (20 votes)	As a Virtual Postcard
Pond landscape (19 votes)	As a Virtual Postcard
+ 71 other photos (20 of which received votes, from 9 to 1 votes each)	-
Others	
Info texts (n=13)	(Used as background material for quizzes; One text in the Children's Peatland section)
Story about an elk	-
Elk's perspective video (n=1)	-

The table illustrates that the different types of creations were widely present in the Virtual Peatland environment. As to puzzles and video clips, two types of quizzes and one video presentation were not represented on the site. Out of the photographs, the three pictures voted by the class as their favourite ones were included in the Virtual Postcard section, as had been agreed with the children. The video presentations were voted about as well, but instead of putting only three most voted videos, all but one were incorporated into the Children's

Peatland section. The one that was not included was left out for reasons related to technical quality.

The role of the information texts – except for one which was placed as an introductory text for a crane-related quiz – was to be used indirectly as source material for the creation of the puzzles, not to be included on the site as such. As discussed above, content creation (and the fact that the contents are concretely on the website for everyone to see) was a very important element of the project for the children and, for many of them, the principal activity through which their contribution showed to them. However, despite including different types of material very widely, there was only one quiz of each kind representing that particular type of quizzes, which is likely to be one factor diminishing the children's experience of their ideas being directly manifest in the outcome.

Meeting the Children's Expectations

Finally, it will be discussed whether the final outcome met the expectations of the children who were involved in the project. In the final questionnaire, the children were presented a statement related to whether the application was what they thought it would be like. The results are presented in Figure 50.

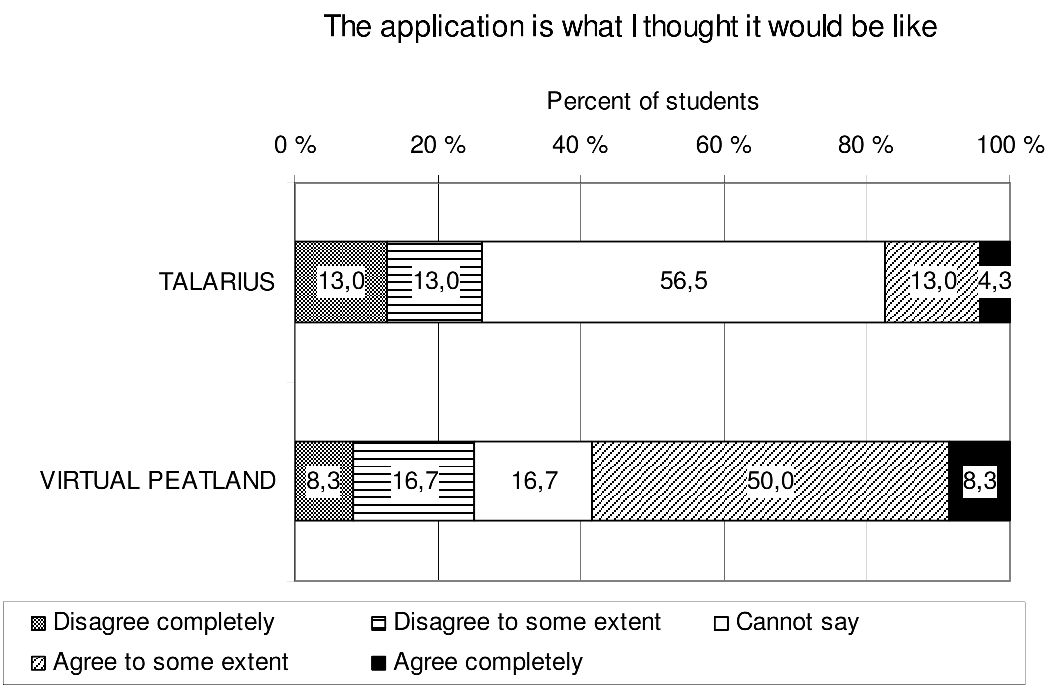

FIGURE 50 Children's views on the outcome meeting their expectations

As the figure shows, slightly more than half of the students (seven out of 12) felt that the website met their expectations at least to some extent. Only one child thought that it was exactly like expected, but for many children, it somewhat was: they were rather satisfied with it but would have wanted it to include even more interactive things to do. Some of the children also pointed out that not all of the creations of the class were included in the Virtual Peatland environment (as seen above).

Interviewer:	If you think about what Virtual Peatland is like now, so how well does it match with the thoughts that you had then, before this project started, about what a virtual peatland website could be like, so is it like you imagined or is it different in some way?
Student 1:	Pretty much the same.
Student 2:	Mm. Well, of course there's always something a bit different.
Student 3:	Mm.
Interviewer:	What else could it include, so that it would be even better like you thought that it would be?
Student 2:	There could be a little different… a little more versatile questions and tasks... especially those active ones.
Interviewer:	Ah, right, in the game.

However, some of the children reported being positively surprised with the versatility of the Virtual Peatland environment and the amount of content it included. Moreover, one child also brought up that, to a large extent, the topic as such defined what the website was like. As it was Virtual *Peatland*, its information and contents were inevitably closely related and defined by the topic area, i.e. peatlands, and therefore it was largely as expected.

> I think it became better than I thought, I thought it would be just kind of quite… quite simple but it's pretty versatile after all.
>
> [It is quite similar because] you'd think that Virtual Peatland is related to peatlands and peatland animals and plants.

In comparison to the Talarius project, there were considerably more of those whose expectations the outcome did meet (Figure 50). However, there was no big difference in the percentage of those who felt it did not; in Talarius, more than half of the students could not say whether it did or did not meet their expectations, unlike in the Virtual Peatland project. It appears that it was easier for the children to some expectations regarding an application clearly related to a specific topic area than one with a more open-ended purpose of use.

5.2.7 Design Collaboration as a Learning Process

Finally, as the issue of learning from the design collaboration arose as an interesting issue in the Talarius project, I will have a look at this theme in some more detail in terms of how it manifested in the Virtual Peatland project. Druin (1999) presents different areas of "design-centered learning" that have been self-reported by the participants in her studies. This, together with some learning-related points discovered in the Talarius project, triggered me to include a question related to learning in the questionnaires the children answered after each Virtual Peatland design session. The question prompted them to reflect on what kinds of things they had learned from the particular session. Learning was also addressed in the final interviews. In the Virtual

Peatland project, the perspective of learning was in an especially important role because the project was rather intensive in terms of the time used for the participation by the partner class, and therefore it was essential for the project to serve as a learning opportunity for the participants.

The learning areas that Druin (1999) discovered include, firstly, learning about the design process; secondly, respect for the design partners; third, group communication and collaboration; fourth, new skills and knowledge related to technology in general; and finally, content issues. The categories that were discovered in the Virtual Peatland project were similar to these to a large extent: the four areas of learning that emerged can be categorized into content-related issues, design skills, social skills, and learning skills. The emphasis of each area varied from one phase to another, according to the types of activities entailed in the main task of a specific session. For example, working in a group was emphasized in the collage creation, whereas skills related to searching for information were essential the making of information texts and quizzes (e.g. working in a group, searching for information, etc.). The learning-related questions that were asked from the children were open-ended with no pre-assigned categories of learning, and they were analyzed in a data-driven way. Hence, e.g. the categories presented by Druin (1999) did not determine from which perspectives the issue was examined; instead, the themes that were identified emerged fully from the children's answers. In the following, each of the four categories of learning that were discovered is discussed in turn.

First of all, as the project was closely linked to a specific content area (unlike the Talarius project, for example), content-related learning was reported by the children at several occasions during the project. They felt that they had learned general knowledge related to peatlands, and especially facts about the species of animals and plants that are characteristic of peatland nature. These facts included knowledge on topics such as what a particular plant or animal species looks like, in what kinds of circumstances a specific plant grows or an animal lives, which plant family a specific species belongs to, and in what ways different plants can be utilized. In addition to the factual issues, the children also reported learning some "meta-knowledge" about peatlands, such as how versatile a theme peatlands are and how the theme can be approached. In other words, the project enhanced some children's understanding of the fact that peatlands are not only a biology-related topic. It includes many other aspects as well, such as a cultural perspective, and peatland-related things can be studied in various different school subjects.

Interviewer:	Then, what about learning… Do you reckon you learned something during this project?
Student 1:	Well, yeah, we learned something from it, yeah.
Student 2:	Yeah, something.
Interviewer:	What did you learn?
Student 1:	Well, more about peatlands, things like… what there is there and what you can do there…
Student 2:	Yeah, and what plants there are and what animals there are and…
Student 1:	Mm.
Student 3:	And what you can use those plants for.

> I learned some animals that live on peatlands. And that nightjar is the official animal/bird of the National Park.
>
> I know where cranes winter, and that cottongrass belongs to the sedge family. And cottongrass grows in tufts.
>
> [I learned that] marsh tea is venomous. The Swedish name of otter is Utter. Maybe something else too.
>
> Peatlands can be studied in many ways. Peatlands can be studied in many school subjects.

Skills related to the design tasks were another essential learning topic. These can be categorized into general design skills and skills related to specific design areas such as planning a game idea. An example of the first category is the way of carrying out tasks: the project activities taught some children to work more methodically and effectively. As regards the latter category, there were new methods for doing different things. The children became familiar, for example, with collages and idea maps which might have been familiar to them already from other contexts, but now they were used in different ways and to accomplish different goals.

> I learned how to work together, how to make a website and how to work gradually.
>
> I have learned to do tasks a lot faster and more effectively.
>
> [I learned] new ways to do group work.
>
> [I have learned] how to develop characters and quizzes.

Social skills were an essential issue as many of the design sessions entailed team work, in groups of different sizes. Sometimes the children worked in pairs or small groups (e.g. quizzes and information texts), sometimes in larger groups (e.g. collages and game drawing), and sometimes the whole class was expected to work together as one group (e.g. the final phase of the idea map creation). There were also different contexts for voicing opinions or presenting some outcomes to an audience; individually as a member of the whole-class group (e.g. building the idea map) or as a member of a small group (e.g. presenting the collages and recording video presentations). Apart from expressing one’s opinion, the presentations and discussions entailed listening to and building on others’ ideas and opinions.

> I learned to listen well and I came up with quite a lot of ideas.
>
> I learned group work. Something about peatlands, and not to be nervous during presentations.
>
> [I learned] that it’s fun to do things in groups, and that you learn and get more [out] of everything.

Finally, the participation also promoted general learning skills. In the compilation of the information texts and quizzes, as well as in the preparing of the video presentations, searching for information was in a crucial role. The children used Internet search engines and books to find facts and formulated coherent presentation texts of their topics. While doing this, they had to compare information found in different sources and assess its reliability. Moreover, they reported learning to express things better in writing by crafting the texts.

> [I learned] that there are a lot of things with the aid of which you can find information about something and that you can find a lot of information also on the Internet through search engines.

> I can maybe make better texts now and I have learned to search for information too.

> [I have learned] that it's fun to do it and you get to do all kinds of things, like search for information and write.

The learning point of view was strong throughout the project. As pointed out in the subsection related to context, the aim was to integrate the sessions to different school subjects as well as possible. Even though this did not work in the best possible way, learning played a major role in all the activities. At one point of the project, the teacher of the class pointed out that the participation in the project had been a valuable learning opportunity for the children but was worried whether the value of the collaboration was reciprocal in that the students' contributions were useful in terms of the development of Virtual Peatland.

> Also the teacher was uncertain about the successfulness of the participatory design. She was worried especially about whether the participation of the […] school serves the development of Virtual Peatland. According to her, the students learn a great deal during the process, but their 'contribution' to Virtual Peatland is not necessarily as hoped for. (Project coordinator / educational specialist and HCI specialist in the field journal)

5.2.8 Conclusions and Inferences from the Virtual Peatland Project

The results from the Virtual Peatland project showed that the project succeeded in some aspects better than the Talarius project, but some of the same problems manifested in this project as well. In the following, I will briefly summarize the results.

In terms of participation methods, the two most significant differences in comparison with the Talarius project were, firstly, the inclusion of content creation in the project, and secondly, an attempt to build a gradual idea generation and elaboration process at the beginning of the project, from the idea maps through the collages and the evaluation of existing learning environments to the making of the quizzes and video presentations. As regards the latter point, the idea maps elicited general-level thoughts on what the environment could entail. These ideas were then taken onto a more detailed level with the aid of the collages and the evaluation of the existing websites. Finally the children concretized the ideas by creating quizzes and preparing video clips based on the species and presentation forms they considered the most interesting.

This leads us to the former of the points mentioned above, namely content creation. While e.g. drawings, news stories, and photo or video diaries have been used in many projects to collect requirements, such methods have not been used with the aim of content creation during a design project. Instead, content creation has been something that happens when such an application that enables the creation and sharing of content is already in *use*. As there have been problems with children seeing their contributions, this project was carried out with the intention of enabling them to create something that they will directly see in the final outcome and that will thereby enhance their ownership of it. The content creation aspect proved to be important for the children. For many children, the tasks related to the making of the content items were the most enjoyable, motivating and memorable activities in the project.

However, the Virtual Peatland project did not completely succeed in avoiding the same "black box" phenomenon as there was in the Talarius project. With the black box I refer to a phase in the project when the users' participation becomes more distanced from the actual development, and once they see the outcome, they no longer recognize their ideas in it. In this project, this happened during the game design phase. It was mainly due to inadequacies of coordination within the research and development group. On the one hand, game design and subject area expertise were not sufficiently present in the planning of the participation methods and their outcomes in order to ensure that the material fits the needs of these fields. On the other hand, the game idea drawing and the other game-related materials created by the children were, for a large part, left aside in the game project. The problem was further intensified by some fundamental personnel changes that happened at this phase and complicated the communication of the children's ideas to the game development group. Moreover, the active development of the game took place mainly during the summer months, due to which the outcome was not continually evaluated with the partner class.

Finally, the issue of learning from participation in a design project – which emerged as an especially interesting issue in the course of the Talarius project – was paid more attention when studying this project. Design project participation proved promising from the perspective of learning, in the sense that it furthered many essential skills and integrated the learning of these skills in a context that dealt with a relevant, concrete real-life goal (i.e. a learning environment for everybody to use).

