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Aki Rasinen

Developing Technology Education

In Search of Curriculum Elements for Finnish General Education Schools

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UNIVERSITY OF JYVÄSKYLÄ

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The future is not some place we are going to, it is one we are creating. The paths to it are not found but made, and the making of these pathways changes both the maker and the destination (UNESCO 1989, p. 9).

ABSTRACT

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A human being in the modern world deals with technology daily. Many countries have initiated technology education in their general education schools in the past years. According to two national curriculum documents in Finland technology is part of general education. These documents do not, however, define what is meant by technological general education, nor do they give operational instructions on how it should be organized in comprehensive schools and upper secondary schools.

The main purposes of this study were to 1) Study the concepts of technology and technology education and 2) Seek for curriculum elements for the development of technology education in Finnish general education schools.

The definitions of the concepts were formulated on the basis of both previously published literature and the present empirical findings. The materials for the curricula of our country were identified through the systematic analysis of the technology education curricula of Australia, England, France, the Netherlands, Sweden, and the United States, and through a structured (and open) survey questionnaire directed at representatives of Finnish universities and polytechnics of technology and at representatives of trade and industry involved with technology. The approach to technology education was explored from the point of view of attainment targets, study methods, and study contents. The results of the analysis of the curricula of the six countries and the survey findings on Finnish experts in the field were compared and the shared elements combined in a table which represents the present view of the elements of technology education curriculum.

This study defines technology as mainly a combination of handicrafts, applied sciences, and information technology. Technology education deals with the study of the interaction between technology and society, the balance between technology and the environment, basic technical know-how, practical skills, and entrepreneurship. All of this should be studied by applying various methods.

The findings support the view that technology should be part of general education for all students from kindergarten to upper secondary and even beyond. The findings of the study can be used todevelop the technology education curriculum at different levels of planning, including daily planning and teaching.

Key words: technology, technology education, technological literacy, general education

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Preface and acknowledgements

I have been working as lecturer of technical work (tekninen työ) at Jyväskylä Teacher Training School of the Faculty of Education of the University of Jyväskylä since 1974. About nine years of my working life I have spent in development co-operation. About seven of these nine years I was developing the teaching of technical subjects (practical subjects, industrial arts, and polytechnic education) of the general education schools and teacher education institutions of Zambia and Namibia. Through these experiences I have also had a chance to become acquainted with technical education, teacher education and development of learning materials in the other countries of southern and eastern Africa.

During my college studies already, in the beginning of the seventies, there was an active discussion going on about the development of attainment targets, methods and contents of technical handicraft (tekninen käsityö), as well as development of teaching and learning in general. The fact that I have been working at Jyväskylä training school with very close links with the section of technical work at the Department of Teacher Education have kept this discussion active for over twenty years. In 1989 I had a leave of absence from my teaching duties and a chance to study the teacher education and school activities of Craft, Design and Technology in England and Scotland. This study tour together with my earlier experiences, discussions and literature reviews acted as a catalyst for the fact that we started serious discussions with Matti Parikka, lecturer in the didactics of technical work at the Department of Teacher Education of the University of Jyväskylä, on the idea of starting a technology education experiment also in Finland. In the end such a development experiment was started in 1991. The experiment has encouraged me to seek for more international contacts and also made it possible to find new contacts in this field. After a study tour to the USA together with lecturers Jouko Kantola and Matti Parikka and the visit of professor William Dugger Jr. from Virginia Polytechnic and State University at Jyväskylä University, a co-operation agreement in the field of technology education between the two Universities was signed in 1993. The experiment has also been introduced at various international conferences in 1993, 1997, 1998 (Parikka & Rasinen 1993, 1997, 1998) and 1999 (Rasinen 1999b).

My personal view that technology should not be developed only by young, healthy, unmarried men, was strengthened at the maternity ward of the General Hospital of Central Finland at the end of June 1992, when my wife gave birth to our daughter. The ergonomics and electronics of the ward would definitely have been something completely different if they had been planned and constructed under the supervision of birth-giving mothers, midwives and medical doctors rather than by technology experts alone.

In my licentiate thesis (Rasinen 1999a) I already aimed at determining some building materials for the technology education curriculum of Finnish general education schools. However, the dissertation at hand aims at a deeper and more critical and extensive analysis of the topic. Since the previous study, new curriculum materials in England, the Netherlands and the United States have been introduced, and also other new data have been collected, analyzed and reported. The present research is also part of the wider technology education experiment which is going on at the Faculty of Education of the University of Jyväskylä.

The present study was made financially possible by the Nyyssönen Foundation, the University of Jyväskylä (Rector's Office and Planning Office), and national employment agency. The Teacher Training School of the University of Jyväskylä gave me a leave of absence from my teaching duties and thus enabled full concentration on doing this research work. I gratefully acknowledge all these support forms.

In addition, I wish to express my gratitude to my supervisor professor Seppo Hämäläinen for his professional and encouraging support. Professor Jouko Kari has also given me valuable instructions during the progress of this study. Moreover, I am grateful to my colleagues at the technology education section of the University of Jyväskylä, lecturers Matti Piilovaara and Timo Rissanen, and Dr. Antti Pirhonen for the important assistance I have received from them. Dr. Jouko Kantola has given me constructive advice on the structure of the report, and Asko Heinonen, lecturer from the Department of Teacher Education in Savonlinna, has led me to valuable sources of methodology. I am particularly indebted to Dr. Matti Parikka for his encouraging, patient, sustained, and supportive guidance. Dr. Tapani Kananoja has guided me to many international sources of information. I also wish to extend my gratitude to my colleagues in Australia, England, France, the Netherlands, Sweden, and the United States of America for their advice and comments while writing this dissertation. Without the professional assistance of Päivi Kärkkäinen my work would not have proceeded at the present speed. I also want to thank Anne Räsänen, lecturer at Jyväskylä University Language Center for her valuable work in checking the English language. Without the answers to my survey questionnaire by several respondents this research would not have been possible.

Finally, I am grateful to professor Ulla Suojanen and professor William E. Dugger for finding time to review my report, and for their valuable comments.

My warmest and loving gratitude is addressed to the members of my family, Tuija, Heini, and Leo, for their patience and support.

Muurame, 14 November, 2000

Aki Rasinen

CONTENTS

1 INTRODUCTION: FINLAND IN SEARCH OF A TECHNOLOGY EDUCATION CURRICULUM

Technology is all around us. We have to deal with it whether we want to or not. Technology makes our everyday life easier and in many ways more pleasant. On the other hand, it may also make our life more difficult, complicated and inconvenient. If it is misused it might destroy our environment and even us.

Even the word technology arouses negative emotions in many of us. People may associate it with pollution, with inconceivable high tech, such as computers and nuclear power plants, or with dirt and grease. On the other hand, technology has diminished distances, improved our national competitiveness and enabled many things which were previously regarded as impossible. From a narrow point of view technology may refer to only, for instance, computer technology. From a wide point of view technology it deals with the interaction between human beings and nature and with all the phenomena connected with these two.

It is people themselves – us – who will decide on the direction of technological development. Every citizen should have a chance to gain general technological education, technological literacy, in the same way as one learns how to become literate and numerate. It is difficult to make justified technological decisions if one has no basis for her or his choices. By developing purposeful curricula, learning materials and teacher education every citizen can be guaranteed basic know-how for her or him to meet the technological world of tomorrow.

In the past ten years many countries around the world have started offering technology education as a subject of its own in general education (primary, lower secondary and upper secondary) schools. Among the first countries to introduce technology education into the curriculum were the United States of America and England, Wales and Scotland. The annual conferences organized by the International Technology Education Association from United States of America and PATT (Pupils' Attitude Towards Technology)-foundation from the Netherlands have gathered together representatives of the subject from different countries to engage in global co-operation. These organizations together with technology teacher education institutions are the first ones to have started research and development in the field of technology education. Research and development work has been going on particularly in the United Kingdom and the United States for over ten years.

Compared to many other industrial countries Finland is dragging behind in the development of technology education at the primary and secondary levels. It was not until the mid-90s that for the first time in the history of the Finnish school system, two important documents - the Framework Curriculum for the Comprehensive School (1994) and the Framework Curriculum for the Upper Secondary School (1994) introduced technological literacy as an educational objective along with other educational objectives.

For the comprehensive school the national guidelines state that the technical development of society makes it necessary for all citizens to have a new kind of readiness to use technical adaptations and to be able to exert an influence on the direction of technical development. Furthermore, it states that students without any regard to sex must have the chance to acquaint themselves with technology and to learn to understand and avail themselves of technology. What is particularly important is to take a critical look at the effects technology has on the interaction between man and nature, to be able to make use of the possibilities it offers and to understand their consequences. (Peruskoulun opetussuunnitelman perusteet 1994, pp. 11 - 12.)

The curriculum guidelines for the upper secondary school describe technological literacy in the following terms: Technological literacy calls for know-how that is necessary when participating in technology-related discussion and policy making. On the other hand, it also calls for the capability to solve problems by making use of the possibilities technology provides. The development in the various spheres of life and society places new demands to all citizens in terms of their ability to use technological applications and influence the direction of technological development. (Lukion opetussuunnitelman perusteet 1994, pp. 12 - 13.)

The above-mentioned quotations clearly prove that the importance of technology education in the schools has been realized at the national level but there seems to be no consensus on what technology education in schools is, or what it actually could be. Both the discussion in this field and practical implementations of these ideas have been obscured by the fact that neither of the above mentioned framework documents clearly states what is meant by technology education or how it should be organized in schools.

The aim of the present study was to find information that could be utilized when planning the technology education curriculum for the comprehensive and upper secondary school. The approach used was firstly, 1) to analyze the technology education curricula of six different countries, and secondly 2) to explore by means of a survey questionnaire what the representatives of Finnish employers in the field of technology and the representatives of the technology education training institutions (polytechnics and universities) might see as the core components of such curricula. On the basis of these explorations the final aim is to draw up the curriculum guidelines of technology education for the Finnish comprehensive and upper secondary schools. The findings of this report can serve the planners of the forthcoming national curriculum which is planned to be published in 2003, and also the local curricula derived from the national one.

My background is a technical work teacher, however, in this research I aim to study the phenomena of technology and technology education free of my subject specialty. Technology is not seen as technical work, textile work or vice versa; technology and technology education are regarded as an independent field of study.

2 BACKGROUND AND FOCUSES

2.1 Technology education experiment

In February 1990 Matti Parikka and I organized a seminar at the University of Jyväskylä to discuss issues related to technology education. Seminar participants included representatives from teacher education, educational research, trade and industry and secondary education. One of the outcomes of the seminar was a joint agreement that technology education experiment should be launched.

On 30 April, 1991, following the application by the Faculty of Education of Jyväskylä University, Central Finland provincial government granted financial assistance to launch the experiment. The faculty gave the planning and experimentation task to Matti Parikka and me. The provincial government also appointed a steering committee to monitor the experiment. This committee included representatives of manufacturing industries, Central Finland Chamber of Commerce, secondary education sector, Municipal School Office, Institute for Educational Research, National Foundation for the Development of Technology, National Board of Education and the provincial government.

2.1.1 General objectives of the experiment

When the experiment was started, it was the first systematic development experiment in our country to be incorporated in the everyday working routines of comprehensive schools in the field of technology education. The aim was to study this specific field of education from many different perspectives: basic concepts, content and structures, learning environment, learning methods, and desired outcomes. The specified objectives were described as follows:

1 To clarify what technology and technology education could mean in the Finnish comprehensive school, upper secondary school and in the education of class teachers. The focus will be on the balanced development of pupils (girls and boys) as individuals and as members of the more and more technical society, in other words basic technological education (technological literacy). An essential question is: How does technology affect the way in which a child forms the picture of the world?
2 To discover by experimentation which teaching methods and organizational procedures are suitable for the study of technology and how these differ from those used in other subjects. The essential point here is how the concept of work changes as technology increases. At the same time we should also discover through what methods pupils might develop those characteristics, personal features, skills, and capabilities that are termed "entrepreneurship". The aim here is to bring the schools and trade and industry closer to one another.
3 To clarify how technology education is related to education in mathematics and natural sciences, and especially how maths and science education could be made more concrete and conceivable through technological activities.
4 To study the interactional relationships of technology and the living environment (the ethics of technology).
5 To clarify which content areas would be suitable for presentation at each grade level and which factors might determine the placing of these content areas.
6 To clarify how occupational safety education should be implied in technology education.
7 To clarify how technology education can support the multicultural education given in general education schools.
8 To clarify what material resources are needed for technology education to succeed in schools. This includes also the idea that technology education should not only remain inside the school building but should also be directed to the outside community.
9 To clarify what kind of training is required by teachers in comprehensive schools, upper secondary schools and teacher education departments, in order for them to teach technology.
10 To clarify what research methods and arrangements are the most suitable for evaluation and development of technology education. The aim is to encourage the students in class teacher education to focus their Masters theses (pro gradu) on the field of technology education. (Parikka & Rasinen 1994, pp. 14 – 15)

The following chapter describes how the issues and problems listed above have been handled in the course of the project. Designing a new curriculum from pre-school to secondary education always requires reliable data on the feasibility of the various alternative implementations possible. As far as technology education is concerned , there is very little experimental data available on any of the above.