Along with other principal issues emerged from the two projects, the aforementioned matters, their implications, and potential solutions will be further discussed in the next, final chapter of the thesis.

6 DISCUSSION

This study has dealt with the involvement of children in the design of technology-based learning environments. The study focused specifically in the design processes of two game-based learning environments. The projects, Talarius and Virtual Peatland, were studied with the aid of the development research approach (Richey et al. 2004; van den Akker 1999), with the aim of providing a broad view on the children's participation from several perspectives. Firstly, the children's own experiences have been addressed; secondly, the developers' views on the issues related to the children's participation have been studied; and third, the outcomes of the projects have been analyzed in order to examine how the children's contribution manifested in them. An important theme in the study was the broadening of the scope of children's involvement in technology design from a basic HCI-focused view towards a more multidisciplinary direction by including the areas of child-centred pedagogy, childhood sociology, and user-created content in it

The conceptual framework used in the studying of the two development projects divided the issues to be addressed into those related to the *process* and those related to the *goals* of user involvement. These issues were studied in each of the two projects. In terms of the process, it was examined how the participation of the users was carried out and how the methods entailed in the process were experienced by the participants – the children and developers alike. As regards the goals of participation, it was analyzed how each of them was realized in the projects.

In this chapter, the results of the study will be summarized and discussed (Section 6.1), and their implications (Section 6.2) as well as their application in schools (Section 6.3) will be considered. The study is also evaluated (Section 6.4), and finally, some areas requiring further research are discussed (Section 6.5).

6.1 A Summary of the Main Results

Below, the results of the study are summarized and discussed. The aim of this summary is to return to have a look at the results in light of the conceptual framework of the study (Figure 4) and the research themes and questions that were derived from it (Table 1). First, the results related to the process of user involvement are discussed. The second subsection focuses on the results that are principally related to achieving the goals of user involvement. It should be noted that there is some overlap between these points of view, as they are closely intertwined with one another. Finally, the third subsection takes a look at the results of the study from the perspective of learning, a point of view which emerged as a crucial aspect of involvement in the course of the study.

6.1.1 Results from the Perspective of the Process of User Involvement

This subsection discusses the results of the study from the point of view of the process of user involvement. The themes addressed below include the structure of the process and the methods used in the projects (research question Q1) as well as the issues that are related to the organization of the design collaboration (Q2).

On a general level, an important aspect of this study was the cyclical nature of the whole research and development process; the results obtained from the first project informed the planning of the latter project in terms of **the process and the methods used** (Q1). Firstly, *the framework serving as the basis was extended* into a more multidisciplinary form after discovering inadequacies in the Talarius project. The principal challenge in the first project was related to the extent to which the children felt that they had been able to influence the outcome: the evolution of the application from initial ideas to the final implementation remained a "black box", not transparent enough for the children to recognize their contribution. Consequently, issues that were seen as potential factors leading to this problem were addressed in different ways in the Virtual Peatland project. Principally, this meant two major adjustments to the process and methods. The first enhancement was the inclusion of content creation as a completely new category of participation activities. Secondly, the whole process was designed in such a way that it proceeded more gradually, in order to enhance the transparency of the process.

Content creation activities – which entailed making quizzes, pictures, and video presentations – ensured that there were concrete examples of the children's creations on the website, and that each child's contribution showed to him/her. The background for this addition lies, on the one hand, in the broadened multidisciplinary framework which entails approaches such as participatory gaming culture and child-centred pedagogy which emphasize, respectively, users' role as active content creators and children's contribution to planning their own ways of learning. On the other hand, it is based on practical observations made in the course of the Talarius project: while testing the

Talarius application, some of the children pointed out being thrilled to see their own questions and materials as pilot contents within the game.

As the importance of content creation exemplifies, the results from the projects examined in this study suggested that it is crucial for the children to see their influence tangibly and specifically in the outcome. The participation methods of more abstract and general nature were seen as somewhat less important by the children – especially from the point of view of how they "got their ideas through" in these activities. However, for the developers it has turned out to be especially important to obtain a great deal of *material of varying types and levels of abstraction*, in order to be able to draw ideas out of the materials and to use them as sources of inspiration. This process, however, can be very indirect and invisible to the children, and ideas born during it cannot necessarily be straightforwardly traced back to the source material – which leads to such problems with the feeling of contribution as these projects revealed.

The need to carry out hands-on activities in order to make the abstract design task more concrete has been frequently brought up in research; such tasks include e.g. creating drawings or low-tech prototypes, making collages, or taking photographs to serve as background material for the definition of requirements (e.g. Bekker et al. 2003; Bilal 2003; Druin 1999, 2002; Verhaegh et al. 2006). In this study, drawings were successful in that they were very rich in the data they provided (as shown by their analysis), that they could be used by the developers as a source of inspiration throughout the project, and that the children enjoyed drawing as a design activity. However, the drawings remained in a somewhat peripheral role despite yielding many ideas of a general nature to the developers. This highlights the need to develop effective ways for analyzing such materials: there is a need for *a quick yet more systematic way for analyzing complex creations such as drawings*. Moreover, it is essential that *the analysis be conducted and its results be reviewed more closely together with the children*. It was at this point when the children lost the connection between their ideas and the product in the Talarius project, and in order to avoid the "black box" phenomenon – meaning that the children feel that their ideas transform into something very different while they are out of sight – the children should be more directly involved in the processing of the ideas and have the chance to comment on the developers' interpretations immediately. This aspect has especially been highlighted in such intensive processes as Druin's design partner approach (e.g. Druin et al. 1999; Knudtzon et al. 2003), and while the same level of intensiveness is challenging to achieve in school-based approaches, the experiences obtained from this study emphasize that it should be paid more attention in them as well.

Consequently, the other main change in the project process, informed by the Talarius project and put into practice in the Virtual Peatland project, was that both on the level of the whole process and on the level of individual sessions, there were efforts to make individual ideas and feedback opinions collective in such a way that the children would *see the progress of the ideas*. In practice, this took place through collaborative creation of idea maps and collective lists of ideas; through ensuring that the children saw each other's creations, and thereby were aware of what kinds of ideas others had come up with; through voting favourite items, such as photographs; through presenting the results of the analyses of the children's creations to them (e.g. the most frequent items in the collages); and through actively involving the children in the process of making a collective creation out of a large number of individual ideas (e.g. the collective game drawing and the initial idea map).

Even though the *process as a whole was planned as a more gradually proceeding continuum* than in the Talarius project, the "black box" problem emerged to some extent in the Virtual Peatland project as well. As regards the gradual idea map creation, for example, the process from individual ideas to a collective idea map was clear and smooth on the level of that single session, but the same graduality should be established on an inter-session level as well. The process from the initial idea map creation to collage creation, to learning environment evaluation, and further to content creation was built in such a way that each phase would logically continue from the previous one. This worked well until the point when the technical development of the Virtual Peatland environment began, at which time there was a discontinuation point.

The principal reasons for this problem boil down to the composition and organisation of the research/development group. Firstly, not all of the developers were committed to the idea of user involvement to the same extent, which led to the diminishing of the role of the children's contributions towards the end of the project. This was further amplified by critical personnel changes in the course of the project. Secondly, the user involvement process was for a large part planned and executed by such researchers who were not experts in the other relevant fields, namely game design and natural sciences. In order to plan the process in such a way that it would have better integrated the biological background, the game design principles, and the users' ideas alike, there would have been a need for *better coordination of all these multidisciplinary areas of expertise, including the users' perspective, already when the participation methods and themes were being planned*.

This issue brings us directly to another principal research question entailed in the category which deals with the process of user involvement, namely the issues related to the **organization, collaboration, and functioning of the design team** (Q2). Within this theme, *motivation* emerged as one of the main factors: an essential issue in the successfulness of children's involvement is whether they are genuinely motivated to participate. The interest toward a project and the motivation to be actively involved in it relies on several factors. Firstly, *being able to participate in a real project* which was not directly equivalent to any regular school activities was a major motivator in itself, and even more so when it dealt with technology design. Indeed, when it comes to the topic of the project, it was the *technology aspect* that was a more noticeable motivator than the subject matter. Hence the Talarius project – although it fared less well in terms of the feeling of contribution and ownership – was considered more interesting than the Virtual Peatland project, mainly due to its emphasis being more heavily on the design of the technological application as such and less on the subject matter (which divided opinions in the Virtual Peatland project, as some were very interested in the peatland issues and some not at all). Moreover, the sheer *possibility to be heard and to voice one's opinions* was a motivating aspect for many children.

The biggest threats to maintaining the children's motivation were the *problems with them seeing their own contribution* in the final outcomes. Even if the participation methods in themselves and the topic of the project as such were motivating and interesting to the children, their motivation suffered from not being able to identify clear links between their ideas and the final outcomes. Ways of addressing this problem have been discussed above: analyzing children's creations more intensively together with the children themselves, discussing in more detail the links between their ideas and the final outcomes, genuine commitment of the whole developer team to the involvement of users, and better integration of the users' point of view to the other perspectives such as educational background, game design principles, and subject area knowledge.

Moreover, the fact that children were involved in the project was a motivating factor for the developers. The direct feedback obtained from the children motivated the developers in their work, and seeing the application being used by the actual users in the course of the project added to the developers' impression of the significance of developing such applications for children in a user-centred way.

When it comes to the *role* of the children in the two projects examined in this study, it can be described as being located between the role of an informant and that of a design partner, in terms of the role taxonomy coined by Druin (2002). When comparing the two projects with each other in this respect, there are some differences. With regard to how the children themselves saw their roles, in the Talarius project they saw themselves principally as feedback providers (i.e. testers in Druin's (2002) terms) – a consistent consequence from the fact that the process was heavily based on the evaluation of prototypes. In the Virtual Peatland project, on the other hand, the children defined their role principally through the creation of contents of different types – which again suggests that the addition of content creation activities to the process was a significant aspect to the children.

As seen above, however, in both of the projects the actual development of the product was somewhat too distanced from the design activities carried out with the children. The problem of the diminishing of the children's role in the course of the projects, for the most part, came down to the organisation of the project. It appeared that establishing a common understanding about the roles of each participant or participant group, and committing to this decision, was rather difficult. Moreover, in the case of the Virtual Peatland project, personnel changes that came into play at a critical stage of the project (early in the development of the Peatland Adventure game) made it yet more difficult to share the understanding of the children's contributions. How can we address this problem? It is, of course, impossible to avoid personnel changes, unexpected changes in the project schedule for external reasons, or other unpredictable problems from happening, but the general framework for the principles of the project should be defined as clearly as possible, as early as possible. It is essential for all participants, the developers and the user participants alike, to commit to the project from the beginning. Therefore, the planning of how the participation will be carried out should start already when the project is being prepared, and the project plan should clearly state the principles of the user involvement and also the procedure of carrying out the process. This does not mean that each participant or participant group is given a specific, narrow role in which they are expected to stay throughout the project. Instead, the aim is that by so doing, both the school (or other stakeholder group) and the members of the developer group can already at that stage *get oriented to the close collaboration and commit to it*. When the integration of the different perspectives is done at such an early stage, it is easier to find the common ground within which to work, and advocating for the children's opinions and planning the ways of their participation are not the sole responsibility of a particular member of the group. Also, if these goals are contained already in the project funding application, it encourages the participants' commitment to them.

6.1.2 Results from the Perspective of the Goals of User Involvement

In this subsection, the results are looked at from the point of view of to what extent the goals of user involvement were achieved in the projects examined in the study. In the conceptual framework of the study, the goals were defined as being related, to bringing the users' expertise into the process (research question Q3); to addressing the needs stemming from the real use context (Q4); to empowering the users, allowing them to have a say, and supporting their feeling of contributing to the outcome (Q5); and to enhancing the quality and viability of the application in real use (Q6).

An important goal of user involvement is the benefit it brings to the development of the application in the form of providing ideas based on the **users' expertise** (Q3). In the projects examined in this study, several areas into which the developers sought the users' expertise were identified, including usability, the appearance and functionality of the application, ways of using the application, the learning effects, and the concrete contents included in the final outcome. An important notion is that while in the Talarius project the goals were rather strongly focused on issues related to usability and the functions of the software, the Virtual Peatland project put more emphasis on incorporating the users' expertise into the creation of content. The shift of emphasis is reflected in the participants' own perceptions of the role of their expertise as well; as brought up above, in the first project the children saw themselves mainly as feedback providers, while in the latter project the activities that were related to making concrete contents to be included in the application were what mostly defined their role in their own eyes. Therefore, the *versatility of the ways of participation and the aspects to which to contribute* plays a crucial role not only in terms of the developers getting adequately diverse material to support their work but also in terms of the children feeling that their expertise has been valuable on many levels.

In terms of being able to address the **real use context** (Q4), the fact that the sessions were carried out in the *actual school environment* was in a crucial role. The real environment provided information principally on issues related to the suitability of the applications for everyday school use and ways of using them in school contexts, but also on technological considerations such as aspects on which user rights restrictions on school computers might have an effect. On another dimension, there were attempts in each project to *integrate the participation process itself into the school work* of the participating class so that it would support rather than disturb the daily school work – in a similar vein as what Rode et al. (2003) are aiming for with their curriculum-focused design approach yet not quite as rigorously. In this case, the correspondence to curriculum and lesson plans manifested most clearly in terms of taking into account the teachers' wishes regarding the structure of the process and providing the children with cross-curricular tasks that offered them valuable learning experiences to draw upon in many school subjects also after the projects.

Participation is also a value in itself, and it is seen as a goal of user involvement in its own right (e.g. Damodaran 1996; Gould & Lewis 1985; Kujala 2003; Gulliksen et al. 2003; ISO 13407, 1999). **Empowerment** (Q5) is closely tied to the sense of ownership, in other words, to what extent the users distinguish their contribution in the product (Cherry & Macredie 1999). As seen above, this aspect was challenging in both of the projects; in Talarius there were problems that manifested throughout the project, and in Virtual Peatland they culminated in the rather fundamental changes that were made to the game idea in the course of the project in order to create a sounder biological basis and a fitting background story to the game. However, the results indicated that the Virtual Peatland project was somewhat more successful in terms of the feeling of influencing the development than the Talarius project, mainly due to the content creation activities included in the project. I will discuss this in more detail below.

In the Talarius project, although the children did feel that they had been able to be active participants in the project, they could not really see how they had contributed to the outcome. Naturally, the goal of user involvement is not to include each and every idea and feedback comment in the product, but the ability to feel empowered depends on whether the users experience that they have had a say and been able to influence what the outcome will be like. As already mentioned in the discussion of the results related to the participation process and methods, there were several potential reasons for the children's ideas not being seen in Talarius. Firstly, *most of the activities were carried out either individually or in pairs*, which led to the children not knowing what others had suggested and thereby not having a comprehensive idea of the views of the class. Secondly, as discussed above, the children's drawings, interviews, feedback etc. were *not analyzed sufficiently closely together with the children themselves*, and neither were the outcomes of the analyses conducted by the developers adequately communicated to and discussed with the children. This also contributed to them not having a broader view on their collective ideas. Thirdly, it was *not explicitly discussed with the children,* for example in the evaluation sessions, *how they linked their ideas to the outcomes*. Finally, it was especially difficult for the children to see the drawings as a useful participation activity; they were able to see the effect of some of their feedback they gave in the evaluation sessions, but *the more abstract ways of participation* (i.e. the drawings, the existing board games, and the interviews that accompanied the drawings) *remained very remote and vague to them*. In the Virtual Peatland project, on the other hand, the results indicated that the children were able to see their influence better than in the Talarius project, despite the problems related to the changing of the game idea. Similarly as in the Talarius project, the children felt that they had been able to participate actively, and in terms of the visibility of their ideas to the children themselves, Virtual Peatland succeeded better. The creation of contents seemed to play an important role in the children's feeling of influencing the outcome. Through these very *concrete creations and their being straightforwardly present in the final outcome*, the children saw more clearly that their participation yielded something that furthered the contents of the application.

Finally, questions related to the **quality and viability of the applications** (Q6) were addressed. The field trials conducted after the projects revealed information on the viability of the applications in real use, and the children who participated in the projects were asked for feedback whether the final outcome met their expectations. The children did not find it easy to estimate whether their expectations were met; this was the case especially with the Talarius application regarding which it was not as straightforward to set expectations because of its nature (a game-making application, as opposed to a ready-made game). As seen above, there was dissatisfaction with the visibility of their ideas in the outcome, something which was improved in the Virtual Peatland environment. In the case of both of the projects, the children's expectations about the basic idea of the product were met. As regards how the applications worked in real use in actual contexts, the field trials yielded principally very positive experiences and valuable information to guide the further development of the application. Below I will briefly discuss the implications on the subsequent development of the applications.

In the *Virtual Peatland* project, there has not been any further development so far after the development project, but several of the children's ideas and the issues observed during the process were included in the directions of future development. Most importantly, the implementation of a game that would be directly based on the children's game drawing has been noted as a focus of future development, as a part of the Children's Peatland section.

The *Talarius* application, on the contrary, has seen several development phases after the pilot version. In the first phase, its usability and technical reliability were improved. The children's feedback and the observations made in the evaluation sessions and field trials played a crucial role as a basis of this work. Moreover, in this version, functionalities supporting the use of the application with younger children, based on the kindergarten field trials, were implemented. As the pilot version only allowed one picture, sound clip, or video clip to be added to each question, based on the kindergarten and school field trials the application was modified to allow a media file to be added to each alternative in a multiple choice question. Hence it enables, for example, multiple-choice questions in which there is a sound clip of a bird's twitter, and several alternative pictures of different birds, out of which the player must identify the one the chirping belongs to. Other features added based on the feedback obtained from the trials include e.g. the possibility to define the number of alternatives in multiple-choice questions, showing the result of the throw of the dice both with the pips of the dice and as a number, the possibility of moving the game token manually instead of it moving automatically according to the outcome of the throw, and adding picture-based icons to the function buttons.

The second phase was a development project in which the application was altered to enable online playing between multiple players. This version was further enriched with elements and functionalities that made it possible for the children to incorporate more game-like and story-like elements. The work was based, on a theoretical level, on the abstract structures of digital games and narrative theories (Nevala 2007). During the process of implementing these functions, the ideas and feedback provided by the children in the development of the pilot application were also linked with the planned new features: several issues suggested by the children were implemented in this version. Some of the most fundamental changes were the possibility to influence the rules of the game in different ways, such as by determining the length of the game and by defining whether the goal was to get to a certain place on the board or to gather the most points within a specific time; the possibility to create characters that have specific attributes as numerical values and thereby affect how the players can interact with one another in the game; and several special squares and events that can be added to the game board to bring excitement and variety into the games made with Talarius.

6.1.3 Learning from the Design Process

Although studying the potential learning effects of the participation in a design process was not a principal focus of this study, several interesting issues arose in the projects regarding this theme. Design collaboration as a learning process is an interesting topic for further research, and to lay groundwork for this, I will discuss the issue here.

Design process conducted in collaboration with users can be a mutual learning process where both the designers and users gain insight on each other's perspectives (e.g. Cherry & Macredie 1999). As discussed in the previous chapter, Druin (1999) has categorized the design-centred learning discovered in her design team into five areas: 1) learning about the design process, 2) learning respect for one's design partners, 3) learning to communicate and collaborate in a group, 4) learning new technology skills and knowledge, and 5) learning new content knowledge. These issues were self-reported both by children and the adults who have participated in Druin's intergenerational design teams (Druin 1999). Cherry and Macredie (1999) and Damodaran (1996) have pointed out similar issues as regards learning from design participation: design collaboration can help users develop an understanding about how technology design is carried out, familiarize them with the particular system and lead to a better understanding of it, and teach them about team work in general.

In this study, learning first came up as one interesting question in the Talarius project, as the developers emphasized it very heavily and it was brought up by some children as well. Therefore, it was brought under investigation in the Virtual Peatland project in some more detail. The need for addressing questions of learning became even more evident as the learning-from-participation perspective was strongly underlined by the teacher of the partner class. *Content area issues* had, naturally, a significant role in the Virtual Peatland project, as both the application being developed and the methods used in the participation process were closely related to the subject matter. On a more general level, three areas of learning were recognized: design, social, and learning skills. The *design skills* entailed more general design skills – such as more methodical ways of carrying out tasks – and more specific design skills, such as different planning and design methods (for instance, idea maps and collages). In terms of *social skills*, the children learned to voice their own opinions as well as to listen to and build upon ideas and opinions presented by others. Also, the contexts of social interaction varied: some tasks required collaboration with many other children, some required effective pair work, and in some the children needed to speak up in front of the whole class. The categories above entail much of the same issues as Druin's (1999) grouping. In addition to these, the design collaboration promoted the children's *general learning skills*, such as searching and evaluating information.

6.2 Implications of the Results: Guidelines for a School-Based Child-Driven Design Process

The previous section summarized the main findings of the study, and in this section I will focus on the implications of these issues in more detail. One of the main goals of the study was to create a comprehensive picture of the issues related to the participation of children in the design of game-based learning environments, especially in a school context. As seen above, the analysis of the two projects examined in this study revealed a great deal of interesting observations about both the successful aspects of the projects and the problems and challenges encountered in terms of user involvement. Based on these results, a set of guidelines has been compiled to summarize the aspects that succeeded well and to help with avoiding the issues that yielded problems. The guidelines for school-based child-driven design are presented in Table 21.

The guidelines have been categorized in three groups. Firstly, there are issues that are related to the successful use of different participation methods and activities in the process. Secondly, there are questions dealing with the organisation of the process on a more general level. Finally, on the broadest level, the categorization addresses issues related to the opportunities of conducting research together with schools. Below, I will discuss each of the categories in more detail.

TABLE 21 Guidelines for school-based child-driven design

Issues related to methods	1. Balance between different types of activities, on different dimensions: - General / Specific - Tangible / Non-tangible - Creative / Reactive 2. Collaborative elaboration - Ensuring link between children's ideas and their implementation, i.e. no "black box" 3. Quick yet systematic methods for analyzing creative contributions - From "ad hoc" use of materials to a more systematic way - Discussing "results with children 4. Inclusion of content creation - Children's visible contribution and ownership
Issues related to the organisation of the process of participation	1. Common ground in the multidisciplinary, multi-party cooperation - Establishing this already when planning the process 2. Ensuring the availability of all necessary expertise at all phases - Essential in maintaining the links between the children's ideas and the final outcome and to assure the viability of the participation activities 3. Bringing the school into a more prominent role - Defining the school's role already when planning the project
Issues related to research collaboration opportunities with schools in general	1. Resources for research collaboration between research institutes and schools - Supports also technology education 2. Making use of the Living Labs approach - Enables research collaboration on a larger scale

6.2.1 Method-related Issues

The first category deals with *method-related issues*. The study brought forward several issues related to participation methods and activities. Firstly, several different types of methods were used in the two projects, and the experiences obtained from them highlight the need for balancing between activities that are different on several dimensions. One dimension deals with the generality or specificity of the outcomes of the method. For example, the idea maps and drawings created in these projects, as well as many other early methods, are general by nature in that they often yield outcomes that require some interpretation, which may lead to problems with seeing links between these early ideas and the way they are implemented. The more specific methods included, firstly, evaluation which enabled the children to point out specific aspects of the prototypes that were problematic as well as to give more detailed and focused suggestions for improvements, and secondly, content creation in which the children produced specific items to be included in the final product.

Another, closely related dimension deals with the concreteness or abstractness of the method. Activities that allow the children to do something concrete such as draw what the application could look like, create content items of different kinds, or try out a prototype, are at the other end of this scale, while non-tangible idea creation methods ranging from interviews to different brainstorming activities such as idea maps, are at the other end. Hands-on activities were preferred by the children, and one can also believe that putting their thoughts in a concrete form allows the children to get a clearer picture of the goal of the project. The third dimension is the creative/reactive aspect, which is also closely linked with the previous ones. Naturally, evaluation methods normally fall into the "reactive" category whereas e.g. content creation and drawing are in the "creative" class. Similarly as in the "general" activities on the general/specific dimension, creative tasks provide a rich selection of outcomes. Moreover, being able to engage in activities in which they can use their creativity is important to the children. However, the division is not necessarily clear-cut in all cases. For example, evaluating existing applications to provide ideas for a new one can be seen as both reactive and creative; on the one hand, the children respond to existing solutions, but they also creatively apply ideas obtained from these in a different context.

Another point dealing with the participation methods is related to avoiding the problem with the children's feeling of a "black box" into which their ideas go, and then come out as something different, without them seeing this process or being able to participate in it. The collaborative elaboration of initial ideas into collective ones proved to be a problem in the two school-based projects. The need for discussing the children's ideas and their implementation was made prominent by the discovery that the children did not see the links between their ideas and the development outcomes. Guha et al. (2004; 2005) have discovered the same challenge with somewhat younger children, and developed a method for merging individual drawings gradually into a collective one. This study highlighted that there is a need for a way of "merging" ideas from one session to another also when each session consists of a different type of activity.

A somewhat related point is the need for more systematic ways of analyzing children's creative contributions such as drawings. In this study, it turned out that they were referred to in an ad hoc manner, without systematically going through the ideas presented in them. The problem boils down to limited time resources, for a large part, and therefore the analysis methods must be quick to use. This is one question in which we could turn to methods employed projects conducted within the realms of child-centred pedagogy and sociology. For instance, annotating children's drawings according to their instructions (Hart 1997, 162-163) can help the developers recognize the aspects which the children consider the most important in their own creations and prevent misinterpretations. According to Hart, this also helps the children feel that their ideas are being taken seriously. Moreover, the conclusions drawn from children's creations should be taken back to the children to be discussed together in order to eliminate misunderstandings.

Related to the two aforementioned points (i.e. avoiding the black box and carrying out collaborative analysis of ideas), a method worth taking into use in the creation of game ideas and concepts together with children is very rapid creation of simple prototypes or mock-ups that concretize ideas immediately. When a particular game idea is suggested in one session, a hands-on mock-up is created by the next session – or even on the spot, if possible – and demonstrated e.g. by simulating the functionality and user interactions with the Wizard-of-Oz technique (e.g. Kelley 1984). Such instant reacting to children's ideas makes the development of these ideas directly visible to them, promoting their ownership over them, and it is also likely to enhance their experience of their ideas being taken seriously and seen as valuable and worth implementing.

The fourth and final point in the method-related issues is related to one particular type of participation activities, namely content creation. It was taken as a part of the process in the Virtual Peatland project, and its significance to the children was great. It was interesting to see how much it mattered to the children to see their own contributions as such in the final outcome. The Virtual Peatland project fitted the content creation aspect well in that the general concept of the learning environment to be developed allowed many different types of elements to be included on the website, from video clips and photographs to puzzles and quizzes. However, it is possible to include a content creation aspect in projects related to other types of applications as well. In the Talarius project, for example, the children were delighted to see their own questions in the question set that was created by the partner class with the aim of functioning as pilot content in the evaluation sessions.

6.2.2 Organisation of the Process and the Design Group

Moving from participation methods onto a somewhat more general level, the second main category deals with issues related to the *organisation of the participation process and the design group*. Problems with multidisciplinary cooperation manifested in the projects that were examined in this study; specialists of different fields did not manage to coordinate their respective expertises adequately well. This is likely to have happened due to a failure to establish a common ground from where to start the process. The specialists – be they educational, HCI, content area, game design, or technological specialists – did not manage to form a collective understanding of the development process. In other words, despite respecting the others' views, they failed to genuinely see outside their own areas of expertise. This problem has been noted in earlier research as well: for example, Clement and Van den Besselaar (1993) as well as Gulliksen et al. (2003) emphasize that in order to establish genuine and successful collaboration, there needs to be a general attitude within the group that supports it. Hence, it is necessary to explicitly state the common principles already when the process is being planned, and to ensure that everyone is committed to them.