2.1.2 Present state of the experiment

The project was funded at the starting stage in 1991 - 1992 by the Central Finland provincial government (Keski-Suomen lääninhallitus) and in 1994 – 1995 by the Federation of Central Finland (Keski-Suomen liitto). Since then there has not been any funding for the program in spite of several applications. For this reason many of the targets stated in the beginning of the experiment have not yet been achieved.

Despite funding problems the project has been very productive in terms of graduate and post-graduate theses and doctoral dissertations. Two dissertations, three licentiate theses and one Master's thesis have already been completed and several more are on the way. The topics of this research work have addressed e.g. the didactics of technology education (Parikka 1993), history of technology education in Finland (Kantola 1997), and the role of technological expertise in the school curriculum (Parikka 1998). In addition , the Department of Teacher Education of the University of Jyväskylä has published in its pedagogical series two reports which deal directly with the project, one on the aims and objectives of the project (Parikka & Rasinen 1994) and the other one on some practical applications for technological studies (Kurjanen, Parikka, Raiskio & Saari 1995). The third report: Kohti teknologiakasvatuksen teoriaa; Teknologiakasvatuskokeilu 1992 - 2000, raportti 3. (Towards a theory of technology education; Technology education experiment 1992 – 2000, report 3.) (Parikka, Rasinen & Kantola 2000) is forthcoming in the research series of the Teacher Education Department. Two other reports have already been published in the same series, one dealing with visions of technology education (Kanaoja , Kari & Parikka 1997) and one conference report on the development of technology education (Kananoja, Kantola & Issakainen 1999).

The present study concentrates mainly on the first objective of the experiment: "to clarify what technology and technology education could mean in the Finnish comprehensive school, upper secondary school and in the education of class teachers". However, it will become clear that many other objectives are also addressed in the course of the research done here..

The research reported here is part of a wide experiment and research project. In addition to the Faculty of Education of the University of Jyväskylä also Savonlinna Teacher Education Department of the Faculty of Education of the University of Joensuu and Hämeenlinna Teacher Education Department of the Faculty of Education of the University of Tampere participate in the project. In Jyväskylä, Matti Parikka (1998) did research in his doctoral dissertation on how leading specialists of technology (the visionaries) see the technology education of general education schools and how teacher education should be developed. Asko Heinonen (2000), lecturer in the didactics of technical work in Savonlinna, has developed teaching and learning methods which are suitable for technology education in teacher education. Markku Luomalahti, lecturer in the didactics of technical work in Hämeenlinna, is doing research on how students should study in order to learn technological thinking. With these efforts the number of research reports increases from the above mentioned.

From the point of view of curriculum development, the research done by Parikka provides ample information on what structures of technology education should be considered when planning the framework curriculum for the comprehensive schools, upper secondary schools and teacher education. The studies done by Heinonen and Luomalahti promote the didactics of technology education in teacher education and develop the learning methods and learning environments involved.

At a later stage, the expectations of parents and pupils will also be explored. The project group in Jyväskylä, Hämeenlinna and Savonlinna have collected data on parents' expectations through a national questionnaire. These data have not yet been analyzed or reported fully. Only one part of the data have been reported in a Master's thesis (pro-gradu) by Meretniemi and Saastamoinen (1998).

2.2 Purpose of the present study

The present study aims at exploring what theoretical building materials could be established for the framework curriculum of technology education. In addition, the aim was to search for more detailed and concrete curriculum materials for provincial, district, municipal, and school purposes. In order to define the scope and focus of each curriculum element (for instance rationale, theory, objectives, methods, contents and means of evaluation), the approach taken was to study, on the one hand, the technology education curricula of six different countries, and on the other hand, to gather information from teachers and researchers of Finnish technology training institutes (Technical Universities and Polytechnics) and the experts of trade and industry operating in the field of technology.

It can be asked how objectively, from the point of society as a whole, the above-mentioned experts in training and business are able to deliberate upon the questions dealing with general schooling. One may also wonder how relevant the curricula of other countries are for the Finnish context. It is, however, quite justified to start exploring the issue by interviewing experts who have been dealing with and are continuously engaged in technology-related operations. It is also advisable to use curriculum materials which already exist and which have been at least to some extent tested in various countries.

2.3 Specified research tasks

The intention of the research was to study what technology and technology education is and what it could be in the Finnish comprehensive and upper secondary schools. By analyzing the curricula of six different countries and by asking the opinions of Finnish experts who train technologists and who work in the technology trade and industry, an attempt has been made to establish some elements for the Finnish technology education curriculum. The more specified research tasks and questions can be derived from the graphic model below:

1 What does technology and technology education mean, or what could it mean, in the Finnish comprehensive school and upper secondary school?

There are many conceptions of technology depending on the person who is interpreting the issue. Traditionally the first research task could be regarded as a review of previous studies and as an introduction to the theory of the phenomena under study. However, the purpose of this research is to seek for a consensus on what could be called technology and technology education in the Finnish school context. From this viewpoint, although this research question deals with the theoretical background, it also aims at finding an answer to an essential problem, and can, therefore, be considered one specific research task. The results of defining the concepts are also compared to the results of analysis of the other data. For these reasons the concept of technology and technology education will be discussed in connection with the findings and not as a theoretical background.

2 How have Australia, England, France, the Netherlands, Sweden and the USA organized the technology education in their schools?

Most of the above mentioned countries have a national technology education curriculum for their schools. What are the attainment targets, methods and contents in the curricula of these countries? How is the curriculum implemented in the schools? These issues are addressed in the examination of these existing curricula.

3 What are the expectations of Finnish technology experts for the technology education provided in our schools?

Technical universities and polytechnics, as well as technology enterprises, will in the future employ our school graduates. What type of learning achievement do they expect from general education?

4 What are the elements and building materials which would best suit the Finnish technology education curriculum?

By synthesizing the answers to the first three questions this study, then, attempts to establish the information which could be used when writing the next national framework curriculum and the more specified curriculum for technology education at Finnish schools.

The results are not presented in a separate chapter, but they are introduced as the study proceeds. In the case of curriculum, for example, it can be observed from so many different viewpoints that the summary alone cannot fully cover the issues involved. The different stages of reaching the summary can also be regarded as research results. These stages can be used, for instance, when planning the local curricula. However, answers to the first research task can be found mainly in Chapters 3 and 8.1, answers to the second research task in 4.4, 5.1 and 8.2, answers to the third research task in 5.2 and 8.3, and answers to the fourth research task in 8.4.

2.4 Introduction to research procedures

The meanings of the concepts of technology and technology education are studied first, followed by an introduction to the requirements for curriculum development. On the basis of these, a model which is used for a systematic analysis of the technology education curricula of six different countries is presented, and curricular elements regarded as important in several of these countries are identified. The analysis proceeds in two phases. Firstly, the curricula of Australia, England, France, the Netherlands, Sweden and the United States of America are studied to obtain a general idea of their contents. After this they are examined more closely in order to identify common features, and on the other hand, also possible special features pertaining to certain countries. These features are called curriculum elements and building (or construction) materials in this study. An umbrella concept is curriculum materials; elements are entities which include several building materials. Elements can be used for example when planning the national curriculum, whereas building materials are used at local (municipal) and school level. After the analysis the elements are presented in a table format to make it easier for the reader to observe them.

The quantitative part of the present study consists of the findings of the survey conducted to elicit the views and expectations of Finnish experts operating in the field. Through a questionnaire study some representatives of technology training institutes and of the technology trade and industry were asked to give their opinions about the contents, methods and attainment targets of technology education. This was done by means of a structured and open questionnaire. Mean values were then calculated for the variables and a factor analysis of the data was performed. On the basis of the means different groups and categories of attainment targets, methods and contents were formed. Through a factor analysis several variables were grouped into smaller groups (factors). By interpreting these factors some latent variables which might explain the opinions of the experts in the complex field of contents, methods and targets of technology education were also explored. Information from these findings can be used when writing the detailed national, provincial or municipal curriculum or when writing the schemes of work for a group of schools or a single school. Finally, the elements that were identified through the analysis of the curricula were studied together with the groupings established by the statistical analysis in order to find possible common features. To conclude, the findings were used to formulate some recommendations for the future technology education curricula of our country.

Figure 1 presents a graphic model of the different stages of research proceedings. The numbers in the boxes of the model refer to the research tasks, and the backward arrows from the box at the bottom describe the ever-changing state of the curriculum.

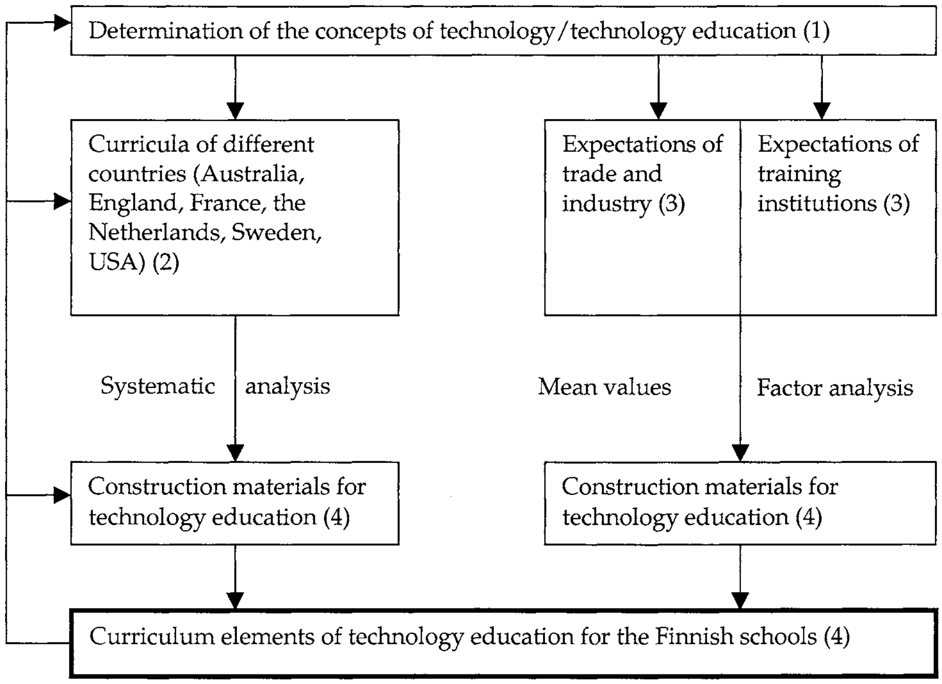

FIGURE 1 Model of the research proceedings in the present study (Numbers in the model refer to the research tasks)

3 CONCEPTS OF TECHNOLOGY AND TECHNOLOGY EDUCATION

In this study, technology and the study of technology are described within the framework of general education. The term "general education" can be defined from many different points of view. It is a very complex and ever changing concept (Välijärvi 1993, pp. 2 – 8). It can be, for instance, defined as preparedness to perceive the reality around a human being in a versatile and harmonic manner in the cultural environment in question (Brunell & Välijärvi 1988, p. 2). From the perspective of social interaction general education is a common language, which provides a basis for rational social conversation independent of the specialization of the different individuals involved. Therefore, it is also very much dependent on culture (Välijärvi 1993, p. 2). Furthermore, general education is independent of the immediate benefits which appear as considerable changes in thinking and acting. These skills assist in learning and adopting professional skills (Välijärvi 1988, p. 4 – 5). The importance on general education has been emphasized in different contexts of education and training over the past years. Discussion on the relationship between general education and professional education has also been active (Välijärvi 1993, p. 3). Some researchers e.g. Välijärvi (1989 p. 6) argue that if a person has no general education he or she is uncivilized: It is uncivilized to concentrate on a specific field of know-how without understanding the world outside one's own narrow sector. It also indicates reluctance and inability to understand the effects of one's doings on nature or other peoples' lives. His characterization of general education can be classified, for instance, as follows:

1 means of getting through the ever-expanding supply of information, and device to outline the reality by taking advantage of diversified information channels;
2 chance to act as an independent and capable member of a society, being prepared to use one's know-how in ever-changing situations in versatile ways;

3 ethic extension of the human mind, in other words, an ability to independently find, choose, and apply knowledge on the basis of one's own internalized value foundation;
4 readiness to understand on the basis of alternative branches of knowledge the matters and factors affecting the development of society, and to take part in the debate and decision-making concerning these matters;
5 a common device for thinking and discussion for a common understanding by representatives of different fields;
6 universal cultural matter, which combines or provides a basis for understanding the differences between various cultures. (Välijärvi 1989, pp 3 – 5; see also Parikka 1998)

The above characteristics are the basis for interpreting the concept of general education in this report. General education refers to such know-how which belongs to the education and schooling of every citizen. This know-how is learned at schools which provide general education. In technology education, these schools should develop in the students such preparedness (basic technological competence, technological literacy, technology education) that they are technologically prepared to meet the challenges of the technological world either as ordinary technology users or as students in the fields of technology. In the report in hand the comprehensive school (primary and junior secondary, peruskoulu) and upper secondary school (lukio) are called general education schools and the comprehensive school is called compulsory education school. By this definition, then, for instance secondary vocational education is not included. This report concentrates only on general education and the teacher education connected to it.

3.1 What is technology?

3.1.1 Technology from the etymological perspective

In everyday discussions technology is often understood as high-tech or computer technology (see also Hansen & Froelich 1994, 180). According to Nykysuomen sanakirja (Dictionary of modern Finnish language)(1990, 408) technology is study, science and comprehension of the working methods which are used to format raw materials to refined products (oppia, tiedettä ja ymmärrystä niistä työmenetelmistä, joilla raaka-aineita muokataan jalostus-tuotteiksi). If one would be satisfied with the understanding of common life or with the definition of Nykysuomen sanakirja, it would not even be necessary to discuss technology education in general education schools. The authors of the Framework curriculum for Comprehensive Schools (1994) and the Framework Curriculum for the Upper Secondary School (1994) have had a wider perspective on technology, although the concept of technology is not exactly defined there, either.

A well known Finnish philosopher von Wright (1987, 14) has deliberated upon the essence and phenomena of technology from many points of view. He states that (Western) science has promoted greatly our ability to foresee and control natural phenomena. This ability has yielded fruits in technology which have influenced human living conditions in a very profound and permanent manner. English literature speaks about 'pay-off' which can also be considered as 'out-put'. The popular images about science have hardly ever before been as positively charged as today, when industrial technology based on scientific knowledge is changing life in practically speaking all countries of the world.

The psychological foundation of Greek philosophy and science can be described as a more implicit than outspoken belief of the fact that the human brain can understand the *logos* of matters, their meaning and internal order, without any assistance from some 'supernatural' authority (von Wright 1987, 23). Logos is thus connected to such expressions as: understanding, realizing, having a good command of the concepts, comprehending the phenomena at hand.

In the Finnish language the word 'tekniikka' has an ambiguous meaning, and refers to both technics and techniques. The word itself does not reveal if the issue in question belongs to the sphere of technics or techniques. Readers or listeners have to make a decision of their own. 'Technics' can mean production of artifacts ('artificial' products or other products) for a certain purpose. The word 'technique(s)' on the other hand, refers to the skill and know-how ('methods') which are needed to get an artifact done. This word is also used when referring to the activities of an artisan or an artist. Technique(s) can be taught and thus passed over from one generation to another, and it can be codified according to different general rules. (von Wright 1987 p. 32) According to Kojonkoski-Rännäli (1995, p. 56), then, the means and equipment which belong to human activities of doing something to achieve a certain target are called 'tekniikka'. All means of productive making, both handicraft and modern production, are 'tekniikka'. Kojonkoski-Rännäli sees 'tekniikka' in a holistic way whereby technics and techniques are combined.

Above technics and techniques there is the concept of technology. According to von Wright (1987, 32 -33) technology is based on the scientific knowledge of the logos which is the basis of *tekhne*, that is, the knowledge of the rational principles ('natural laws') which are applied by technicians while working. According to Heidegger (1985, 16 - 17, 24 -25, 154 - 156) the word tekhne is Greek and refers to both handicraft know-how and art, but also to understanding and knowledge in their widest meaning, like coping with or getting over something or getting acquainted with something. It is the doing that brings out of the being something that would not come out by itself, but has got the potential to appear in one form or another. Therefore, it is important that in addition to merely producing items, one part of the making process is knowledgeable control of both planning and executing the plans in practice. Making things in such a way that the different parts of the process are realized separately from each other, and done by different people, is not part of tekhne. So, for instance, activities done by different people in line production do not belong to tekhne, even though these people might be working with a very high quality technological innovation. (see also Kojonkoski-Rännäli 1995, 56 - 57). According to Parikka (1998, p. 40) the historical and etymological development of the concept of technology is from handicraft via technics to technology. Thus, technology has developed from handicraft and technics. Together with handicrafts are skills, arts and the use of handicraft devices (tools); together with technics go handicrafts skills, tools and machines but also the planning and making of machines; and, finally, together with technology are technics, as well as scientific know-how and application (applications of natural sciences and automation). In the concept of technology scientific know-how, thinking and understanding are emphasized. Therefore it is more justified to use the term technology instead of the term technics in teaching and research (compare e.g. biology, ecology, psychology, and theology).

For Mitcham (1991, p. 87) technology is a synonym for tekhne. Technology is the critical point where knowledge and will are combined for making artifacts and using artifacts. Artifacts may also affect the mind and the will. More than ten years earlier Mitcham (1980) considered technology from four different points of view: as a target, as a process, as know-how and from the viewpoint of will.

Dyrenfurth and Mihalevich (1987) indicate that there are several interpretations of the term technology which differ from each other. They sum up the definitions in three main categories:

- Technology is taken up to test and polish the theories of effective action. This activity can be lead only from practice... It is praxiological know-how - know-how about practice
- Technology is ... know-how about how to make something about regulations, sometimes about scientific theories, sometimes about pragmatic experiences (technics)
- Technology is a social process where abstract economical, cultural and social values are formed and developed and where certain products and technics are put into practice. These can be seen in clearly separated technical problem-solving activities, which are called engineering. Engineering sciences are phenomena describing the above mentioned processes. (Dyrenfurth & Mihalevich 1987, p. 6).

Naughton's (1986, p. 27) definition is also based on similar know-how and practical objectives: "Technology is about applying scientific and other type of organized information in practical tasks. These tasks are given by (hierarchically organized) social systems and they are connected with people and machines. "

3.1.2 The linguistic perspective

Henchey (1987, pp. 42 - 44) defines technology as a "means of controlling the environment, which does not include only tools and technics but also system, environment, way of thinking and different values". He classifies different features of technology and gives examples to describe how technology can be interpreted at different levels according to its complexity as a tool or as an instrument; as a process or as a method; as a system, which integrates the instruments and elements to a structure or an organization; as environment; as epistemology or way of thinking and finally as ethics, as system of values, which is the most important. Pytlik, Lauda and Johnson (1985) also see technology as a social phenomenon - from a point of view of the relationship between human beings and nature. "The technology of human beings is their means of adapting with environment." (ibid., p. 7).

Kantola (1997, p. 51) emphasizes the problems which occur when translating the English language and German language terms. He points out that Heidegger does not use the word technology but the German word *technik*. According to Niemi-Pynttäri (1988, p. 25) the word *technik* has been translated in Finnish texts as technology because Heidegger does not refer to any single working mechanism, but to an entity, in other words technology. Fores and Rey (1986, p. 25) state that the German word *technik* means the operation of objects made by nature and human beings and the methods used for producing these objects. They find it unfortunate that the word *technik* is missing from the English language. According to Pursell (1994) the word technology in the English language has originally meant the discourse of arts and skills or studying ("a discourse or treatise on an art or arts"). Pytlik et. al (1985, p. 4) agree with Pursell when pointing out that the word technology has been used in England for the first time in 1615, when technology was given the following definition: a discourse or treatise (study) of art or arts; a scientific study of practical or industrial skills. In the 19th century and since then technology in the English language has meant working skills and practical know-how (see also Mannerkoski 1986, p. 3).

Kananoja (1989, p. 84) argues that the meaning of the term technology varies from culture to culture. In the English speaking countries technology is a synonym for technics. In the French, German and Slavic language groups technology is normally used in a narrow and specialized way: wood technology, machine technology etc. In Finland the present practice follows more the English direction. Mannerkoski (1986, p. 2) points out that in German universities and polytechnics technology has mainly referred to making and treating of materials and using machines in the process.

The close co-operation between Germany and the United States in the field of technology education has brought the present interpretations of the term technology closer to one anoher. Researchers from both countries have published together many articles dealing with technology education. In institutions training technologists, technology is divided according to the training programs offered by the institutions (Yliopisto-opinnot 1996 - 1997, pp. 205 - 214). These institutions have close relations with the trade and industry, and often also aim to do research according to their needs. For instance, Lappeenrannan teknillinen korkeakoulu (Lappeenranta University of Technology) offers the following study programs: energy technology, electrical engineering, chemical technology, mechanical engineering, information technology, industrial engineering and production, and business administration.

3.1.3 Technology as a school subject

Layton (1994, p. 19) expresses his worry about the fact that technology in higher education, unlike e.g. chemistry, physics or history, does not cover a uniform well-established academic field, which could act as a model and source for its development. Instead, there are many branches of technology and engineering sciences which cover materials, energy, production, agriculture and food, biotechnology and medical technology, environment, communication, electronics, computer technology, transport and space. Because of this lack of unity and the existence of many special areas, it is understandable that development of a kind of "general technology" has been proposed. This would form a basis suitable for technology at school, and would comprise basic concepts and principles of technology. If this type of a conceptual structure of technology is not developed, any attempts to incorporate technology education in the general education program may meet insecurity and confusion (see also Lewis, 1991, Savage & Sterry, 1990 and Ropohl, 1992, pp. 74 - 79). Marsh (1997b) expresses his concern on the state of technology studies by dedicating to it one whole chapter out of 14 other chapters dealing with curriculum planning and development. The titles of the other chapters deal with such concepts as curriculum frameworks; school audits; aims, goals, and objectives; selection of method; profiles, records of achievement, and portfolios; using textbooks; curriculum integration; different planning models and curriculum development and implementation; as well as assessment. None of the traditional school subjects are given any special attention.

The starting point of technology education in the general education schools deviates clearly from the point of view of technology training institutions. For instance, in Australia technology education is based on four basic principles: 1) planning, making and evaluating, 2) information, 3) materials 4) systems (A statement on technology for Australian schools 1994, p. 9). In the United States of America the universals of technology are: 1) contexts, 2) processes, 3) knowledge (International Technology Education Association, Technology for all Americans, A rationale and structure for the study of technology 1996, p. 17). Standards for Technological Literacy: Content for the Study of Technology publication is organized in five major categories: 1) the nature of technology, 2) technology and society, 3) design, 4) abilities for a technological world, 5) the designed world. In the Netherlands the areas of technology education are listed as follows: 1) technology and society, 2) technical products and society, 3) planning and making of products (Huijs, 1997, see also deVries 1999).

Custer (1991) reminds us that there are shortcomings in the definitions of technology:

1 The historic confusion of the role of technology in education, politics and industrial growth.
2 The existence of many different and controversial approaches of technology in the academic discussion.
3 Lack of conceptual depth and clarity while pointing out the existing need for technology education. (Custer 1991, p. 114; see also Kankare 1997, 39).