A related concern is whether all the necessary expertise is present at all phases of the process. To illustrate this with the Virtual Peatland project, the whole development group (especially the game development team) had not been established yet when the participation process with the children started. Those researchers who principally planned and participated in the activities with the children at the early stages of the project had little game design or content area expertise. Consultation was sought from external specialists, but as the game development project – in which content area and game expertise became in a greater role – started, it manifested that the material produced by the activities did not adequately fit the needs of these fields. Hence, in the game project the children were in a smaller role. To sum up, in order for the participation process and the outcomes it yields to integrate all the different perspectives (e.g. that of the users, that of game design principles, that of pedagogical background) in the best possible way, the input of the specialists of all these fields is needed when planning the process. Similarly, the users' expertise as well as user involvement expertise should still be present in the implementation phase to ensure that the users' ideas and feedback do not move from the foreground to the background.

Similarly, the school's commitment is crucial with regard to being able to carry out the participation process without having to be concerned e.g. about settling each participatory session separately, and also to enable a gradual and adequately intensive structure of participation, through which the children are better able to see and contribute to the development of their ideas. Moreover, as user-driven innovation has become a generally valued approach in technology design, having a coherent and extensive plan of user participation already in the project proposal can be of great value and constitute a significant benefit in the search for funding.

6.2.3 Collaboration Opportunities between Schools and Research Institutes

The school-related issues bring us to the final category in the table, namely the issues related to research collaboration opportunities between schools and universities on a more general level. Participating intensively in a research project requires a great deal of resources – especially time – from both parties. However, participation in development projects supports technology education and, as seen also in this study, serves as a learning opportunity on several levels. Still, participation is usually an extra activity which takes time from other activities. Thus there is a need for solutions for integrating participation opportunities more seamlessly into school work and for allocating more resources for research collaboration.

One promising key to this challenge is the Living Labs approach, which enables active user involvement on a large scale. Living Labs are "regional innovation environments focusing on user communities embedded within 'real life'", thereby providing a broad view on the human aspects of technology in real use, both for industry and public sector (Living Labs Roadmap Work Group 2007, 7). The Living Labs approach is constantly evolving. As regards the future of Living Labs, the need for setting up such Living Labs that focus on a specific domain or theme – such as e-health, mobility, or media – has been recognized (Living Labs Roadmap Workgroup 2007, 50). As the use of educational technologies is becoming more and more widespread, this domain is one area which calls for the Living Labs approach to support need-driven innovation in the school context on a larger scale.

6.3 Applying the Results in Schools

In this section, I will broaden the discussion towards the application of the results in the context of everyday school work. Continuing from the previous theme, I will discuss the implications of technology design projects for school work in general. Overall, what motivated the children to participate in the projects in this study was, for a part, being able to speak up in issues that were interesting to them, i.e. computer-related questions, and the fact that there was interest toward their opinions and views on things. However, currently the possibilities for children, and schools, to participate in real technology-related development projects are very limited. It was pointed out by the children and teachers alike that the participation was a valuable learning opportunity, and that not every school had a chance to be involved in something similar to what they had participated in. One question to consider would be, therefore, whether issues related to the design of technology could be in some way incorporated into school work.

In the current Finnish core national curriculum, technology education is included as one specific theme area ("Human and Technology"). The goal, according to the core national curriculum, is the following:

> Basic education must offer basic knowledge on technology, its development and effects, guide [the student] to rational choices and lead [the student] to consider technology-related ethical, moral, and equality-related questions. In education, the

> understanding of tools, equipment and machinery should be developed, and their use taught [to the students]. (Perusopetuksen opetussuunnitelman perusteet 2004, 42)

One of the more specific content themes in the curriculum, related to the Human and Technology area, is "the development of ideas, modelling [and] evaluation of technological ideas, and the life cycle of products" (Perusopetuksen opetussuunnitelman perusteet 2004, 43). Participation in a technology development project addresses this goal on a broad spectrum. Naturally, apart from special cases such as the projects addressed in this study, it is rarely possible to create new applications from scratch within the limits of current school resources, but it is well worth thinking about involving children in other types of technology-related planning and decision-making. Firstly, by using specific tools for creating technological applications, the children are able to both design and implement their creations. Such tools can be easy-to-use editing applications, such as Talarius (which was pointed out by a teacher to be suitably located in between ready-made edugames and basic authoring tools such as word processors), or tools which require more technical skills, such as simple programming tools for children. There is also an increasing amount of research on children as game creators (cf. e.g. Kafai 2006). Especially Neverwinter Nights, a toolset for creating 3D adventure games, has been popular in the creation of games with children and studies related to this (e.g. Robertson & Nicholson 2007; Steiner et al. 2006).

Secondly, the evaluation and decision-making related to technology used in schools is one area in which children can be heard. Involving children in the evaluation and choosing of learning environments or other technological tools to be used in class gives them a voice in the choice of technologies, offers them a chance to get familiar with new ways of learning with the aid of technology, and to assess these technologies critically. As seen in the projects addressed in this study, children have a great deal of insights as to how things could and should be, and readily take the chance to give feedback and suggestions. While using specific technological tools to create something new based on their ideas gives them a chance to act as designers and implementers themselves, evaluating and choosing between different existing technologies gives them something concrete to try and to base their feedback on, enabling them e.g. to pay attention also to very specific design or usability issues which play a crucial role in the experience of using a technological application. Moreover, by participating in the choosing of their learning tools they obtain an authentic possibility to have say in school decision-making on a very concrete level.

Finally, the motivating nature of content creation is worth mentioning in this context as well. Many teachers have already adopted techniques related to content creation into their teaching, in the form of e.g. website building projects. Solutions such as wikis, blogs, and other comparable tools for sharing and publishing contents are easily adoptable for classroom use in various contexts, providing the children a chance to have their creations digitally published. Another dimension to content creation are the aforementioned game creation toolsets, which enable the children to make games for others to play, and also to obtain feedback about what they have created.

The possibilities for children to be involved in creative use, design, and evaluation of technology – for example in the aforementioned ways – as part of everyday life are essential in terms of acquiring the skills needed in mastering new, trans-media literacy. One approach to defining this new literacy is "21st Century Literacy" which consists of four different areas of literacy: technology literacy, information literacy, media creativity, and social competence and responsibility (Bertelsmann Foundation & AOL Time Warner Foundation 2002, 4). Technology literacy refers to the ability to use the Internet or other new media for communication and accessing information, while information literacy is concerned with the gathering of information and critically evaluating it. Situating the information into a right context and assessing its quality and relevance are skills relevant for this type of literacy. (Ibid., 14) While these two literacies refer to the person as a *user* of information or technology, the third component addresses specifically the perspective of a content *creator*. Media creativity, i.e. the ability to produce and publish media content (either on a small scale or to worldwide audiences), is seen as an increasingly essential competence in many different contexts ranging from learning to work and to civic activities as a consequence of the growing of the user-created content phenomenon (ibid., 14). Finally, a point related to each of the aforementioned skills is the importance of social competence and responsibility. This refers to considering "the social consequences of an online publication and the responsibility vis-à-vis minors" (ibid., 14). The discussion on different new forms of literacy comprises an essential framework for considering the motivation for carrying out creative technology-related projects in schools.

6.4 Evaluation of the Study

This section deals with the evaluation of the study. First, the contributions of the study are discussed. The second subsection takes a look at the limitations and issues related to the research setting and methods as well as to the questions addressed by the study.

6.4.1 Contributions

The main contributions of the study are fourfold. Firstly, it provides a comprehensive account of the involvement of children in the development process of game-based learning environments in a school context. Although there is relatively much research in which new methods and practices for user involvement have been developed, research which addresses both the user participants' and the developers' experiences through regular data collection throughout a project as well as a systematic analysis of the concrete effects of the user involvement on the outcomes, in an attempt to create a thorough picture of such projects, has been scarce. Such experiences have been mostly by-products of studies principally focusing on other questions. The study brought forward many important and interesting issues related to carrying out design projects in collaboration with school children, including both successful and problematic aspects of the projects. These issues have been summarized and their implications discussed in the previous sections.

Secondly, the study expands the scope of children's involvement beyond mere technology design. There are fields in which children's active participation has been an issue of interest much before technology design (e.g. child-centred pedagogy and sociology), but these have not yet been addressed much in the technology design context. Learner-centred design and child-computer interaction have looked into e.g. developmental psychology and educational sciences to tailor technologies and participation methods to children, but they have not delved deeper in these fields than to the application of developmental theories. This study can be seen as an attempt to create a link between two very different approaches to children's participation: that of technology design on the one hand and that of active citizenship and child-centred pedagogy on the other. Moreover, the phenomenon of player-created content has been included in this extended framework, as it is closely related both to games and to users' active role in the use and design of technology. This broadened perspective yields new methods and practices for carrying out development projects with children, and it lends itself to be further developed and applied. One potential direction for this expansion could be educational philosophy and questions related to the essence of childhood and its manifestation in the context of involvement.

Third, the study provides new practices for involving children in the design of game-based learning environments as well as information about applying existing methods. In this study, the main focus has been on the addition of content creation as a part of the design process, derived from the broadened framework of user involvement. The integration of content creation activities in the Virtual Peatland project was based on both the concept of player-created content and child-centred pedagogy emphasizing children's participation in the planning of their ways of learning. One main problem related to children's involvement, recognized both in earlier research and in this study, is conveying to the participants a feeling of contributing and having a say. Especially this concern is addressed in the methods developed in this study. Based on the results obtained in the study, a set of guidelines for conducting child-driven school-based development projects was put together.

Finally, in order for the study to be of use as broadly as possible, the implications of the results are also discussed from the perspective of everyday school work. As pointed out by the children and the teachers whose classes participated in this study, the possibility to be involved in the projects provided a unique experience and a valuable learning opportunity. However, while it is true that not every school or a class has the chance to participate from start to finish in a project in which a technological application is developed, I believe the experiences obtained from this study can be applied in a variety of ways within the scope of daily school work as well.

6.4.2 Limitations and Issues Worth Noting

In order to gather authentic experiences from design participation with children, research needs to be carried out in conjunction with one or several actual development projects. Therefore, the potential alternative research approaches for this study entailed especially case study, action research and design-based research. An approach that was principally design-based but included elements from each of the aforementioned strategies was used in this study. The study was conducted in a multidisciplinary research group that has adopted development research – which is a research approach generally used in studies of educational interventions, to study the intervention and/or its development process (Richey et al. 2004; van den Akker 1999) – as its collective principal research approach, and therefore development research was chosen as the main research approach to be used in this study as well. As development research addresses both the product and the process and has goals on two levels – more specific ones that are related to the particular case being studied and more general ones that aim to provide principles for broader use (van den Akker 1999) – it was seen as well suited to the needs of this study. Principally, however, the focus of this study was on the more general, process-related issues.

The structure of development research was reflected in the data collection and analysis as well. During each project, preliminary analyses were conducted in order to inform the process while it was still ongoing and to introduce potential immediate changes or additions to it. More thorough analyses of the data gathered during the processes were conducted after the projects. The data gathering methods used in the study represented the three main strategies of qualitative data gathering: enquiring, experiencing, and examining, i.e. interviews (and questionnaires), observations, and documents (Patton 2002, 4; Wolcott 1992). Data was gathered from three perspectives: the developers, the children, and the applications developed. The final questionnaires administered to the children after the projects included Likert-scale statements which yielded simple numerical data as well, but principally the data gathered were qualitative. The final questionnaires entailed identical statements and questions for the participants in both projects, in order to allow a certain extent of comparing between the two cases.

The main benefits of the qualitative and case-based nature of the study are related to the richness of data and the intensiveness of the research process. Being involved in the projects enabled me to observe issues that would not necessarily have arisen otherwise, and led me to look into them in more detail. However, looking critically at my role, I could have been involved in the projects even more closely than I was. Thereby I could potentially have recognized sooner the problems that were encountered in both projects regarding the gap between the children's ideas and the developers' creations and been able to try to avoid and diminish them by reacting to them already at an earlier time.

As data were gathered from different participants (children, developers, researcher's own observations) and in different forms (documents, interviews and questionnaires, products and design session outcomes), a multifaceted general account of the proceedings of the projects could be formed. Qualitative, case-based approached bring about certain limitations as well. Firstly, a common concern in qualitative and case-based research is that generalizability is limited when the results are, firstly, interpretive, and secondly, based on a single case or few cases with a small number of participants. However, it has been argued that it is possible to generalize from a case to theory or principles, and further to other cases. Walsham (1995) points out that from a rich description of a case, it is possible to generalize to 1) concepts, 2) theory, 3) specific implications, and 4) rich insight. The results can further be applied to other cases. For this reason, I have aimed to provide as detailed descriptions of the cases as possible and, based on them, gathered a set of main conclusions in the form of guidelines for future projects. However, there is one particular issue related to generalization that needs to be brought up. Namely, both of the case projects in this study have been conducted within university research projects which have their own particular qualities and conditions (entailing both limiting and facilitating factors), and therefore all experiences obtained from them are not necessarily applicable to projects conducted e.g. in game development firms.

A related concern is the soundness of the conclusions drawn – in other words, whether the data are extensive enough and whether the interpretations based on the data are correctly made. In this study, as seen above, data were gathered comprehensively in many forms and from many perspectives, hence it can be said that the amount of data as such is adequate. Some issues related to data gathering methods need to be discussed here, however. A problem with the final interviews and questionnaires was that a very long time had passed since the earliest design sessions, and therefore the children did not remember much about them any longer. This was likely to lead to the most recent activities (mainly evaluation sessions) being mentioned more in their comments. The problem was recognized in the Talarius project, and due to this, in the Virtual Peatland project the collection of feedback was carried out differently. Instead of having only one feedback questionnaire at the end of the project, the children filled in a specific questionnaire immediately after each session to give their comments and feedback on said session.

Related to data gathering, the use of questionnaires instead of interviews needs also to be mentioned. Except for the final interview of the Virtual Peatland project, all inquiry data collected from the children were gathered with paper questionnaires. One problem related to this procedure is that the questionnaires do not allow follow-up questions in a similar way as oral interviews, and therefore they leave more room for the analyzer's interpretations – including potential misinterpretations. However, as data were being gathered throughout the project, potential unclear issues could be brought up later. Another problem with paper questionnaires is that answers are often quite short, and with interviews it could have been possible to get more detailed answers. Many children answered rather briefly in the interviews as well, however. Hence the difference between questionnaire and interview answers was not considerable. This suggests that it was somewhat difficult for the children to consider their participation on a "meta-level".