Hansen and Froelich (1994, pp. 179 - 203) have written a very extensive and fundamental article on defining technology. They consider technology from both a discipline-based and from educational perspectives. The discipline-based perspective they consider from 1) historical, 2) anthropological and 3) philosophical points of view. While dealing with the educational perspective they present 1) technology as part of general education, 2) a feminist viewpoint and 3) the problems facing the schools. They come to the conclusion that technology should not be defined from the point of view of the discipline but rather from the point of view of the experiences and education of the person concerned. The definition for technology education which refers to school practices must be without bias for gender, class, and ethnicity.

Alamäki (1999, pp. 23 - 26) emphasizes that the definition of technology is strongly associated with the approach of technology education. According to him two categories of definitions can be distinguished: firstly, technology is mainly human activity geared toward satisfying human needs and wants by modifying the nature and human-made environment, and secondly, technology is primarily a study of humans' modification of nature and human-made environment. However, there is also a third group which includes both the study-based definition and the human activity-based definition in the definitions of technology.

In the definition given by the working group of the technology education experiment at the University of Jyväskylä, technology was divided into *technique* (this refers to production: skills and know-how (methods) to make a product: "how should I make it?") and *technics* (this refers to equipment: tools and machines needed to produce a product: "by what means?"). On this basis *technology* was further defined as follows: Technology is the understanding of the functions of technical instruments, equipment and machines and their controlled and skillful use in order to create products and services (Parikka & Rasinen, 1994, pp. 16 - 18).

Figure 2 presents how technics and technique are derived from technology.

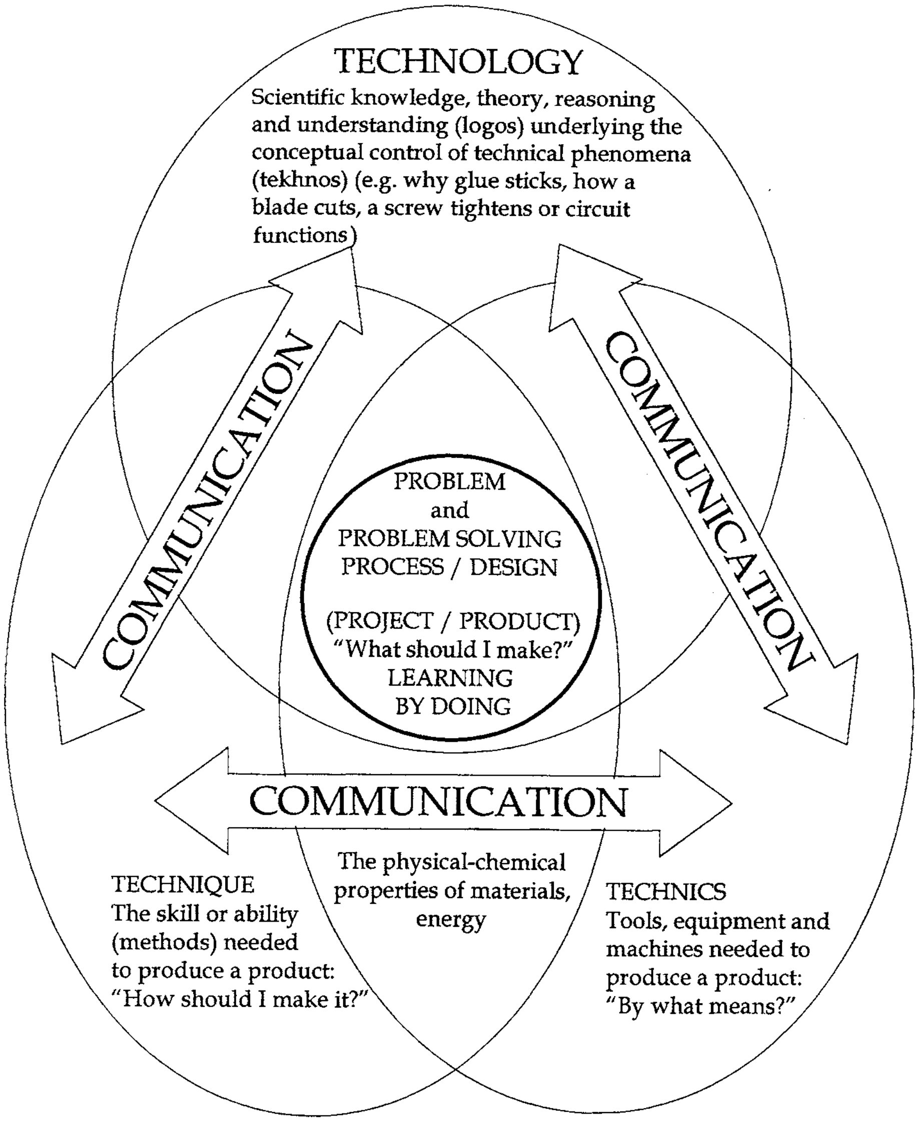

FIGURE 2 Concept of technology (Parikka & Rasinen 1993, p. 195)

3.1.4 Technology and natural science

In the present study technology is considered as a discipline of its own. However, because the relationship between technology and natural science is discussed extensively particularly in British and American literature of the field (e.g. Eggleston 1992, 1993, pp. 20 - 34; Layton 1993; Solomon 1993), it is also necessary to introduce some main points regarding the comparison of the two branches of science. It is important to realize the fact that the background of the authors is clearly reflected in their definitions and comparisons (DeVore 1980; Dyrenfurth & Mihalewich 1987 and Naughton 1986).

One of the topics for discussion is the hierarchical order between technology and science. Which is more important? Is technology dependent on science or vice versa? Can science exist without technology? Is technology an independent area of science or is it mere applied science? For instance Frey (1989, p. 28) and Lewis (1993, p. 175) believe in the superiority of science. Woolnough (1986, pp. 156 - 157) argues that technology should be part of science studies. Dyrenfurth and Mihalevich (1987), on the other hand, suggest that technology is not part of science but an independent field. Furthermore, according to Lauda (1985, p. 4) there are societies with technology but no science. He gives several examples of a built environment where human beings have made many technological inventions without knowing the natural laws (different processes, e.g. production of iron, building medieval cathedrals, making steam engines, electric light, movies). Also Wiens (1988, p. 185) gives several examples which support the idea that technology has preceded science. As one example he mentions fire, which was used thousands of years before the chemistry of combustion was understood and before the laws of thermodynamics were defined. Likewise Locatis (1988) gives examples like steam engine, barbed wire, and plasma computer tube as evidence for many inventions to have been developed independently of science, with inadequate or non-existent scientific knowledge, or through incorrectly constructed or applied science theories. He also notes that some inventions like the wheel have been invented well before there was scientific research on the topic.

Opposite views of the relationship between science and technology have also been presented. Lauda (1985) and Wiens (1988) give examples of innovations which have been developed through scientific discoveries. These include, for instance, the galvanometer and magneto. Furthermore Wiens (1988, p. 196) gives an example of fusion as a possible source of energy. There is enough scientific know-now but with the present technology the fusion process cannot be sustained. DeVore (1980, p. 239) and Pinch & Bijker (1987, p. 19), then, describe several studies which have tried to seek for a clarification on how much technological innovations are dependent on science. Convincing support for the hierarchical relationship between technology and science, however, has not been achieved. According to Fensham (1992) the literature in the field indicates a broad consensus on the fact that technology and science are two different disciplines. However, at the same time, they are dependent on each other. Hansen & Froelich (1994) have made a thorough literature review on the above issue, and this paragraph also leans on their article. They finally come to the conclusion that, although many authors have given their views to clarify the differences between technology and science, there does not seem to be a clear and simple explanation on what it is exactly that distinguishes the two (ibid. 1994, p. 195).

Dugger (1993, pp. 174 - 187) observes the relationship between technology, science and mathematics. According to him (1993, p. 176) technology is a study of our human-created and controlled world and universe (see also DeVore 1980, p. 241; Frey 1989, p. 33; Maley 1985; Mitcham 1980, p. 317; Wiens 1988, p.195). Science is a study of our natural world and universe (National Research Council 1992). Mathematics is a study of all conceivable abstract patterns and relationships (American Association for the Advancement of Science 1993). Dugger emphasizes the injustice and difficulty of comparing these three disciplines, for instance because they overlap in many ways. On the other hand, however, they also clearly differ from each other. When the natural world is altered by technology it has impacts on both science and technology. Science is dependent on technology for testing, experimenting, checking and putting into practice its new laws, theories, and principles. Likewise, technology is dependent on the research, conformity, principles, and database of science. Because these three disciplines contribute considerably to one another, Dugger (1993) compares them with each other in order to make it easier to understand their differences and relationship. Since in the literature of the field science and technology, their similarities and differences, are most commonly compared, an example of the comparison between technology and science is introduced here in Table 1.

TABLE 1 Comparison of technology and science (Dugger 1993, pp. 178 - 179)

TECHNOLOGY	SCIENCE
Involved with our human created world	Involved with our natural world/universe
Concerned with "how to"	Concerned with" what is"
Knowledge created and being created	Knowledge discovered or being discovered
More directly involved	Detached... Generates knowledge for its own sake
Guided by trial and error or skilled approaches derived from the concrete	Concerned with reality and its basic meaning
Used in combination with such words as: application, instrumental principles, tools, response to perceive needs, artifacts, practice, effectiveness, empirical laws, invention, innovation	Used in combination with such words as: theory, theoretical principles, research, generalization from theory
Its success or failure is usually determined by social acceptance and success in the marketplace	Its success is not judged by social unity

(continues)

TABLE 1 (continues)

Action-oriented & requires intervention	Research/theory-oriented
Involved constantly in studying means-ends relationship	Remains separate from what is being investigated
Systems-oriented	Laws/principles-oriented
Making/doing things	Understanding things
Philosophical relationship: pragmatism	Philosophical relationship: realism
Dependent on science and mathematics	Dependent on technology and mathematics

3.1.5 Technology and society

The rapid development of technology has changed our society. It has affected the daily life of an individual and it has affected global solutions. The development of, for instance, railways, cars, airplanes, telegraph, and telephone, has brought different people and different cultures closer to each other. These developments have had many positive effects, but also many negative ones, particularly social and environmental. Technology affects the economy and vice versa. It enables the establishment of high standard hospital services, but also the construction of high standard war equipment. Technology can be developed in the direction where it adapts to current needs and the current environment, but it can also be developed in the direction where it is in a constant process of change and renewal. It is the society that should control technology and not the other way round. In a humanistic society the ethics of technology have to be controlled consciously.

Pantzar (1996) considers technology from the societal, or more particularly, from the consumers', perspective. He does not actually define technology, but refers to the material and spiritual products of a human culture, that is, to artifacts. For him such words as artifacts, goods, commodities and objects are almost synonyms. He emphasizes that confrontation of culture and nature is artificial while speaking about the life-spans of commodities and biographies of artifacts. Pantzar claims, on the one hand, that consumer surveys have neglected the technological specialty of products, and on the other hand, that innovation and diffusion surveys, which concentrate on single products, have almost completely forgotten the role of households and consumers. The consumer has been seen either as a trivial "black box", which adapts straight away and smoothly to all new technics, or as a rational and calculating actor who simply determines the direction of the development of technology. Both extreme ends, that is, both technological determinism and technological voluntarism are very problematic from the point of view of the latest research of technology (Pantzar 1996, pp. 12 - 13). Also Niiniluoto (1986, pp. 4 - 25) discusses technological determinism and voluntarism in his philosophical article. He comes to the conclusion that "determinists are right in that the development of technics is a complex law-like process, which seems to set orders, 'technological imperatives' to human beings. Voluntarists are right in that the humankind does not have to obey these orders, because behind them there are always either outspoken or non-outspoken value premises." (Niiniluoto 1986, pp. 21 - 22)

3.1.6 Technology and handicraft

Handicraft teaching and technology teaching have seldom been compared in the research literature. Comparisons are mainly done - as above - between technology, science and mathematics. The reason for this is obviously that, for instance, in England and the United States handicraft education has developed into technology education. According to Alamäki (1999, p. 37), technology education has evolved from craft education in many countries. He also argues that, due to technology education still being in the evolution process, many approaches from crafting to applied science are being used in technology.

In Finland, Kantola (1997) and Parikka (1998) define technology as an umbrella concept for handicraft education. Anttila (1993), Peltonen (1988) and Suojanen (1993), on the contrary, regard handicraft education as an umbrella concept for technology education. Alamäki (1999, p. 14), then, explains that 'käsityö' is the official name and overall term for a subject group that consists of the school subjects 'tekninen työ' (technical work) and 'tekstiilityö' (textile work). "'Käsityö in the Finnish educational context has no direct English equivalent but implies a combination of crafts, design and technology education." (ibid. 1999, p. 173.) He also notes that "the contents and processes of the Finnish 'tekninen työ' correspond to the international view of technology education. He goes on by saying that in many Finnish publications (e.g. Alamäki 1998a; 1998b; 1999; Alamäki & Suomala 1998; Kankare 1997) the English equivalent of the term 'tekninen työ' is technology education. (ibid. 1999, p. 14.)

Experts of craft education and technology education, whether Finnish or foreign, agree on particularly one view. Both groups see that an essential part of learning is the creative planning and production process (Anttila 1993, Hill & Lutherd 1999, Eggleston 1994, Lindfors 1992, Peltonen 1988, Suojanen 1993, Yli-Piipari 1991). Kojonkoski-Rännäli (1998, p. 368) distinguishes, mainly following Bunge (1985, p. 220), the handicraft production activity and the technological production activity. According to her, hands-on methods are used in handicraft, whereas in technology methods of modern technology are used. In this study thinking and use of brains is considered to lead all work done by hand. Hand work, working with hands, hand skills, handicrafts and hands-on activities are considered synonymous in this report, and are part of practical work.

3.1.7 A compact definition of technology

Parikka (1998, pp. 33-72) has done an extensive study on the meaning of technology as a concept and as part of general education. To explore the components of technology in general education he has conducted a qualitative analysis of its essential content from four perspectives: 1) etymological, 2) effects of technology on culture, society and environment, 3) technological systems, and 4) technological innovation processes. On the basis of the definitions he has designed a three-dimensional cube model to visualize the dimensions of technology; these are: technological systems in society, innovation processes, and the effects of technology. Technological systems in society include information technology, technology used in health services and administration, in building and construction, in industry and industrial life, and in agriculture and forestry. The processes of perceiving, learning, and planning provide the basis for the innovation process. The effects of technology are cultural, societal, and environmental. All of these domains were derived from the empirical data of Parikka's research.

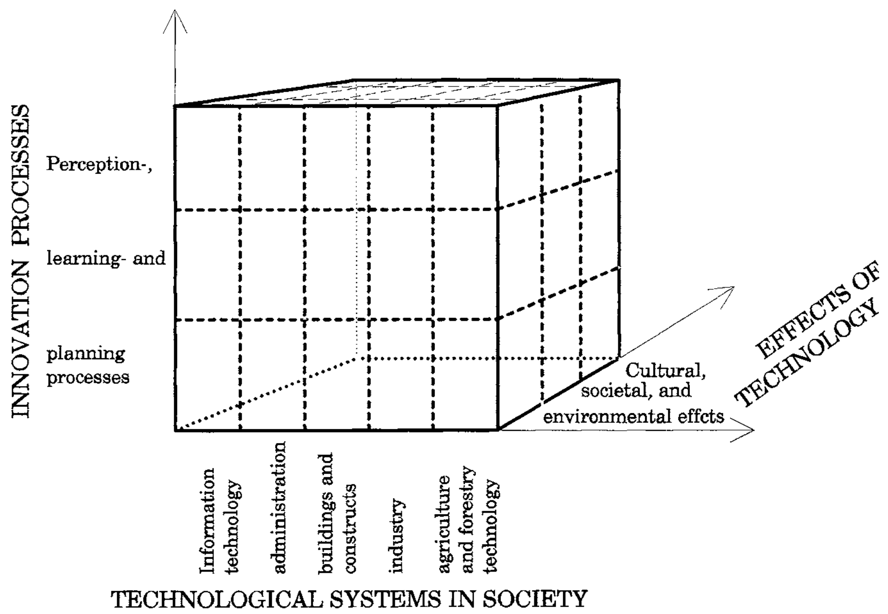

FIGURE 3 A cube model for defining the concept of technology (Parikka 1998, p. 72)

When comparing Parikka's model to the model from the United States, i.e. the universals of technology education (Technology for all Americans, International technology education association, 1996, detailed in Chapter 4.4.6), many similarities can be found between the models. However, realization of the entity is completely different in these two approaches. For instance, in the model from the United States technological systems and consequences are linked to the process dimension, whereas in Parikka's model processes, systems and effects (consequences) form the three main dimensions. In both models technology has been realized in an extensive manner. The innovation processes in Parikka's model refer directly to a learning activity. Therefore it is justified to claim that it is more suitable for didactic purposes.

3.1.8 Summary of the concept of technology in the present study

Technology can be defined in many different ways. How it is determined depends on the background, academic field, history and presumptions of the person explaining the concept. The empirical research findings to follow in this report may bring more light to the definition. Therefore, at this stage there is no need to limit the approach, but see technology at this stage from a very wide perspective. It is equally the first stone ax as well as the latest invention of electronics industry. One of the broadest definitions for technology has been stated by Hansen and Froelich (1994, p. 202) who say that technology is the means by which people mediate between nature and themselves. At this stage of this report this definition may be used as it is open enough to the interaction of different variables.

3.2 What is technology education?

Technology education, technological education, technology teaching, teaching of technology or technology and teaching are almost synonyms which refer to the school subject in the schools where general education is provided. The attainment target is to achieve technological competence, basic technological education, general technological education or technological literacy/literacy in technology. The most commonly used terms are technology education and technological literacy.

3.2.1 Technology education

Before defining the term technology education at the onset of the technology education experiment in Jyväskylä, we familiarized ourselves thoroughly with the domestic and foreign literature on this discipline. On the basis of the extensive literature review we formed our own view, where we emphasize that the first issue to observe is the historical point of view of technology. In other words, technology as an element of creating culture, controlling culture and regulating culture. In comprehensive schools and upper secondary schools the following also have to be taken into account:

1 attainment targets, this is, what type of technological readiness is probably needed in the future;
2 learning contents, this is, what themes, materials and instruments will be chosen as media and activity stimulus for learning;

3 what kind of working methods and learning strategies are the most convenient to use (Parikka & Rasinen 1994, p. 19).

In technology education the importance of the pupil's everyday environment, working with hands, thinking skills and practical planning skills are emphasized. From these the following definition for technology education can be derived:

Of central importance is the pupils' growth (sensitization) in the recognition, description, specification, understanding, solving and evaluating of technological problems. These learning and educational outcomes can generally be called basic technological education, i.e. they serve to clarify how technology affects the pupil's conception of the world (Parikka & Rasinen 1994, p. 19)

3.2.2 Technological literacy

Particularly in the literature from the United States the concept of technological literacy is used to describe basic technological education. Also Kankare (1997, p. 83) argues that "teknologinen perussivistys" (basic technological education) would be the best translation in the Finnish language for technological literacy. In his research, however, he also uses synonymously the literal translation ("teknologinen lukutaito") of the concept of technological literacy. Kantola (1997) has introduced another concept, technological competence, which was profoundly studied by Parikka (1998). Parikka notes that technological competence is close in its meaning to technological literacy, but the approach can be regarded as slightly broader. Alamäki (1999, pp. 52-55) has compared the concepts of technological literacy and technological capability. According to him both concepts can be seen as the outcome of technology education. Technological capability originates from the English literature in the field and technological literacy from the United States.

Dyrenfurth (1991, p. 31) has collected together definitions of technological literacy from the 1970's and 1980's:

- "...an understanding of the application of science and engineering to the solution of concrete problems." (Miller 1986, p. 5)
- "...the possession of a broad knowledge of technology, together with necessary attitudes and physical abilities to implement the knowledge in safe, appropriate, efficient, and effective manner. Technological literacy requires that one be able to perform appropriate tasks using tools, machines, materials, and processes of technology. Industrial technological literacy, a subset of technological literacy, may be defined as 'the ability to understand, appreciate and efficiently make and use the man made world'." (Lux, 1978)
- "...an understanding of the systems of technology." (Jones 1984, p. 8)
- "...the creation, use and control of technical means is embedded in the social, economic and political fabric of our society." (Bowden 1982 p. 9)
- "...the issue is the understanding and control of the behavior of technological systems as a major component of social systems and as critical factor in cultural change and distribution within societies." (DeVore 1987b, p. 22)
- intended to "...control technical means by intelligent sensitive human beings." (DeVore 1987a)
- technology and the teaching of values. The AAHE Bulletin (pp. 8-10) cited the 1983 Atlantic Council Policy paper which stressed "...that today's youth must

understand the needs, uses, and limitations of technological knowledge and the challenges of traditional values technology can pose. How can they use technology for human purposes and not be overshadowed by it?" (Billington 1985, p. 8)
- to "...integrate work and life", to "...provide flexibility and mobility both of skills and of geography," and to find "...a set of meaningful values." (Deforge 1981)
- an ability to experience, observe, examine, draw and design things for and from environment. As a result, young people should be able to:
  - understand the steps in a process
  - develop mental images/ideas into forms that they can see and react to
  - look at the physical world in alternative ways (Smalley, not dated)

As a summary Dyrenfurth proposes that technological literacy necessarily requires the ability to do technology, that is, to use it and not merely to recognize technological processes. Technological literacy requires more than just the ability to identify technological components or to be aware of technology's effects. Although these characteristics (recognizing, identifying, and awareness) are important and necessary characteristics of technological literacy, without the ability to do, they are unfortunately not sufficient. The ability to do necessarily involves skills to some extent. Skillful operations are an essential part of technology. (Dyrenfurth 1991, pp. 31 - 31). In Finland Kolehmainen (1998, p. 75) has drawn up a list of the key components of technological literacy. In addition to the above definitions Kolehmainen emphasizes the importance of lifelong learning and the importance of evaluating the manifestation of technology.

During the past three years five doctoral dissertations dealing with technology education have been published in Finland. In all of these (Alamäki 1999, Autio 1997, Kankare 1997, Kantola 1997 and Parikka 1998) the concept of technology education is discussed. Autio and Kankare regard technology education to be a part of "tekninen työ" (technical work) in the Finnish school curriculum. According to Alamäki the Finnish "tekninen työ" corresponds to the international term technology education. Kantola, in turn, proposes that "tekninen työ" has evolved and will evolve towards technology education. Parikka sees technology education as an umbrella, under which "tekninen työ" falls.

Parikka's research concentrates on technological competence, which is seen as the target of technology education. According to his research the structure of technological competence is consisted of the conceptual level and functional level. Even from a global perspective Parikka's model is obviously one of the most extensive and comprehensive characterizations of technology competence. He also examines the definitions of technological literacy given by different specialists, and comes to the conclusion that there are several similarities in the concepts of technological literacy and technological competence. In his conclusion Parikka (1998, p. 120) integrates the definitions of different researchers as follows: The issue at hand is about education which is future-oriented and in which the targets are those technological characteristics which assist the learners of today and the adults in the future to 1) make ethically durable choices of technological commodities, 2) use them ingeniously and 3) develop more and more feasible and more and more environmentally friendly solutions.

3.3 Summary of the definitions of the concepts of technology and technology education

Both the educational and the professional background of the person defining technology and technology education determine the definition. Similarly, the perspective of the definer (be it educational, societal, ethical etc.) and her/his academic field have an affect on the definition.

According to the constructivist concept of learning learners construct their own definitions using the information available. At this stage of the present study, neither technology nor technology education is defined in more exact terms; instead, the phenomena are approached as openly as possible. Therefore, at this stage, technology can still be seen as interaction between human beings and nature and as implementation of human innovations. The aim is for learners to achieve an ability to utilize, control, and understand technology through technology education. As the exploration proceeds, construction materials, to be used for more exact definitions, are looked for, to be finalized by the findings of the empirical research.

This chapter has concentrated on defining the concepts of technology and technology education on the basis of a literature review. It has dealt with the theory that is behind the actual empirical research tasks, but already gives partial answers to the first research question, namely, " what does technology and technology education mean, or what could it mean, in the Finnish comprehensive schools and upper secondary schools?" The inquiry will be continued in the following account of the empirical part of the study.