The organisation and coordination of the development teams (and problems caused by these) have been mentioned in the results of the study as one crucial problem area in both of the development projects. It was a problem of the research process as well, because the research and the development were closely intertwined. As pointed out above, I was personally involved in the development projects (to some extent in the Talarius project, and very closely in the Virtual Peatland project), but I did not adequately succeed in building a collective understanding among the groups about the involvement and role of the children.

Another limitation is that the teachers' role, which emerged as an important issue in the course of the study, has only briefly been touched upon in the results. The question that arises is to what extent the results and the children's experiences from the participation were dependent on a specific teacher – in other words, how much they were affected by the role the teacher adopted in the process. As the teachers' role was not included as a specific research question and thereby not deliberately addressed in the course of the projects, the data cannot give a comprehensive and definite answer to the question about the effect of their role on the results. However, points that are related to the teachers' influence and contributions to the proceedings of the projects are mentioned in the result sections in order to bring the perspective of their participation forward as well.

Finally, I will briefly look back at the discussion related to ethical issues in Chapter 3. It was noted there that as the research and the development are intertwined, the results related to the children's experiences about their participation in the development also reflect their views on their participation in the study. As the results have indicated, the children generally enjoyed being involved in the projects. The process succeeded well in providing the children with new interesting experiences, which is valuable in itself. Many of them felt privileged by having the chance to take part in a project that entailed many such learning opportunities and activities that are available to few children in general. However, problems were encountered as regards the feeling of being able to influence the outcome, which in turn may have led to some children being frustrated and disappointed with the participation. Although these results are valuable in terms of future projects, their implications on these children must not be overlooked. In this respect, the research process was in an important role: through the interviews, informal discussions, and feedback questionnaires in the course of the project, they were able to make their opinions and experiences on the process known. Furthermore, in the development projects some children pointed out some of their ideas not being realized because their opinion happened to be in the minority. Thus, in the reporting of the research results I have tried to aim for a balance between presenting the results from the point of view of how the majority of the children felt about each issue (especially by presenting the results of the Likert-scale statements from the final questionnaires) and bringing up single participants' views in the form of the qualitative data gathered by interviews and open-ended questions, be they in accordance or conflicting with the opinion of the majority of the group.

6.5 Future Research

The final section deals with issues that arose as interesting questions for future research, especially those that were touched upon briefly in this study but would require more research in order for one to be able to draw more comprehensive conclusions on them. Firstly, continuing from the previous section, the teachers' role is an interesting question to be explored in future research. In general, the teacher perspective in design collaboration with children has not been studied much, although design projects carried out with children often take place in schools or kindergartens where teachers are in a key role. For example, Druin's acknowledged approach with children as design partners has been criticized for not adequately addressing teachers' roles in design (Pardo et al. 2005; Robertson 2002). The issue has been tackled by some researchers, such as Pardo et al. (2005) who have outlined seven different roles teachers can have in technology development projects: facilitator, tester, informant, research partner, translator, liaison, and helper. Out of these roles, almost all can be seen to have been present in the projects examined in this study. In the Talarius project, due to the less intensive structure of the process, the roles were somewhat narrower than in the Virtual Peatland project which featured almost all of the aforementioned roles. However, what this still does not tell is whether and how the teacher's role and his/her interactions and communication with the children in the design sessions influenced the children's experience on their own participation and roles in he project. Nevertheless, it would seem that a more versatile role of the teacher was an important factor and is worth addressing in more detail in future research.

Secondly, similarly as the teacher perspective, questions related to learning from designing were touched upon in this study but call for further research. There are some results related to the issue in the literature (e.g. Damodaran 1996; Druin 1999; Druin & Fast 2002), pointing out general areas of learning. However, what is of special interest – especially with the aim of making the results useful to as broad an audience as possible – is the integration of design projects to school work, and the learning opportunities related to this. The discussion on new literacies (e.g. Bertelsmann Foundation & AOL Time Warner Foundation 2002) provides an interesting background for approaching these questions.

Finally, as the results of the study generally indicate, there is a need to develop the child-focused school-based design approach further. The multidisciplinary framework and methods from the disciplines within its scope lend themselves to be creatively applied, adjusted, and further extended. Some challenges, such as the black box phenomenon, still require attention and creative solutions for finding ways around them. Some potential solutions are suggested in this study, and putting them into practice is the logical next step in this research process.

REFERENCES

Acuff, D.S. & Reiher, R.H. 1997. What kids buy and why: the psychology of marketing to kids. New York: The Free Press.

Andersen, K. 2002. Using drawing in designing educational software with children. Poster presented at the International workshop on Interaction design and children, Eindhoven, Netherlands.

Baauw, E. & Markopoulos, P. 2004. A comparison of think-aloud and post-task interview for usability testing with children. In Proceedings of the 2004 conference on Interaction design and children, College Park, Maryland, USA. New York: ACM, 115–116.

Barr, P., Noble, J. & Biddle, R. 2007. Video game values: human-computer interaction and games. Interacting with Computers 19 (2), 180-195.

Bekker, M., Beusmans, J., Keyson, D. & Lloyd, P. 2003. KidReporter: a user requirements gathering technique for designing with children. Interacting with Computers 15 (2), 187–202.

Bertelsmann Foundation & AOL Time Warner Foundation. 2002. White Paper: 21st Century Literacy in a Convergent Media World. Berlin, Germany. Available at http://sueculig.com/digital/web_design/21century/white/WhitePaperEnglish.pdf (Retrieved October 2008)

Bevan, N. & Curson, I. 1999. Planning and implementing user-centred design. In CHI '99 extended abstracts on Human factors in computing systems, Pittsburgh, Pennsylvania, USA. New York: ACM, 137–138.

Beyer, H. & Holtzblatt, K. 1999. Contextual design. interactions 6 (1), 32–42.

Bilal, D. 2003. Draw and tell: children as designers of web interfaces. In R.J. Todd (Ed.) Proceedings of the 66th annual meeting of the American Society for Information Science & Technology (ASIST 2003), Long Beach, CA, USA. Medford, NJ: Information Today, 135–141.

Blomberg, J., Giacomi, J., Mosher, A. & Swenton-Wall, P. 1993. Ethnographic field methods. In D. Schuler & A. Namioka (Eds.) Participatory design: principles and practices. Hillsdale, NJ: Lawrence Erlbaum, 123–155.

Blomberg, J.L. & Henderson, A. 1990. Reflections on participatory design: lessons from the Trillium experience. In J. C. Chew and J. Whiteside (Eds.) Proceedings of the SIGCHI conference on Human factors in computing systems, Seattle, Washington, USA. New York: ACM, 353–360.

Brandt, E. & Grunnet, C. 2000. Evoking the future: drama and props in user centered design. In T. Cherkasky, J. Greenbaum, P. Mambrey & J. K. Pors (Eds.) Proceedings of the Participatory design conference, New York, NY, USA. Palo Alto: CPSR, 11–20.

Brandt, E. & Messeter, J. 2004. Facilitating collaboration through design games. In Proceedings of the Eighth Conference on Participatory Design, Toronto, Canada. New York: ACM, 121–131.

Bruckman, A. & Bandlow, A. 2003. HCI for kids. In J. Jacko & A. Sears (Eds.) The human-computer interaction handbook: Fundamentals, evolving

Technologies, and emerging applications. Mahwah: Lawrence Erlbaum, 428–440.

Buur, J. & Bagger, K. 1999. Replacing usability testing with user dialogue. Communications of the ACM 42 (5), 63–66.

Bødker, S. 2000. Scenarios in user-centred design – setting the stage for reflection and action. Interacting with Computers 13 (1), 61–75.

Bødker, S., Grønbæk, K. & Kyng, M. 1993. Cooperative design: techniques and experiences from the Scandinavian scene. In D. Schuler & A. Namioka (Eds.) Participatory design: principles and practices. Hillsdale, NJ: Lawrence Erlbaum, 157–175.

Charles, D., McNeill, M., McAlister, M., Black, M., Moore, A., Stringer, K., Kücklich, J. & Kerr, A. 2005. Player-centred game design: player modelling and adaptive digital games. In de Castell S. & Jenson J. (Eds.) Changing Views: Worlds in Play - Selected Papers of the 2005 Digital Games Research Association's Second International Conference. Vancouver: Digital Games Research Association & Simon Fraser University, 285-298.

Cherry, C. & Macredie, R.D. 1999. The importance of context in information system design: an assessment of participatory design. Requirements Engineering 4 (2), 103–114.

Christians, C.G. 2000. Ethics and politics in qualitative research. In N.K. Denzin & Y.S. Lincoln (Eds.) Handbook of qualitative research (2nd ed.). Thousand Oaks: Sage, 133-155.

Chung, S. & Walsh, D.J. 2000. Unpacking child-centredness: a history of meanings. Journal of Curriculum Studies 32 (2), 215–234.

Clark, A. 2005. Listening to and involving young children: a review of research and practice. Early Child Development and Care 175 (6), 489–505.

Clark, A. & Moss, P. 2001. Listening to young children: the Mosaic approach. London: National Children's Bureau.

Clark, D. 1995. Introduction to instructional system design. ISD handbook. Available at http://www.nwlink.com/~donclark/hrd/sat1.html (retrieved January 2007).

Clement, A. & Van den Besselaar, P. 1993. A retrospective look at PD projects. Communications of the ACM 36 (4), 29–37.

Crabtree, A. 1998. Ethnography in participatory design. In R. Chatfield, S. Kuhn & M. Muller (Eds.) Proceedings of the 1998 Participatory Design Conference, Seattle, Washington, USA, Palo Alto: CPSR, 93–105.

Damodaran, L. 1996. User involvement in the systems design process – a practical guide for users. Behaviour & Information Technology 15 (6), 363–377.

Design-Based Research Collective. 2003. Design-based research: an emerging paradigm for educational inquiry. Educational Researcher 32 (1), 5–8.

Dindler, C., Eriksson, E., Iversen, O.S., Lykke-Olesen, A. & Ludvigssen, M. 2005. Mission from Mars – a method for exploring user requirements from children in narrative space. In Proceedings of the 2005 conference on Interaction design and children, Boulder, Colorado, USA. New York: ACM, 40–47.

Donker, A. & Markopoulos, P. 2001. Assessing the effectiveness of usability evaluation methods for children. In N. Avouris & N. Fakotakis (Eds.) Advances in human-computer interaction I (Proceedings of the Panhellenic Conference with International Participation in Human-Computer Interaction 2001). Patras: Typorama Publications, 409–410.

Downes, T. 1999. Children's participation in evaluating the role of new communication and information technologies in schools. Education and Information Technologies 4 (3), 331–341.

Dray, S., Siegel, D., Feldman, E. & Potenza, M. 2002. Why do version 1.0 and not release it? Conducting field trials of the Tablet PC. interactions 9 (2), 11–16.

Druin, A. 1999. Cooperative inquiry: developing new technologies for children with children. In Proceedings of the SIGCHI conference on Human factors in computing systems, Pittsburgh, Pennsylvania, USA. New York: ACM, 592–599.

Druin, A. 2002. The role of children in the design of new technology. Behaviour & Information Technology 21 (1), 1–25.

Druin, A., Bederson, B., Boltman, A., Miura, A., Knotts-Callahan, D. & Platt, M. 1999. Children as our technology design partners. In A. Druin (Ed.) The design of children's technology. San Francisco: Morgan Kaufmann, 51–72.

Druin, A. & Fast, C. 2002. The child as learner, critic, inventor, and technology design partner: an analysis of three years of Swedish student journals. International Journal of Technology and Design Education 12 (3), 189–213.

Ehn, P. & Kyng, M. 1991. Cardboard computers: mocking-it-up or hands-on the future. In J. Greenbaum & M. Kyng (Eds.) Design at work. Hillsdale, NJ: Lawrence Erlbaum, 169–195.

Ehn, P. & Sjögren D. 1991. From system descriptions to scripts for action. In J. Greenbaum & M. Kyng (Eds.) Design at work. Hillsdale, NJ: Lawrence Erlbaum, 241–268.

Ermi, L. & Mäyrä, F. 2005. Player-centred game design: experiences in using scenario study to inform mobile game design. Game Studies 5 (1). Available at http://gamestudies.org/0501/ermi_mayra/ (retrieved December 2006).

Fielding, N. 1995. Qualitative interviewing. In N. Gilbert (Ed.) Researching social life. London: Sage, 135–153.

Fleer, M. 2003. Early childhood education as an evolving 'community of practice' or as live 'social reproduction': researching the 'taken-for-granted'. Contemporary Issues in Early Childhood 4 (1), 64–79.

Francis, M. & Lorenzo, R. 2002. Seven realms of children's participation. Journal of Environmental Psychology 22 (1-2), 157–169.

Gallagher, C.B. 2004. "Our town" - children as advocates for change in the city. Childhood 11 (2), 251–262.

GameGame. 2006. Aki Järvinen. Available at http://gamegame.blogs.com/ (retrieved December 2007).

Gaver, B., Dunne, T. & Pacenti, E. 1999. Cultural probes. interactions 6 (1), 21–29.

Gaver, W.W., Boucher, A., Pennington, S. & Walker, B. 2004. Cultural probes and the value of uncertainty. interactions 11 (5), 53–56.

Gediga, G., Hamborg, K.-C., and Düntsch, I. 2002. Evaluation of software systems. In A. Kent (Ed.) Encyclopedia of Library and Information Science, Vol. 72. New York: Marcel Dekker, 166-192.

Good, J. & Robertson, J. 2006. CARSS: A framework for learner-centred design with children. International Journal of Artificial Intelligence in Education 16 (4), 381-413.

Goodlad, S. & Hirst, B. 1989. Peer tutoring: a guide to learning by teaching. London: Kogan Page.

Gotel, O. & Finkelstein, A. 1997. Extended requirements traceability: results of an industrial case study. Proceedings of the 3rd IEEE International Symposium on Requirements Engineering, Annapolis, MD, USA. Los Alamitos: IEEE Computer Society, 169-178.

Gould, J.D., Boies, S.J. & Ukelson, J. 1997. How to design usable systems. In M. Helander, T.K. Landauer & P.V. Prabhu (Eds.) Handbook of Human-Computer Interaction. Amsterdam: Elsevier, 231-254.