4 BACKGROUND OF DATA GATHERING

Chapter three could have been written under the title of this chapter as the case would be in a traditional research report. The first research task was, however, analyzed extensively in the previous chapter because it also leads to the actual empirical research methods. While the study proceeds, the methods and framework for classification are developed from the data at hand. The methods are modified to suit the material at hand, and the empirical data are interlocked and developed as the research proceeds. For these reasons this chapter does not deal with methods only, but presents the background used for their development and modification.

4.1 Data gathering procedures: systematic analysis and survey

The purpose of this study is to find building elements for the Finnish technology education curriculum. This is done via two approaches: firstly, by studying the technology education curricula of six different countries and, secondly, by surveying the views of Finnish technology experts. At the beginning the purpose was to cross-tabulate the elements from the curricula of the six different countries. They, however, differ to such a degree from one another that it was impossible to perform any cross-tabulations. Some of the curricula are very detailed, "lehrplan"-type curricula, which present the framework with contents and objectives, and some are very general, curriculum-type curricula (where the approach is often concentrated on the planning of students' learning experiences, which are closely connected with students activities) (Malinen 1985, pp. 17 - 19 and 39 - 45). Because of this difference in the way of writing the different curricula, the systematic analysis method was chosen to be applied in this study.

The Finnish view is represented by experts working in the field of technology: by teachers and researchers at technological universities and polytechnics, and experts within the technology industry. The technology teachers and representatives of technology industry were sent a survey questionnaire with structured and open questions. The aim was to find out what they think should be the attainment targets, methods and contents of technology education in general education schools. The mean values were calculated from the variables of the structured part and a factor analysis conducted. The questionnaire which was developed in collaboration with the lecturers of technical work from the teacher education departments of Jyväskylä, Hämeenlinna, and Savonlinna was used in this study. The justification for choosing this questionnaire and this target group is explained in Chapter 5.2.

Through combining the systematic analysis of existing curricula and the survey on the views of Finnish experts, an attempt is being made to establish elements which belong or could belong to the curricula of technology education in Finland. Finally the important elements of technology education, established by these procedures, are introduced.

4.2 Survey based on questionnaire

The survey which was directed to Finnish experts of technology forms the quantitative part of the research. One group of experts are the teachers and researchers who are specialized in some special field of technology and are training students who have graduated from the general education system. The questionnaire (Appendix 2) was sent to polytechnics and technical universities in different parts of Finland. The other group of experts are the representatives of the technology industry. The questionnaire was sent to technology enterprises of different sizes in different parts of Finland. It included structured questions about the attainment targets, methods and contents of technology education in the general education schools, and also open questions.

4.3 Justification for choosing the existing curricula

Technology education is a new school subject even in those countries where it is already studied, and has only been introduced during the past decade. The International Technology Education Association (ITEA), PATT (Pupils' Attitude Toward Technology) -foundation and many universities in Britain are the first organizations to have started the research and development of technology education.

The International Technology Education Association (ITEA) is a United States-based organization. ITEA is a publisher of an international journal on technology education. PATT-foundation, on the other hand, is based in the Netherlands, but has organized well over ten annual international conferences. In these conferences researchers and educators from different parts of the world have presented the latest findings of technology education research. The personal contacts established during PATT-conferences and study tours have made it possible for me to obtain the curricula from different countries and also the opportunity to gain specific information if needed.

At the beginning the purpose was to analyze as many technology education curricula from around the world as possible. After reading through all the curricula I had access to, however, I decided to concentrate on the above mentioned six countries only. This is because some of the curricula from the other countries were pre-vocationally biased, some were only draft documents, and some were not up-dated for today's school system and therefore not relevant for this particular study. For instance, in Canada and Germany, which are technologically well developed, and which are actively developing their technology education, a national curriculum does not exist. In both these countries, different states or provinces have their own independent curricula. In the United States different states are also independent in their curriculum development. However, it is justified to include the United States in the study, because there has been a massive program to develop the national standards which can be used when planning technology education curricula at state, school district or school level. It has to be emphasized that Standards for Technological Literacy is not a national curriculum, but it does support curriculum planning at local level. The curriculum from Hungary which was available for analysis was not updated, and the recently revised curriculum, which obviously would have brought more insight to the approach, was unfortunately not yet completed when the analysis was conducted. Furthermore, because the aim of this research is to develop the Finnish curriculum, such countries as South Africa and Zambia (see Rasinen 1995), which are still in a development process, were not included in this study. In South Africa, technology education is still at a pilot phase, and in Zambia actual technology education is not part of the school curriculum. Instead, in Australia, England, France, the Netherlands, Sweden and the United States technology education has developed rapidly in the past ten years, and profound research and experiment programs and development of learning materials have been implemented in Australia, England, the Netherlands, and the United States, in particular. Not only the contents of the curricula of the above six countries but also their activeness in international publication and conferences, together with the information obtained in interviews with international experts of technology education, convinced me that these countries would be the best resources also for the development of the Finnish technology education curricula.

If the purpose of this study were to compare the different curricula, it would have been more advisable to choose, for instance, randomly a certain number of curricula to be analyzed, or to choose randomly for instance one country from each continent, etc. Since, however, the aim is to gain the latest and most updated research information and the most modern methods and contents of technology education for Finnish purposes, it is justified to concentrate on some leading countries with more comprehensive national curricula of technology education.

4.4 Introduction to existing technology education curricula of different countries

In the Finnish discussion about plans for teaching, learning and education two basic concepts have been used since the idea of writing these plans was adopted at the beginning of the past century. The first one, *lehrplan*, comes from Germany, from Herbart and his successors, and the other one, *curriculum*, from the United States, from Dewey and his successors. *Lehrplan* is understood as general (administrative) instructions on how teaching should be organized. *Curriculum* is regarded as pedagogic and didactic instructions on how learning should be organized. (see e.g. Malinen 1985). In English the concepts of syllabus and scheme of work are used to describe how studies are organized. Marsh (1997b, p. 4) argues that " a 'syllabus' is usually a summary statement about the content to be taught in a course or unit, often linked to an external examination". In this research curriculum is understood as the general instructions, syllabus is more detailed, and scheme of work is closer to actual lesson plans. According to Hirsjärvi (1982) the curriculum (opetussuunnitelma) is a preplan of all arrangements which aim at fulfilling the educational objectives of school. Saylor, Alexander and Lewis (1981, p. 8) define curriculum as "a plan for providing sets of learning opportunities for persons to be educated". In the analysis of the plans of six different countries all plans of different countries are called curriculum (although they are of different nature).

According to Madaus and Kelleghan (1992, p. 128) the curriculum consists of six different components: 1) contents; 2) general objectives of the whole school; 3) objectives of a specific curriculum or learning unit; 4) curriculum materials, in which the contents, subject matter, and skills to be studied have been chosen and arranged in a certain order, and materials which can be presented in many kinds of documents such as syllabi, teachers' guides, textbooks, workbooks, computer software and other kinds of documents; 5) transaction, usually in a classroom where different issues are being studied, such as contents, subject matters, skills and values which pupils are expected to experience, gain or learn, as well as other matters, i.e. skills and values which are not included in the curriculum, but with which pupils are dealing with in or out of the classroom; 6) results of activities affected by learning materials, teachers and pupils; the results can be desired or non-desired. Furthermore, for instance, Norris, Aspland, MacDonald, Schostak, and Zamorski (1996) emphasize also the importance of introducing the teaching methods in the curricula. Yet another factor that influences the structure of the curriculum is the national administrative approach. For instance in Finland, the policy at the moment is decentralization. The national curriculum is very general and the municipalities and individual schools plan their own curricula. England, on the contrary, has moved back towards a centralized system, where for instance all graduating pupils sit similar examinations all around the country, and the same curriculum materials are used in different parts of the kingdom. (See e.g. Webb, Vulliamy, Häkkinen, Hämäläinen, Kimonen, Nevalainen & Nikki 1997).

When studying the curricula, different methods can be used according to the prevailing need. The methods to be applied can be, for instance, surveys, interviews, case studies, historical studies, philosophical studies or theoretical analysis (Walker 1992, p. 109). Walker (1992, 133) introduces the five main approaches of qualitative research: interpretive approach, artistic approach, systematic approach, theory-driven approach, and critical/emancipatory approach.

Darling-Hammond and Snyder (1992. Pp. 57 - 72), on the other hand, outline empirical curriculum research as follows:

1 Goals of curriculum inquiries
2 Quantifying the curriculum
3 Early curriculum indicators: The search for one best system
   - Curriculum counting
   - Differentiating curriculum
4 Alternative research tradition: The quest for responsive curriculum
5 Research on teaching: The curriculum enacted
6 Statistical research on schooling: The quest for more meaningful curriculum indicators
   - Looking for school effects
   - Looking for policy answers
   - Looking for better measures.

The above-described theory for the study of curriculum and curriculum planning leads to the theory of comparative curriculum research. According to Mitter (1980) and Pantzar (1985, p. 49) the options for comparing curricula are as follows:

1 analytic – hermeneutic comparison
2 quantitative – qualitative comparison
3 micro – macro comparison (for instance according to the regional expanse)
4 comparison within – in between the system
5 relative – absolute comparison
6 homology – analogy comparison.

The quantitative and qualitative characteristics which are observed in comparative research and on which the measuring and comparison is based on, can be called indicators (Pantzar 1985, pp. 50 - 51).

Originally the idea in this research was, mainly on basis of the grouping of Madaus and Kelleghan, to cross-tabulate the curricular information of different countries on the basis of common indicators. This task turned out to be impossible, due to the variety of the approaches. For instance, the Swedish technology education (teknik) curriculum is only three pages long. On the other hand, in Australia A statement on Technology for Australian Schools is 44 pages long, and complemented by Technology – a Curriculum Profile for Australian Schools, which is 152 pages long. In addition to these two documents, there is an extensive CD-ROM which supports the two written documents. In between these two extreme ends are the other countries included with their curricula of different detail and approach. The curricula of France and the Netherlands are quite general and provide the basic outlines for implementation. Technology for all Americans: A rationale and structure for the study of technology (1996) is supported by Standards for Technological Literacy: Content for the Study of Technology (2000). These documents give quite extensive information and examples for the teachers and other stakeholders on how to go about with technology education in the United States. The English curriculum states out general information and specified attainment targets for different key stages of learning. It also gives examples of schemes of work for the teachers to be able to create their own schemes of work. A very extensive information package is also available for all teachers on the Internet. Because a comparative approach was not applicable in this context, and because the aim of the study was not to compare but to look for building elements for the Finnish curriculum, another approach (detailed in chapter 4.6) was used in this study.

To make it easier to get a holistic picture of the various curricula, the six components of Madaus and Kelleghan (1992) were formatted in such a way that the curricula of different countries could be presented in a table format with three columns. After several attempts a structure with the following three column titles was selected: attainment targets, national status, and integration and other observations. This chapter could also be included under research findings, because it already deals with the analysis of the curricula. However, the approach here is not systematic enough yet, rather, the purpose is to brief the reader on the contents of the curricula under study. The following account clarifies the reasons for selecting the research methods in question and gives them direction. The curricula of the six countries vary from very exact *lehrplan*-type (Australia and England) documents to relatively open *curriculum*-type (Sweden and the United States of America) documents. Some are combinations of the two types, with a curriculum-type emphasis but with many lehrplan-type components (France and the Netherlands) (see e.g. Malinen 1992, p. 15). The approach here differs from the systematic analysis which will follow below in Chapter 5.1.

The references for the following subchapters are as follows:

- Australia: A statement on technology for Australian schools, A joint project of the States, Territories and the Commonwealth of Australia initiated by the Australian Education Council 1994;
- England: Design and technology in the National Curriculum 2000;
- France: Ministére de l'Education Nationale Bulletin officiel spécial Décembre. 1995. Noveaux programmes de 6e and Ministére de l'Education Nationale Bulletin officiel hors série Nil du 13 février. 1997. Noveaux programmes du cycle central;
- The Netherlands: Huijs, H. 1997. The new core objectives for the subject technology in the Netherlands. In I. Mottier & M. deVries (eds.) Assessing technology education. Proceedings PATT-8 conference April 17 - 22, 1997. Scheveningen and deVries, M. J. 1999. Developing technology education by learning from other countries and from industry. In T. Kananoja, J. Kantola & M. Issakainen (eds.) Development of technology education-Conference –98 (pp. 137 - 149). University of Jyväskylä. Department of Teacher Education. The Principles and Practice of Teaching 33;
- Sweden: Kursplaner för grundskolan 1994;
- The United States of America: Technology for all Americans: A rationale and structure for the study of technology 1996, and Standards for technological literacy: Content for the study of technology. 2000. Reston VA: International Technology Education Association.