Gould, J.D. & Lewis, C. 1985. Designing for usability: key principles and what designers think. Communications of the ACM 28 (3), 300-311.

Greenwood, C.R., Delquadri, J.C., & Hall, R.V. 1989. Longitudinal effects of classwide peer tutoring. Journal of Educational Psychology 81 (3), 371-383.

Guha, M.L., Druin, A., Chipman, G., Fails, J.A., Simms, S. & Farber, A. 2004. Mixing ideas: a new technique for working with young children as design partners. In Proceedings of the 2004 conference on Interaction design and children, College Park, Maryland, USA. New York: ACM, 35-42.

Guha, M.L., Druin, A., Chipman, G., Fails, J.A., Simms, S. & Farber, A. 2005. Working with young children as technology design partners. Communications of the ACM 48 (1), 39-42.

Gulliksen, J., Göransson, B., Boivie, I., Blomkvist, S., Persson, J. & Cajander, Å. 2003. Key principles for user-centred systems design. Behaviour & Information Technology 22 (6), 397-409.

Hall, L., Woods, S., Dautenhahn, K. & Sobreperez, P. 2004. Using storyboards to guide virtual world design. In Proceedings of the 2004 conference on Interaction design and children, College Park, Maryland, USA. New York: ACM, 125-126.

Hammersley, M. & Gomm, R. 2000. Introduction. In R. Gomm, M. Hammersley & P. Foster (Eds.) Case study method: key issues, key texts. London: Sage, 1-16.

Hanna, L., Risden, K. & Alexander, K.J. 1997. Guidelines for usability testing with children. interactions 4 (5), 9-14.

Hanna, L., Risden, K., Czerwinski, M. & Alexander, K.J. 1999. The role of usability research in designing children's computer products. In A. Druin (Ed.) The design of children's technology. San Francisco: Morgan Kaufmann, 3-26.

Hanna, L., Neapolitan, D. & Risden, K. 2004. Evaluating computer game concepts with children. In Proceedings of the 2004 conference on Interaction design and children, College Park, Maryland, USA. New York: ACM, 49-56.

Hart, R.A. 1997. Children's participation: the theory and practice of involving young citizens in community development and environmental care. London: Earthscan Publications.

Hevner, A.R., March, S.T., Park, J. & Ram, S. 2004. Design science in information systems research. MIS Quarterly 28 (1), 75-105.

Holtzblatt, K. & Jones, S. 1993. Contextual inquiry: a participatory technique for system design. In D. Schuler & A. Namioka (Eds.) Participatory design: principles and practices. Hillsdale, NJ: Lawrence Erlbaum, 177-210.

Holzinger, A. 2005. Usability engineering methods for software developers. Communications of the ACM 48 (1), 71-74.

Hornbæk, K. & Frøkjær, E. 2005. Comparing usability problems and redesign proposals as input to practical systems development. In Proceedings of the SIGCHI conference on Human factors in computing systems, Portland, Oregon, USA. New York: ACM, 391-400.

Huberman, A.M. & Miles, M.B. 1994. Data management and analysis methods. In N.K. Denzin & Y.S. Lincoln (Eds.) Handbook of qualitative research. Thousand Oaks: Sage, 428-444.

Hujala, E. 2002. Uudistuva esiopetus. Oulu: Varhaiskasvatus 90 Oy.

Humphreys, S. 2005. Productive players: online computer games' challenge to conventional media forms. Journal of Communication and Critical/Cultural Studies 2 (1), 36-50.

Höysniemi, J., Hämäläinen, P. & Turkki, L. 2003. Using peer tutoring in evaluating the usability of a physically interactive computer game with children. Interacting with Computers 15 (2), 203-225.

Iacucci, G., Kuutti, K. & Ranta, M. 2000. On the move with a magic thing: role playing in concept design of mobile services and devices. In D. Boyarski & W. A. Kellogg (Eds.) Proceedings of the conference on Designing interactive systems, New York, NY, USA. New York: ACM, 193–202.

Inkpen, K. 1997. Three important research agendas for educational multimedia: learning, children, and gender. In T. Muldner & T.C. Reeves (Eds.) Proceedings of AACE world conference on educational multimedia and hypermedia 97, Calgary, Canada. Charlottesville: AACE, 521-526.

Inkpen, K. 2001. Drag-and-drop versus point-and-click mouse interaction styles for children. ACM Transactions on Computer-Human Interaction 8 (1), 1-33.

ISO 9241-11. 1998. Ergonomic requirements for office work with visual display terminals (VDTs), part 11: Guidance on usability. Geneve: International Organization for Standardization.

ISO 13407. 1999. Human-centred design processes for interactive systems. Geneve: International Organization for Standardization.

Johnson, J.M. 2000. Learning as part of the design process. In J. Johnson: Design for learning: values, qualities and processes of enriching school landscapes. Available at http://www.asla.org/latis1/LATIS-Process.htm (retrieved October 2006).

Joiner, R.W. 1998. The effect of gender on children's software preferences. Journal of Computer Assisted Learning 14 (3), 195-198.

Jones, C., McIver, L., Gibson, L. & Gregor, P. 2003. Experiences obtained from designing with children. In S. MacFarlane, T. Nicol, J. Read & L. Snape (Eds.) Proceedings of the 2003 conference on Interaction design and children, Preston, UK. New York: ACM, 69-74.

Kafai, Y. B. 2006. Playing and making games for learning: instructionist and constructionist perspectives for game studies. Games and Culture 1 (1), 36-40.

Kankaanranta, M. 1998. Kertomuksia kasvusta ja oppimisesta: portfoliot siltana päiväkodista kouluun. Jyväskylä: Institute for Educational Research, University of Jyväskylä.

Kantner, L., Hinderer Sova, D. & Rosenbaum, S. 2003. Alternative methods for field usability research. In Proceedings of the 21st annual international conference on documentation, San Francisco, California, USA. New York: ACM, 68-72.

Karat, J. 1997. Evolving the scope of user-centered design. Communications of the ACM 40 (7), 33-38.

Karlsen, J.I. 1991. Action research as method: reflections from a program for developing methods and competence. In W.F. Whyte (Ed.) Participatory action research. Newbury Park: Sage, 143-158.

Karlsson, L. 2005. Sadutus – Avain osallistavaan toimintakulttuuriin. Jyväskylä: PS-kustannus.

Kelley, J.F. 1984. An iterative design methodology for user-friendly natural language office information applications. ACM Transactions on Office Information Systems 2 (1), 26-41.

Kemmis, S. & McTaggart, R. 1988. The action research planner (3rd ed.). Victoria: Deakin University Press.

Kensing, F. 1983. The trade unions' influence on technological change. In U. Briefs, C. Ciborra & L. Schneider (Eds.) Systems design for, with and by the users. Amsterdam: North-Holland.

Kensing, F. & Blomberg, J. 1998. Participatory design: issues and concerns. Computer Supported Cooperative Work 7 (3), 167-185.

Kensing, F. & Munk-Madsen, A. 1993. PD: Structure in the toolbox. Communications of the ACM 36 (4), 78-85.

Kiili, J. 2006. Lasten osallistumisen voimavarat. Tutkimus Ipanoiden osallistumisesta. Jyväskylä Studies in Education, Psychology and Social Research 283.

Kinos, J. 2001. Lapsilähtöinen varhaiskasvatus. In E. Hujala (Ed.) Puheenvuoroja lapsista ja varhaiskasvatuksesta. Oulu: Varhaiskasvatus 90 Oy.

Kinos, J. 2002. Kohti lapsilähtöisen varhaiskasvatuksen teoriaa. Kasvatus 2/2002, 119-132.

Kirakowski, J. 2002. Using ISO 13 407 as a guide to personal knowledge and competence. Available at http://www.ucc.ie/hfrg/certification/iso13407_intro.html (retrieved October 2006).

Knudtzon, K., Druin, A., Kaplan, N., Summers, K., Chisik, Y., Kulkarni, R., Moulthrop, S., Weeks, H. & Bederson, B. 2003. Starting an intergenerational technology design team: a case study. In S. MacFarlane, T. Nicol, J. Read & L. Snape (Eds.) Proceedings of the 2003 conference on interaction design and children, Preston, UK. New York: ACM, 51-58.

Kujala, S. 2003. User involvement: a review of the benefits and challenges. Behaviour & Information Technology 22 (1), 1-16.

Kyng, M. 1995. Making representations work. Communications of the ACM 38 (9), 46–55.

Lacasa, P. & Martínez, R. 2006. Media influences on children's lives: a mime theatre inspired by the Tomb Raider video game. Paper presented at the American Educational Research Association (AERA) 2006 Annual Meeting, San Francisco, California, USA.

Living Labs Roadmap Work Group. 2007. Living Labs Roadmap 2007-2010. Recommendations on networked systems for open user-driven research, development, and innovation. Available at http://www.ami-communities.eu/bscw/bscw.cgi/306354 (retrieved June 2008).

Maguire, M. 2001. Methods to support human-centred design. International Journal of Human-Computer Studies 55 (4), 587-634.

Markopoulos, P. & Bekker, M. 2003. Interaction design and children. Interacting with Computers 15 (2), 141-149.

Martin, M. 2004. Satu elämän kosketuspintana. Lapsen ja aikuisen kerronta. In I. Sava & V. Vesanen-Laukkanen (Eds.) Taiteeksi tarinoitu oma elämä. Jyväskylä: PS-kustannus, 77-106.

Melton, G.B. 1992. Respecting boundaries: minors, privacy, and behavioral research. In B. Stanley & J.E. Sieber (Eds.) Social research on children and adolescents: ethical issues. Newbury Park: Sage, 65-87.

Miles, M.B. & Huberman, A.M. 1994. Qualitative data analysis: an expanded sourcebook (2nd ed.). Thousand Oaks: Sage.

Morrow, V. & Richards, M. 1996. The ethics of social research with children: an overview. Children & Society 10 (2), 90-105.

Mukti, N.A. & Hwa, S.P. 2003. Effective design multimedia content materials: child-centered design. In T.M.T. Sembok, H.B. Zaman, H. Chen, S. Urs & S.H. Myaeng (Eds.) Digital Libraries: Technology and Management of Indigenous Knowledge for Global Access (Lecture Notes in Computer Science vol. 2911). Berlin: Springer, 615-626.

Muller, M.J. 1991. PICTIVE – an exploration in participatory design. In S.P. Robertson, G.M. Olson & J.S. Olson (Eds.) Proceedings of the SIGCHI conference on human factors in computing systems, New Orleans, Louisiana, USA. New York: ACM, 225-231.

Muller, M.J. 1992. Retrospective on a year of participatory design using the PICTIVE technique. In P. Bauersfeld, J. Bennett & G. Lynch (Eds.) Proceedings of the SIGCHI conference on human factors in computing systems, Monterey, CA, USA. New York: ACM, 455–462.

Muller, M.J. 2001. Layered participatory analysis: new developments in the CARD technique. In Proceedings of the SIGCHI conference on Human factors in computing systems, Seattle, Washington, USA. New York: ACM, 90-97.

Muller, M.J. 2003. Participatory design: the third space in HCI. In J. Jacko & A. Sears (Eds.) The human-computer interaction handbook: Fundamentals, evolving technologies, and emerging applications. Mahwah: Lawrence Erlbaum, 1051–1068.

Nesset, V. & Large, A. 2004. Children in the information technology design process: a review of theories and their applications. Library & Information Science Research 26 (2), 140-161.

Nevala, H. 2007. Narratiivit pelisuunnittelijan työkaluina. Unpublished Master's thesis. Department of Computer Science, University of Jyväskylä.

Nevanpää, T. 2007. The potential of a digital learning game in supporting inquiry learning about swamp ecosystems. Presentation at Earli 2007: SIG Invited Symposium, Budapest, Hungary, August 29, 2007.

Nielsen, C. 1998. Testing in the field. Proceedings of the 3rd Asia Pacific Computer Human Interaction Conference, Kangawa, Japan, 285-289.

Nielsen, J. 1993. Usability engineering. Boston: Academic Press.

Norman, D.A. & Spohrer, J.C. 1996. Learner-centered education. Communications of the ACM 39 (4), 24-27.

Nousiainen, T., Nevanpää, T., Kankaanranta, M. & Nikkilä, L.-E. 2008. User-centred design of Virtual Peatland for in-depth understanding of peatland ecosystems. In Proceedings of the 13th International Peat Congress, Tullamore, Ireland. Jyväskylä: International Peat Society.

OECD. 2007. Participative web: user-created content. DSTI/ICCP/IE(2006)7/ FINAL. Available at http://www.oecd.org/dataoecd/57/14/ 38393115.pdf (retrieved July 2007).

Olsson, E. 2004. What active users and designers contribute in the design process. Interacting with Computers 16 (2), 377-401.

Oosterholt, R., Kusano, M. & de Vries, G. 1996. Interaction design and human factors support in the development of personal communicator for children. In M. J. Tauber (Ed.) Proceedings of the SIGCHI conference on Human factors in computing systems, Vancouver, Canada. New York: ACM, 450-457.

Pagulayan, R.J., Keeker, K., Wixon, D., Romero, R.L. & Fuller, T. 2003. User-centered design in games. In J. Jacko & A. Sears (Eds.) The human-computer interaction handbook: Fundamentals, evolving Technologies, and emerging applications. Mahwah: Lawrence Erlbaum, 883-906.

Pakkanen, M.-S. 1998. Kolmas kivi auringosta? In I. Sava (Ed.) Taikomo. Taidekasvatus monikulttuurisessa koulussa. Ajattelua Taikomon takana. Helsingin kaupungin opetusviraston julkaisusarja A13, 100-114.

Pardo, S., Vetere, F. & Howard, S. 2005. Broadening stakeholder involvement in UCD: Designers' perspectives on child-centred design. In Proceedings of the 19th Conference of the Computer-Human interaction Special interest Group (Chisig) of Australia on Computer-Human interaction, Canberra, Australia. Narrabundah: CHISIG, 1-9.

Passig, D. & Levin, H. 1999. Gender interest differences with multimedia learning interfaces. Computers in Human Behavior 15 (2), 173-183.