All of these documents can be regarded as nationally accepted guidelines for technology education within the countries concerned. At the early stages of the research the aim was to analyze also other than developed Western countries. Therefore, the draft curriculum for technology education in South Africa was also carefully analyzed (Rasinen 1999a, pp. 56 - 58). However, this curriculum is still in a draft form (Draft Guidelines for Developing Technology Learning Programmes, 1997) and it is only piloted in some schools. The aim is to offer technology education for all girls and boys in the whole country by 2005 (Ankiewitcz, Myburgh & van Rensburg 1997, p.178; see also Davids, 1997). The results from this analysis did not bring any extra information compared to the six countries mentioned above. The implementation of the program is also behind schedule, because there are not enough trained teachers to teach the subject (C. Benson, personal communication May 4, 2000). For these reasons South Africa, among some other countries, was left out of this study. One might argue that if the aim of the study is to look for information for Finland from other countries, it would be advisable also to study a country which is in a stage of implementing the subject area, but the written information available at he moment does not seem to add any value to the research questions and thus to the Finnish context. When more information becomes available, South African experiences can also be taken into account when writing the Finnish curriculum.

The French curriculum was translated by Lea Airaksinen (MA in French and English) and the Swedish curriculum by myself. In international conferences and by e-mail it has been possible for me to check that my interpretations of the curricula have been correct.

4.4.1 Technology education curriculum of Australia

In Australia technology is one of the eight subject areas to be studied. The curriculum is formed of three different documents: 1) A statement on technology for Australian schools (1994), which explains the rationale and general objectives; 2) Technology – a curriculum profile for Australian schools (1994), which gives more detailed information on the implementation of the classes; and 3) Switched on curriculum-CD ROM (1997), which gives even more detailed information, schemes of work and ideas for the teacher. Technology is divided into four categories of understanding the content of the learning area, which are called strands. These strands are:

- Designing, making and appraising
- Information
- Materials
- Systems.

The strands are interrelated and on the basis of these strands the technology education programs of the schools are monitored, revised and reformed.

TABLE 2 The technology education curriculum of Australia

ATTAINMENT TARGETS	NATIONAL STATUS	INTEGRATION/OTHER OBSERVATIONS
BACKGROUND • People meet technology daily • Technology affects the cultural, societal, environmental and economical changes COMMON AND AGREED NATIONAL GOALS FOR SCHOOLING IN AUSTRALIA (1989) (Extracts from the technology education point of view) • to respond to the current and emerging economic and social needs of the nation, and to provide those skills which will allow students maximum flexibility and adaptability in their future employment and other aspects of life • to develop in students: • skills of analyzing and problem solving • skills of information-processing and computing • an understanding of the role of science and technology in society, together with scientific and technological skills • an understanding of and concern for a balanced development of the global environment • a capacity to exercise judgment in matters of morality, ethics and social justice	EIGHT BROAD AREAS OF LEARNING: the arts, English, health and physical education, languages other than English, mathematics, science, studies of society and environment, technology In technology programs theory and practice are integrated. They include parts from science, ethics, mathematics, graphics, culture, aesthetics, and history. To be studied by both girls and boys during the compulsory years of schooling (years 1-10).	Technology programs can be structured and presented either as discrete programs or combined with other areas of learning. Technology programs in primary schools give students a broad foundation for further learning. They are taught by classroom teachers, sometimes in association with specialists or resource people, with varying allocations of time to allow different activities. Secondary school technology programs become more specialized as students progress towards year twelve, often leading to discrete programs. In upper secondary years, many technology programs focus on life and work outside school, and on further education. In the secondary school, technology brings together a number of different areas of study. They include: • agriculture • computing/information technology • home economics • media • industrial arts, manual arts, design and technology

(continues)

TABLE 2 (continues)

THE IMPORTANCE OF TECHNOLOGY
• people become more innovative, knowledgeable, skillful, adaptable and enterprising
• these qualities will enable people to:
  • respond critically and resourcefully to challenges
  • devise creative ways of generating and applying ideas
  • translate ideas into worthwhile outcomes
  • find innovative solutions to community needs
  • focus on the design of techniques and products
  • deal with uncertainty in an informed way
  • cooperate in flexible teams
  • appreciate cultural differences
  • learn throughout their lives
  • use local, national, regional and international networks
	Integration:
	Technology involves the development and application of ideas and principles from other areas of learning – for example, the applied sciences, engineering, and business and commerce

4.4.2 Technology education curriculum of England

The National Curriculum in England was revised in 2000. Previously England and Wales had a joint curriculum (1996). The revised national curriculum will become statutory gradually over a three year period. Design and technology education studies became statutory as of August 2000 for key stages one to three, and key stage four will be in force as of August 2001. This study examines the new curriculum.

The compulsory schooling is divided into four key stages:

	Year group	Class level
Key stage 1	5-7	1-2
Key stage 2	7-11	3-6
Key stage 3	11-14	7-9
Key stage 4	14-16	10-11

Subjects to be studied:

At key stage one and two
English, mathematics, science, design and technology, ICT (information and communication technology), history, geography, art and design, music, and physical education;

At key stage three
Like at key stages one and two plus one modern foreign language;

At key stage four
English, mathematics, science, design and technology, information and communication technology (ICT), a modern foreign language, and physical education. Some of these will be statutory as of August 2001. From August 2002 onwards the subject Citizenship will be statutory for key stages three and four.

TABLE 3 The technology education curriculum of England

ATTAINMENT TARGETS	NATIONAL STATUS	INTEGRATION/OTHER OBSERVATIONS
THE GENERAL OBJECTIVE: Design and technology prepares pupils to participate in tomorrow's rapidly changing technologies. They learn to think and intervene creatively to improve quality of life, they become autonomous and creative problem solvers, as individuals and as members of a team. Through needs, wants and opportunities they develop a range of ideas and make products and systems.	One of the core subjects. To be studied by both girls and boys One of the subjects to be marked after national examinations for GCE (General Certificate of Education) when finishing the compulsory education.	To be integrated where it is convenient, for instance with arts, mathematics and science The curriculum states nine attainment levels which become hierarchically more and more difficult. These levels give information on the standard of pupils' performance and also assistance for teachers' assessment. The ninth level describes very exceptional performance only.

(continues)

TABLE 3 (continues)

They combine practical skills, aesthetics, social and environmental issues, and reflect and evaluate present and past design and technology, its uses and effects. Through design and technology they become discriminating and informed users of products, and become innovators.

THE SPECIFIC OBJECTIVES:
Pupils should be taught to:
- develop, plan and communicate ideas
- work with tools, equipment, materials and components to make quality products
- evaluate processes and products
- know and understand materials and components

The specific objectives become more demanding the higher the keys stage is. At key stage four one more objective is added to the list:
- know and understand systems and control

4.4.3 Technology education curriculum of France

Technology education is a compulsory subject area for all junior secondary (11-15 years) pupils regardless of their branch of study. The junior secondary school lasts for four years. Technology should be studied also in primary school, but at the moment there is a detailed curriculum only for class levels six (11-12 years, adaptation level), five (12-13 years, first central level), four (13-14 years, second central level) and three (14-15 years, orientation level).

TABLE 4 The technology education curriculum of France

ATTAINMENT TARGETS	NATIONAL STATUS	INTEGRATION/OTHER OBSERVATIONS
Technology education aims to clarify the connections between work, products and human needs, and through this the effects of technology in society and culture. When studying technology pupils will have to face concrete situations where they have to apply know-how and implementing skills. These skills will be enriched during the study process. THE GENERAL OBJECTIVES Technology education gives pupils a chance to: • get acquainted with technical systems, their implementation and use • get used to using the correct and disciplined language • get acquainted with special methods of technology, where a variety of solutions can be found to a certain problem • know how to use their know-how in different situations to solve a problem • use in a rational way equipment and control systems, by obeying safety precautions and laws of ergonomics • observe development, different means of production and different technical solutions to a similar technical problem	The aim is to use 3/5 of the total study time for production, learning by doing. Integration with mother tongue is seen important. This goes together with specific terminology, alteration of the language, text processing (with a computer) criticality towards commercials; a critical consumer. Study lessons per one week: • adaptation level 1h 30 min • central level 1h 30min-2h • orientation level 2h For both girls and boys	In primary school, class teachers to teach and in secondary school subject teachers to teach. INTEGRATION: Mother tongue, science, social studies, a lot of emphasis on computing

(continues)

TABLE 4 (continues)

- observe and build connections between the schools and enterprise
- take a critical stand and interfere in the world
- of technics without emotional obstacles

Technology studies must continue from primary school to secondary school without any gaps.

In primary schools simple mechanisms, electric plans, energy production and production generally is dealt with. Small projects whereby computers are also used.

In secondary schools production, marketing, needs analysis, the professions of industry and service, CAD/CAM-applications are studied.

4.4.4 Technology education curriculum of the Netherlands

In the Netherlands all the pupils go to the comprehensive school, "Basisvorming", until the age of 15/16. After a national and international debate of what should be the contents of basic education, the present curriculum was published in 1998. There are at least 15 subject areas to be studied, one of them technology. There are six general objectives to be achieved within all the subject areas:

- working on interdisciplinary themes
- learning to carry out a task or a plan
- learning to learn
- learning to communicate
- learning to reflect on the learning process and the future

Technology is studied from three different perspectives:

- technology and society
- technical products and systems
- designing and making products

TABLE 5 The curriculum of technology education of the Netherlands

ATTAINMENT TARGETS	NATIONAL STATUS	INTEGRATION/OTHER OBSERVATIONS

GENERAL OBJECTIVES:
 	
Pupils should:
• become familiar with those aspects of technology which are significant to the proper understanding of culture, to the way which pupils function in society and significant to the pupils' further technical development
• acquire knowledge and understanding of the function of technology, in close relationship between technology and natural sciences and between technology and society
• become actively involved in applications of technology
• learn to design and make solutions for human needs
• learn how to use a number of technological products in a safe manner
• are given the opportunity to explore their abilities and interests with regard to technology
 	
SPECIFIC OBJECTIVES
 	
A. Technology and society
• everyday living
  • technological development, negative and positive
  • how people and situations can influence the development of new products
	Technology Action Plan was implemented from 1993 to 1997 for primary schools (pupils from age 4 to 12). Financed jointly by Ministries of Education, Culture and Science and Ministry of Economic Affairs. The purpose was to stimulate attention to technology inside and outside of primary schools. Important to combine thinking and doing. Lemmen 1997, p. 118)
	
	One of the fifteen subject areas in secondary schools (pupils of age 12-18).
	
	Technology education curriculum should offer equal opportunities for boys and girls and should appeal to both sexes (Huijs 1997, p. 107).
	
	180 teaching hours allocated to technology education at secondary level (first and second year of secondary technology is studied for two teaching hours per week)
	
	National tests at the end of secondary school.
		At primary level not as a subject area of its own. Is integrated with crafts, arts and natural sciences.
		
		At secondary level a subject area of its own but also integrated with mathematics, science and social studies.

(continues)

TABLE 5 (continues)

- expressing opinions on technical developments based on arguments including norms and values; distinguishing between facts and opinions, cause and effect, occasion and effect
- industry
  - various phases in production process
  - working conditions
  - quality control
  - division of work (gender and different nationalities)
- professions
  - technical equipment used in various professions, changes in professions as a result of developments in technology
  - environment
  - effects of technology on the environment

B. Technical products and systems
- materials
  - materials and their properties, functionality, manufacturing and design
- energy
  - transmission of energy (mechanical, pneumatic, electrical and hydraulic)
- information
  - modern communication system (signal transmission, storage and conversion)
  - control-system (signal input, signal processing, signal output)
  - analog and digital systems

(continues)

TABLE 5 (continues)

- function of a control system
- steering CAD/CAM-machines (CAD computer aided design, CAM computer aided manufacture)

C. Design and making of products
- solving design problems
  - connection and construction problems
  - transmission problems
  - control problems
- design, production, and evaluation

4.4.5 Technology education curriculum of Sweden

In Sweden a study subject called "teknik" (technics) is regarded in this study as synonymous with technology education. According to the national curriculum from 1994 "teknik" teaching aims at developing in pupils an understanding of the essence of technics. More specially, the aim is to increase understanding on how production conditions, society, physical environment and, through all these, living conditions are changing. Technical know-how becomes a more and more important prerequisite for the control and use of the technology around. Pupils have to achieve basic technical competence (grundläggande teknisk kompetens).