Patton, M.Q. 2002. Qualitative research and evaluation methods (3rd ed.) Thousand Oaks: Sage.

Perusopetuksen opetussuunnitelman perusteet. 2004. [The core national curriculum for basic education.] Opetushallitus. [The Finnish National Board of Education] Available at http://www.oph.fi/ops/perusopetus/pops_web.pdf (retrieved December 2007).

Phillips, E. and Klawe, M. 1995. Engaging children as collaborative researchers: A classroom study with electronic mathematical games. Available at http://www.cs.ubc.ca/nest/egems/reports/engaging.doc (retrieved April 2008).

Piaget, J. 1970. Science of education and the psychology of the child. New York: Orion Press.

Punch, M. 1994. Politics and ethics in qualitative research. In N.K. Denzin & Y.S. Lincoln (Eds.) Handbook of qualitative research. Thousand Oaks: Sage, 83-97.

Read, J. 2005. The ABC of CCI (Child Computer Interaction). Interfaces Nr. 62, 8-9.

Read, J. & MacFarlane, S. 2006. Using the fun toolkit and other survey methods to gather opinions in child computer interaction. In Proceedings of the 2006 conference on Interaction design and children, Tampere, Finland. New York: ACM, 81-88.

Read, J., MacFarlane, S. & Casey, C. 2002. Endurability, engagement and expectations: measuring children's fun. In M.M. Bekker, P. Markopoulos & M. Kersten-Tsikalkina (Eds.) Proceedings of Interaction Design and Children, International Workshop, Eindhoven, The Netherlands. Eindhoven: Shaker Publishing, 189-198.

Reeves, T.C. 2000. Enhancing the worth of instructional technology research through "design experiments" and other development research strategies. Paper presented at the Annual Meeting of the American Educational Research Association, New Orleans, Louisiana, USA.

Richey, R.C., Klein, J.D. & Nelson, W.A. 2004. Developmental research: studies of instructional design and development. In D. Jonassen (Ed.) Handbook of research for educational communications and technology (2nd ed.). Mahwah, NJ: Lawrence Erlbaum, 1099-1130.

Riihelä, M. 2001. The storycrafting method & the storycrafting video. Helsinki: Stakes. Available at http://www.edu.helsinki.fi/lapsetkertovat/english/Riihela_Storycrafting_method_and_videoMR.pdf (retrieved October 2006).

Robertson, J. 2002. Experiences of designing with children and teachers n the StoryStation project. . In M.M. Bekker, P. Markopoulos & M. Kersten-Tsikalkina (Eds.) Proceedings of Interaction Design and Children, International Workshop, Eindhoven, The Netherlands. Eindhoven: Shaker Publishing, 29-41.

Robertson, J. & Nicholson, K. 2007. Adventure Author: a learning environment to support creative design. In T. Bekker, J. Robertson & M. B. Skov (Eds.) Proceedings of the 6th international Conference on Interaction Design and Children, Aalborg, Denmark. ACM: New York, 37-44.

Rode, J.A., Stringer, M., Toye, E.F., Simpson, A.R. & Blackwell, A.F. 2003. Curriculum-focused design. In S. MacFarlane, T. Nicol, J. Read & L. Snape (Eds.) Proceedings of the 2003 conference on Interaction design and children, Preston, UK. New York: ACM, 119-126.

Rudd, J., Stern, J. & Isensee, S. 1996. Low vs. high-fidelity prototyping debate. interactions 3 (1), 76-85.

Salen, K. & Zimmerman, E. 2004. Rules of play: game design fundamentals. Cambridge: MIT Press.

Salvador, T. & Howells, K. 1998. Focus Troupe: using drama to create common context for new product concept end-user evaluations. In CHI 98 conference summary on Human factors in computing systems, Los Angeles, CA, USA. New York: ACM, 251-252.

Sanders, E. B-N. 2002. From user-centered to participatory design approaches. In J. Frascara (Ed.) Design and the social sciences. London: Taylor & Francis, 1-8.

Sato, S. & Salvador, T. 1999. Playacting and Focus Troupes: theater techniques for creating quick, intense, immersive, and engaging focus group sessions. interactions 6 (5), 35-41.

Scaife, M. & Rogers, Y. 1999. Kids as informants: Telling us what we didn't know or confirming what we knew already? In A. Druin (Ed.) The design of children’s technology. San Francisco: Morgan Kaufmann, 27-50.

Scaife, M. & Rogers, Y. 2001. Informing the design of a virtual environment to support learning in children. International Journal of Human-Computer Studies 55 (2), 115-143.

Scaife, M., Rogers, Y., Aldrich, F. & Davies, M. 1997. Designing for or designing with? Informant design for interactive learning environments. In S. Pemberton (Ed.) Proceedings of the ACM CHI 97 Human Factors in Computing Systems Conference, Atlanta, Georgia, USA. New York: ACM, 343-350.

Schuler, D. & Namioka, A. 1993. Preface. In D. Schuler & A. Namioka (eds) Participatory design: principles and practices. Hillsdale, NJ: Lawrence Erlbaum, xi-xiii.

Seeto, D. & Herrington, J. 2006. Design-based research and the learning designer. In L. Markauskaite, P. Goodyear & P. Reimann (Eds.) Proceedings of the 23rd annual conference of the Australasian Society for Computers in Learning in Tertiary Education: Who’s learning? Whose technology?, Sydney, Australia. Sydney: Sydney University Press, 741-745.

Sieber, J.E. 1992. Planning ethically responsible research: a guide for students and internal review boards. Newbury Park: Sage.

Soloway, E., Gudzial, M. & Hay, K.E. 1994. Learner-centered design: the challenge for HCI in the 21st century. interactions 1 (2), 36-48.

Soloway, E., Jackson, S.L., Klein, J., Quintana, C., Reed, J., Spitulnik, J., Stratford, S.J., Studer, S., Eng, J. & Scala, N. 1996. Learning theory in practice: case studies of learner-centered design. In M. J. Tauber (Ed.) Proceedings of the SIGCHI conference on Human factors in computing systems CHI’96, Vancouver, British Columbia, Canada. New York: ACM, 189-196.

Sotamaa, O., Ermi, L., Jäppinen, A., Laukkanen, T., Mäyrä, F. & Nummela, J. 2005. The role of players in game design: a methodological perspective. In Proceedings of the 6th DAC Conference - Digital Experience: Design, Aesthetics, Practice, Copenhagen, Denmark. Copenhagen: IT University of Copenhagen, 34-42.

Spinuzzi, C. 2002. A Scandinavian challenge, a US response: methodological assumptions in Scandinavian and US prototyping approaches. Proceedings of the 20th annual international conference on computer documentation, Toronto, Ontario, Canada. New York: ACM, 208-215.

Steiner, B., Kaplan, N. & Moulthrop, S. 2006. When play works: turning game-playing into learning. In Proceedings of the 2006 Conference on Interaction Design and Children, Tampere, Finland. New York: ACM, 137-140.

Stringer, E.T. 1996. Action research: a handbook for practitioners. Thousand Oaks: Sage.

Svanæs, D. & Seland, G. 2004. Putting the users center stage: role playing and low-fi prototyping enable end users to design mobile systems. In Proceedings of the SIGCHI conference on Human factors in computing systems, Vienna, Austria. New York: ACM, 479- 486.

Sykes, J. & Federoff, M. 2006. Player-centred game design. CHI '06 extended abstracts on Human factors in computing systems, Montreal, Canada. New York: ACM, 1731- 1734.

Tauriainen, L. 2000. Kohti yhteistä laatua – henkilökunnan, vanhempien ja lasten laatukäsityksiä päiväkodin integroidussa erityisryhmässä. Jyväskylä Studies in Education, Psychology and Social Research.

Taxén, G., Druin, A., Fast, C. & Kjellin, M. 2001. KidStory: a technology design partnership with children. Behaviour & Information Technology 20 (2), 119-125.

Theng, Y.L., Mohd-Nasir, N., Thimbleby, H., Buchanan, G., Jones, M., Bainbridge, D. & Cassidy, N. 2000. Children as design partners and testers for a children's digital library. In J. L. Borbinha & T. Baker (Eds.) Proceedings of the 4th European Conference on Research and Advanced Technology for Digital Libraries, Lisbon, Portugal (Lecture Notes in Computer Science vol. 1923). London: Springer, 249-258.

Thomas, N. & O'Kane, C. 1998. The ethics of participatory research with children. Children & Society 12 (5), 336-348.

Thompson, R.A. 1992. Developmental changes in research risk and benefit: a changing calculus of concerns. In B. Stanley & J.E. Sieber (Eds.) Social research on children and adolescents: ethical issues. Newbury Park: Sage, 31-64.

Topping, K.J. 1988. The peer tutoring handbook: promoting co-operative learning. London: Croom Helm.

Tudor, L.G., Muller, M.J., & Dayton, T. 1993. A C.A.R.D. game for participatory task analysis and redesign: macroscopic complement to PICTIVE. In S. Ashlund, K. Mullet, A. Henderson, E. Hollnagel & T. White (Eds.) INTERACT '93 and CHI '93 conference companion on Human factors in computing systems, Amsterdam, The Netherlands. New York: ACM, 51-52.

Tymchuk, A.J. 1992. Assent process. In B. Stanley & J.E. Sieber (Eds.) Social research on children and adolescents: ethical issues. Newbury Park: Sage, 128-139.

van Aken, J.E. 2004. Management research based on the paradigm of the design sciences: The quest for field-tested and grounded technological rules. Journal of Management Studies 41 (2), 219-246.

van den Akker, J. 1999. Principles and methods of development research. In J. van den Akker, R.M. Branch, K. Gustafsson, N. Nieveen & T. Plomp (Eds.) Design approaches and tools in education and training. Dordrecht: Kluwer, 1-14.

van Kesteren, I.E.H., Bekker, M.M., Vermeeren, A.P.O.S., & Lloyd P.A. 2003. Assessing usability evaluation methods on their effectiveness to elicit verbal comments from children subjects. In S. MacFarlane, T. Nicol, J. Read & L. Snape (Eds.) Proceedings of the 2003 conference on Interaction design and children, Preston, UK. New York: ACM, 41-49.

Verhaegh, J., Soute, I., Kessels, A. & Markopoulos, P. 2006. On the design of Camelot, an outdoor game for children. In Proceedings of the 2006 conference on Interaction design and children, Tampere, Finland. New York: ACM, 9-16.

Walsham, G. 1995. Interpretive case studies in information systems research: nature and method. European Journal of Information Systems 4 (2), 74-81.

Wang, F. & Hannafin, M.J. 2005. Design-based research and technology-enhanced learning environments. Educational Technology Research & Development 53 (4), 5-23.

Whyte, W.F. 1989. Advancing scientific knowledge through participatory action research. Sociological Forum 4 (3), 367-385.

Wildman, D. 1995. Getting the most from paired-user testing. interactions 2 (3), 21-27.

Williamson, B. 2003. The participation of children in the design of new technology: a discussion paper. Available at http://www.futurelab.org.uk/download/pdfs/research/disc_papers/Participation_of_Children_in_Design_discpaper.pdf (retrieved October 2006).

Wixon, D. 2003. Evaluating usability methods: why the current literature fails the practitioner. interactions 10 (4), 28-34.

Wolcott, H.F. 1992. Posturing in qualitative research. In M.D. LeCompte, W.L. Millroy & J. Preissle (Eds.) The handbook of qualitative research in education. San Diego: Academic Press, 3-52.

Wood, C. 1998. Meeting customer needs using participatory techniques. In Proceedings of the Australasian Computer Human Interaction Conference, Adelaide, Australia. Washington, DC: IEEE Computer Society, 336.

Yin, R.K. 1994. Case study research: design and methods (2nd ed.). Thousand Oaks: Sage.

APPENDIX 1: DATA OF THE TALARIUS STUDY

DOCUMENTS	**Phase reports**	Start-up phase [9 pages] Analysis phase [13 pages] Design phase [12 pages] Implementation phase [13 pages] Take-into-use and finishing phase [18 pages]
	Risk reports	Analysis phase [7 pages] Design phase [9 pages] Implementation phase [9 pages] Take-into-use and finishing phase [7 pages]
	Other reports	Usability analysis report [46 pages] Final report [21 pages]
INTERVIEWS AND QUESTIONNAIRES	**Developers**	Interview, autumn term: Expectations and early experiences [notes: 2 pages] E-mail interview, spring term: Experiences from the project [1 page]
	Children	Questionnaire: Halfway [n=12] Questionnaire: Final [n=23] Interview: Games made in the previous year [n=19] Interview: Game drawings [Notes: 5 pages]
RESEARCH DOCUMENTS	**Research journals**	Field journal: Autumn term [14 pages] Field journal: Spring term [11 pages] Research report: Autumn term [32 pages] Research report: Final report [78 pages]
	Meeting memos	Memos [n=11; 15 pages altogether]
ARTEFACTS	**UI drawings**	Drawings [n=20]
	Application	UI mock-ups [3 alternatives for game board making, 3 for question creation, 3 for playing] Final application

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FIELD TRIAL DATA	**School trial**	Field notes [9 pages] Children's questionnaire: Before the field trial period [n=20] Children's questionnaire: After making games [n=20] Children's questionnaire: After playing games [n=21] Teacher's interview [transcript 6 pages + notes 3 pages]
	Kindergarten trials	Kindergarten 1: Field journals and notes [7 pages] Kindergarten 2: Field journals and notes [12 pages]

APPENDIX 2: DATA OF THE VIRTUAL PEATLAND STUDY

DOCUMENTS	**Game design documents**	Document on the children's ideas [6 pages] Peatland Game (game proto 1): Design document [36 pages] Peatland Game (game proto 1): Educational specialist's evaluation [1 page] Peatland Adventure: Plan of the development project [24 pages] Peatland Adventure: Pedagogical script [35 pages] Peatland Adventure: Production script [34 pages] Peatland Adventure: Game plan [40 pages] Peatland Adventure: Final report [44 pages]
	General documents	Plan for carrying out user involvement, version 1 [11 pages] Plan for carrying out user involvement, version 2 [13 pages] Document on the implementation of children's materials [14 pages] Document on the structuring of children's materials [14 pages] Educational specialist's evaluation on the user involvement process [7 pages] Educational specialist's evaluation of the first project year [6 pages]
INTERVIEWS AND QUESTION-NAIRES	**Participation experiences**	Questionnaire: Idea map creation [n=13] Questionnaire: Collage creation [n=25] Questionnaire: Quizzes and info texts [n=23] Questionnaire: Game-related activities [n=22] Questionnaire: Final Questionnaire [n=12] Interview: Final Interview [n=10 (in 3 groups); transcript 13 pages]
	Evaluation feedback sheets	Existing learning environments [n=14] Prototype evaluation, Peatland Game (collective list on whiteboard) Prototype evaluation, Peatland Adventure [n=12] Prototype evaluation, the whole Virtual Peatland site [n=19]
RESEARCH DOCUMENTS	**Research journals**	Field journal [109 pages]

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ARTEFACTS	**Idea maps**	Individual idea sheets [n=26] Collective list (whiteboard) Idea map (whiteboard)
	Collages	Collages (n=10; 5 related to the most interesting themes, 5 related to unfamiliar themes)
	Game design material	Game idea drawing Characters accompanying the drawing [n=5] Characters for Peatland Adventure [n=25]
	Content creation material	Quizzes/puzzles [n=27] Video presentations [n=7] Photographs [n=74] Info texts [n=13] Elk's story "Elk's perspective" video clip Voting results (video clips and photographs)
	Application	Peatland Game prototype Virtual Peatland (final)
FIELD TRIAL DATA	**School trial**	Questionnaire [n=57]

APPENDIX 3: TALARIUS: QUESTIONS FOR THE CHILDREN HALFWAY THROUGH THE PROJECT

1. Is the current version of the application what you imagined this game-creation application to be like? Why / why not?

2. In what things do you think your participation helps the developers?

3. What has been the most fun or interesting thing in the project participation so far? Why?

4. What about the most difficult or boring thing? Why?

APPENDIX 4: TALARIUS: FINAL QUESTIONNAIRE FOR THE CHILDREN

PART 1: What is your opinion on the following statements? Mark 1, 2, 3, 4, or 5 in the box, according to whether you agree or disagree with the statement, and write a brief explanation below the questions.
1 = strongly disagree, 2 = somewhat disagree, 3 = cannot say, 4= somewhat agree, 5 = strongly agree

1. The application is what I thought it would be like. ☐
Why / why not?

2. I have been able to participate actively in the project. ☐
How have you participated?

3. My suggestions for improvements have shown in the development of the application. ☐
How have they shown?

4. It was fun to test the application. ☐
Why / why not?

5. My comments have helped the developers. ☐
How?

6. I think that the application would now be different if we had not participated. ☐
If yes, how would it be different?

7. It was boring to test the application. ☐
Why / why not?

8. I have had power over what the application is going to be like. ☐
Which things have you been able to influence?

9. I would have wanted to participate also in other ways than those used now. ☐
In what kinds of ways would you have liked to participate?

10. It was easy to come up with ideas about the functions of this kind of an application. ☐
Why was it easy / difficult?

11. It was difficult to explain the board game made last year (in the interview last autumn). ☐
Why was it (not) difficult?

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12. It has been easy to give comments about using the application. ☐
Why / why not?

13. It was interesting to participate in the project. ☐
What has been interesting? / Why has it not been interesting?

14. It was hard to concentrate on testing the application. ☐
Why / why not?

15. It has felt difficult to give feedback. ☐
If yes, what has been difficult?

16. Making the drawing about a screen of the application (last autumn) was easy. ☐
What made it easy or difficult?

17. I would rather have used the application alone than in pairs in the evaluation sessions. ☐
Why / why not

18. I always understood the tasks in the evaluation sessions. ☐
If there was something difficult, what was it?

19. The development of the application could be clearly seen at different times. ☐
How did it show?

20. I would have liked to have more control over the development of the application. ☐
Which aspects would you have wanted to influence more?

PART 2: Answer also these open-ended questions

1. What has been difficult in the project?
2. What has been interesting in the project?
3. What kinds of suggestions for improving the application have you given during the project?
   a. Which of them have shown in the development of the application? How?
   b. Which of them have not shown? Why do you think that is?
4. What kinds of ideas do you have for the further development of the application?
5. In what kinds of situations would you like the application to be used in school?
6. What kind of a game would you like to make with the application? What theme or topic would it be related to? Describe the game briefly. What could one learn with it? What kind of material would you add to it (e.g. pictures, sounds, video)? What would the background image be like? How and from where would you get these materials? You can use a drawing of what the game would look like as an aid in your explanation.

APPENDIX 5: TALARIUS: INTERVIEW QUESTIONS FOR THE DEVELOPERS

FIRST INTERVIEW (AUTUMN TERM)

General expectations about the project

- What kinds of thoughts did the theme "children as participants" raise?
- How familiar were you with the concept of participatory design?
- How did you start shaping and planning the proceeding of the project (starting points)?

The children's and the teacher's ideas

- What kinds of thoughts did the children's ideas about the application raise (what were the most crucial issues)?
- What about the teacher's ideas?

User interface drawings

- Are there common features in the drawings?
- Have you got practically applicable ideas based on them?

SECOND, E-MAIL INTERVIEW (SPRING TERM)

1. What do you feel have been the most successful aspects of the project so far?
2. In which aspects have there been problems? What kinds of problems?
3. Have some observations related to the children's participation (a result obtained in the testing sessions, some comments by the children etc.) surprised you or been totally different from what you would have expected?
4. How do the results from the testing of the first user interface mock-ups show in the development of the application at this point?
5. What kind of information did you especially want to get from the testing [of the first prototypes] held on Wednesday, December 17th?
6. What kinds of observations did you make in the testing of December 17th?

APPENDIX 6: VIRTUAL PEATLAND: FINAL QUESTIONNAIRE FOR THE CHILDREN

What do you think about the following things related to the Virtual Peatland project? Choose one of the numbers from 1 to 5 according to whether you agree or disagree. Answer also the clarifying questions below (you can continue on the flipside if there is not enough space.	Completely disagree	Somewhat disagree	Cannot say	Somewhat agree	Completely agree
1) Virtual Peatland is what I thought is would be like. *Why / why not?*	1	2	3	4	5
2) My ideas and contributions can be seen on Virtual Peatland. *What ideas can be seen?*	1	2	3	4	5
3) The development of Virtual Peatland could be clearly seen during the project. *If yes, how did it show?*	1	2	3	4	5
4) I have had control over what Virtual Peatland will be like. *Which aspects do you feel you have been able to influence?*	1	2	3	4	5
5) I have been able to participate actively in the project. *How have you participated?*	1	2	3	4	5
6) I think that Virtual Peatland would now be different if we had not participated in the project. *If yes, how would it be different?*	1	2	3	4	5
7) My ideas and comments have helped the developers of Virtual Peatland. *In what ways?*	1	2	3	4	5
8) It was interesting to participate in the project. *What has been interesting about it? / Why has it not been interesting?*	1	2	3	4	5
9) I would have wanted to have more control over the development of Virtual Peatland. *What aspects would you have wanted to influence more?*	1	2	3	4	5
10) I would have wanted to participate in the project in other ways than those that were used now. *How else would you have wanted to participate?*	1	2	3	4	5

APPENDIX 7: VIRTUAL PEATLAND: THEMES OF THE CHILDREN'S FINAL INTERVIEW

1) VIRTUAL PEATLAND IN GENERAL

What is good / the best about Virtual Peatland? Why?
What about bad / the worst? Why?
To what extent does it meet your expectations? Why / why not?

2) REALIZATION OF THE CHILDREN'S IDEAS IN VIRTUAL PEATLAND

Which ideas show in Virtual Peatland? (Personal ones / Collective ones, of the whole class?)
Which ideas do not show? (Personal ones / Collective ones, of the whole class?)
When you think about the realization of ideas in Virtual Peatland, how would you assess it? (Seeing that a specific, own idea is there / Thinking about the ideas of the whole group / Other)
What kinds of ideas are the most important ones to be realized? Why? (E.g. ideas related to a specific topic..?)

3) DIFFERENT PARTICIPATION ACTIVITIES

Visualization of each participation activity with the aid of PowerPoint slides on a laptop, and assessing each activity in terms of fun/enjoyability and usefulness regarding the development of Virtual Peatland. Clarifying questions, e.g.:
You liked activity X the most – what about Y, what did you think about it?
Why did you like X more than Y? / Why was Y not as enjoyable as X?
Why was X more useful than Y? / Why was Y not as useful as X?

4) PARTICIPATION IN GENERAL

What was best about participating in the project? Why?
What was the worst thing about participating in the project? Why?
Do you think you were able to bring forward your opinions? Did the researchers understand the ideas of the class?
Did you learn something from the project? What?
What would you tell if someone asked you what the role of you students was in this project?
If the Virtual Peatland project started over now, and you would be participating in the design, what would you like to be done differently? Why?

YHTEENVETO (FINNISH SUMMARY)

Lapset ja teknologia -aihepiiriä koskeva tutkimus on pitkään keskittynyt pääasiassa siihen, miten teknologia vaikuttaa lapsiin ja esimerkiksi heidän oppimiseensa. Yhä enemmän on kuitenkin kiinnostuttu tarkastelemaan aihetta myös siitä näkökulmasta, miten lapset saadaan mukaan ideoimaan, suunnittelemaan ja arvioimaan heille tarkoitettuja teknologisia sovelluksia. Lapsia ei enää nähdä pelkästään teknologian vaikutusten tutkimuskohteina tai uusien sovellusten passiivisena kohderyhmänä, vaan heidän asiantuntemustaan omasta elämänalueestaan pidetään tärkeänä siinä missä aikuistenkin. Keskeisiä käsitteitä ovat siis käyttäjälähtöisyys ja käyttäjien osallistuminen. Näiden lähestymistapojen avulla pyritään toteuttamaan sovelluksia, jotka vastaavat käyttäjien todellisia tarpeita ja vaatimuksia – ja siten lisäävät heidän tyytyväisyyttään lopputuotokseen –, mutta olennainen lähtökohta on myös käyttäjien vaikuttamismahdollisuuksien edistäminen.

Tämä tutkimus käsittelee lasten osallistumista pelinomaisten oppimisympäristöjen suunnitteluun. Tutkimus on toteutettu Jyväskylän yliopiston Agora Centerissä, ja siinä on tarkasteltu kahden pelinomaisen oppimisympäristön kehitysprojekteja. Ensimmäisessä projektissa kehitettiin pilottiversio Talarius-oppimisympäristöstä, jonka avulla lapset voivat tehdä lautapelinomaisia tietokonepelejä. Toisen projektin tavoite oli kehittää Virtuaalisuo, suoteemaan liittyvä www-pohjainen ja pelinomainen oppimisympäristö. Kummassakin projektissa oli pääasiallisena osallistujaryhmänä luokka alakouluikäisiä lapsia.

Tutkimuksen tavoitteena on ollut luoda kattava ja moniulotteinen käsitys lasten osallistumisesta teknologian suunnitteluun sekä soveltaa, analysoida ja kehittää menetelmiä ja toimintatapoja käyttäjälähtöisen suunnitteluprosessin eri vaiheisiin monitieteisistä lähtökohdista käsin. Käyttäjien osallistumista on tarkasteltu tutkimuksessa kahdella eri ulottuvuudella, analysoiden toisaalta osallistumisprosessia ja toisaalta sen tavoitteita. Prosessiin liittyen on tutkittu sen rakennetta ja eri vaiheissa käytettyjä menetelmiä sekä käyttäjien ja kehittäjien välistä yhteistyötä. Tavoitteisiin liittyen puolestaan on analysoitu, miten käyttäjien asiantuntemus ja todellinen käyttökonteksti on tuotu mukaan prosessiin, missä määrin lapset tuntevat vaikuttaneensa lopputuotokseen, ja miten hyvin tuotos vastaa odotuksia ja todellisia käyttötarpeita. Näitä kysymyksiä on tutkittu niin lasten kuin kehittäjienkin näkökulmasta, sekä havainnoimalla osallistumisaktiviteetteja ja analysoimalla projektien lopputuotoksia. Tutkimuksessa on käytetty development research -lähestymistapaa, jota on sovellettu tutkimusprosessin syklimäiseen rakenteeseen: ensimmäisestä projektista saadut tulokset toimivat taustana toisen suunnittelulle ja toteutukselle.

Teknologian suunnitteluprojektiin osallistuminen tarjoaa lapsille arvokkaita oppimis- ja vaikuttamismahdollisuuksia. Tunteakseen omistajuutta lopputuloksesta ja kokeakseen saaneensa vaikuttaa siihen, lapsille on tärkeää nähdä hyvin konkreettisesti omat kontribuutionsa tuotokseen ja saada selvästi

seurata ja edistää ideoidensa kehittymistä ja muovautumista läpi koko prosessin. Näihin haasteisiin on tutkimuksessa haettu ratkaisua selkeämmin toistensa varaan rakentuvien vaiheiden mukaisesti etenevästä ja läpinäkyvämmästä osallistumisprosessista sekä konkreettisen sisällöntuottamisen tuomisesta uudeksi olennaiseksi osaksi osallistumistapoja.

Tutkimuksen tulokset luovat osallistumistavoista ja -kokemuksista uutta tietoa, jota voidaan hyödyntää lasten kanssa toteutettavissa suunnitteluprojekteissa. Lisäksi tutkimus laajentaa monitieteistä näkökulmaa käyttäjälähtöisyyteen tarkastelemalla, mitä muilta tieteenaloilta (kuten lapsilähtöisestä varhaiskasvatuksesta tai lapsuuden sosiologiasta) tai muista relevanteista ilmiöistä (kuten käyttäjien tai pelaajien sisällöntuotannosta) on opittavissa ja sovellettavissa lapsilähtöiseen teknologiansuunnitteluun. Tuloksia voidaan soveltaa tulevien suunnitteluprojektien lisäksi myös laajemmin. Erityisen merkittävä potentiaalinen soveltamiskonteksti on lasten teknologiataitojen ja medialukutaidon tukeminen kouluopetuksessa.