This competence is connected with the development of knowledge in the role of technical development, historical perspective and reflection and solving of technical problems in certain ways. In addition, there is need to develop an ability to analyze and value the relationship and team work between human beings – society – technics and nature. The way technics is used and its effects on the environment arouse a number of ethical questions dealing with basic values.

TABLE 6 The technology education curriculum of Sweden

ATTAINMENT TARGETS	NATIONAL STATUS	INTEGRATION/OTHER OBSERVATIONS
GENERAL OBJECTIVES • the history and development of technical culture, effects of technics on people, society and nature • Awareness of the technics around us • reflect, evaluate and valuate the effects of the choices of different technics on human beings, society and nature • update the technical know-how on the use and structures of technics for own standpoints and practical situations • positive interest toward technics and confidence in own abilities to solve technical problems The objectives to be achieved have been stated by the end of grades five and nine. Offers also a basis for the forthcoming choices of study fields and profession Study methods: • practical work and exploration • tests, observations, constructions • planning, making, evaluation	To be studied at primary and junior secondary levels Equally for girls and boys	The technical culture is mainly based on the know-how tradition which has been achieved through practical work. The present development is based more than previously on scientific research and systematic development work. To be integrated with history, science and social studies. About the nature of the study subject: • the development perspective: effects on individuals, society and nature from historical and from international point of view • humans – technics – nature • the task of technics: alter, store and control • component – system point of view • construction and workshops: identification of the problem, construction and evaluation

4.4.6 Technology education curriculum guidelines in the United States of America

In the United States there are national standards for different core subjects. At the moment there are standards for English, language arts, geography, music, art, social studies and foreign languages, mathematics (Curriculum and valuation standards for school mathematics were approved as early as 1989) and science (National Science Standards were approved in 1996). The youngest subject with national standards is technology education. The standards were approved at the beginning of the year 2000. The Technology for All Americans Project has been engaged for the past years in research and development of technology education. In 1996 a statement and policy paper called Technology for All Americans: A Rationale and Structure for the Study of Technology was published. This publication provides the rationale and structure for technology education in the United States. On the basis of this document, another policy statement namely, Standards for Technological Literacy: Content for the Study of Technology was developed, and published at the beginning of year 2000. These two documents can be used for local curriculum planning.

TABLE 7 Technology education curriculum guidelines in the United States of America

ATTAINMENT TARGETS	NATIONAL STATUS	INTEGRATION/OTHER OBSERVATIONS
• Technology is human innovation in action • Every citizen should be technologically literate, able to use, manage, and understand technology • The framework for technology education concentrates on the universals of technology. The universals are considered to be significant and timeless – even in an era dominated by uncertainties and accelerated change. The universals of technology education are formed of knowledge, processes, and contents. Figure 4 below explains the more detailed concepts included in the three main categories.	• Technology should be integrated as one of the core-subjects from kindergarten to junior and senior high schools and even beyond • Technology should be compulsory at every study level regardless of sex • The local conditions, aspirations of individuals, career, and abilities influence at the background the development of the curriculum for technological literacy • Technology one of the core subjects • Ultimate goal: technological literacy for all	• Technology education can be integrated with other school subjects especially with science and mathematics • TAA-project has created content standards for technology program(s) in K-12 schooling • Technology program should be coordinated with other school subjects to increase learning between different subjects

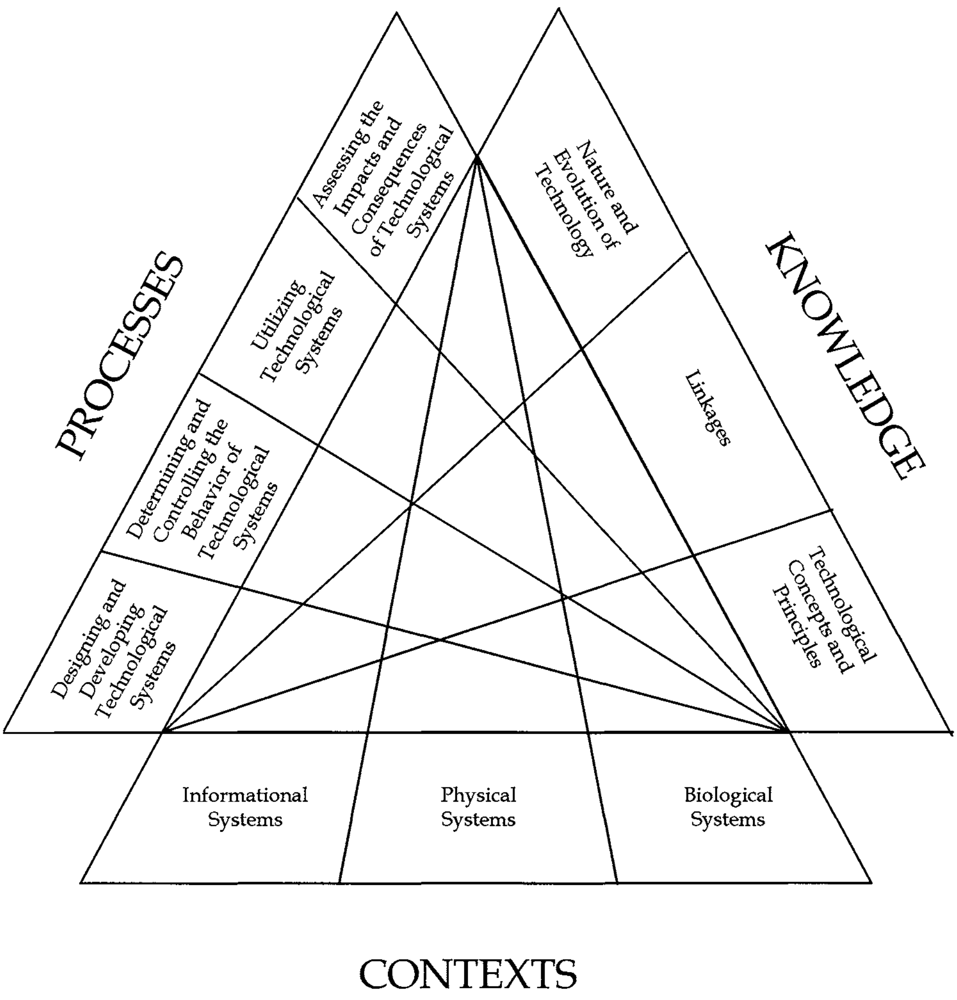

FIGURE 4 The universals of technology education (TAA 1996)

4.4.7 A short summary of the curricula of different countries

As has already been stated above, the structure of the different curricula varies from very exact lehrplan-type curricula to quite general curriculum-type curricula. All of the documents described above are relatively young. The curricula of Australia and Sweden are the oldest ones, dating back to 1994. The curriculum for lower classes in France is from 1995 and the curriculum for upper classes from 1997. The attainment targets of the Netherlands were revised in 1998/1999 (see also deVries 1999, p. 143). In England the curriculum was revised this year (2000), and in the United States of America the technology education standards were accomplished only recently (2000).

There are several reasons for the curricula to differ from one another. One of the reasons is the national policy of the country concerned. For instance, in Canada and Germany the different states have very independent decision-making authorities. They plan their own curricula, although some general national guidelines may exist to show the direction to the planners. In some countries the regional characteristics (for instance local industry) may be considered when planning the curriculum. National examinations exist in Australia and England. These obviously lead to a quite similar study program all around the country. In Finland and Sweden, then, the national instructions are quite general, and the local authorities plan the more exact curriculum. The national educational policy also affects teacher education. If teachers are expected to plan the curriculum, syllabus and schemes of work, this has to be considered also in the training of teachers. All in all, teacher education and curriculum planning have to work hand in hand.

According to the technology education curricula of the above six countries technology is studied by both girls and boys. In all of the curricula the importance of studying the effects of technology on society are emphasized, and Sweden underlines the importance of the history of technology. France is the only country which does not directly refer to studies of the relationship between technology and the environment. In all countries learning how to plan, make and produce, as well as evaluate is highlighted. The ability to tolerate uncertainty is studied in Australia and the United States of America. In the Australian curriculum the importance of life-long learning and learning innovative skills are clearly emphasized.

The more exact analysis and summary of the curricula, which is also based on the above tables, is presented in chapter 5.1. As was also stated above in the beginning of chapter 4.4, the study of the various curricula can be integrated with the other findings of this study, and serves also as a background for the research procedures used. For this reason, it was justified to present it at this stage, before introducing the other analysis results.

4.5 Technology education in the curricula

One of the interests in the present study was to examine the philosophy behind the curricula. Unfortunately it was not possible to have access to such information that also the philosophy behind the curricula could have been analyzed. The rationale for technology education is clearly stated out, for instance, in the documents from the United States and Australia. In the general curricula of all the six countries technology education is clearly seen as part of general education for all. The various curricula do not describe the process preceding the publication of the final curriculum documents, neither do they tell what different interest groups have affected the contents of the documents. However, some information on this has been collected by interviewing specialists from different countries. In the following analysis only the intended (written) curriculum is studied. In chapter 5.1.7 the implementation of the written curriculum in different countries is discussed. It is a well known fact that these two curricula do not always coincide with one another. (see for instance Malinen 1992, p. 24, Lahdes 1989, p. 83 and Kangasniemi 1985.) Figure 5 describes the different stages in implementing the curriculum according to Malinen (1992, p. 24, see also Saylor, Alexander & Lewis 1981, p. 5).

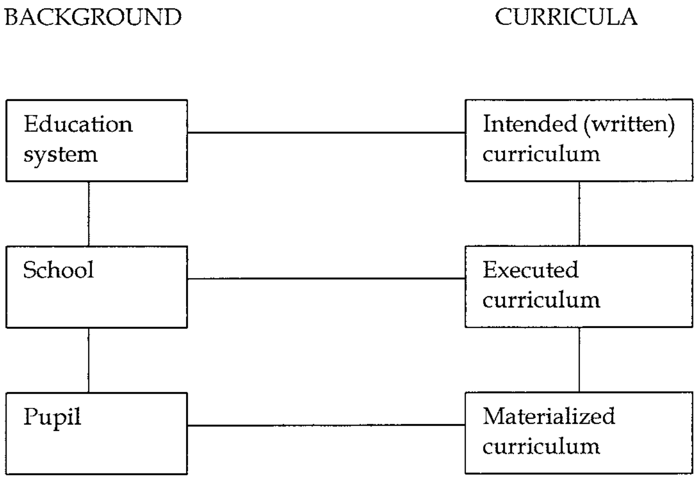

FIGURE 5 Different stages in implementing the curriculum (Malinen 1992, p. 24)

Although only the written curricula are studied in the following pages, they are studied in a versatile manner from the point of view of different background variables (presented below in Chapter 4.5.2 in Figure 9). It is obvious that the curriculum is in an ever-changing state, and that the written curriculum may in some cases already be old when it is published. In the same way the persons implementing the curriculum influence considerably the way in which the implementation of the curriculum is in reality carried out. The technology education curricula of Australia, France, England, the Netherlands, Sweden and the United States of America were all revised in the 1990's, even over the past two years (e.g. England, France, the Netherlands and the United States). Therefore, adequate information on their implementation is still lacking.

4.5.1 Society, school and individual in the curriculum

When writing out a curriculum many different frames of references and background theories can be utilized. Saylor, Alexander and Lewis (1981, pp. 28 - 29), for instance, consider the main elements of a curriculum plan to be the following: persons to be educated; goals and objectives; curriculum design, instructional modes, evaluative processes; and student progress, which are affected by external forces and the bases of the curriculum.

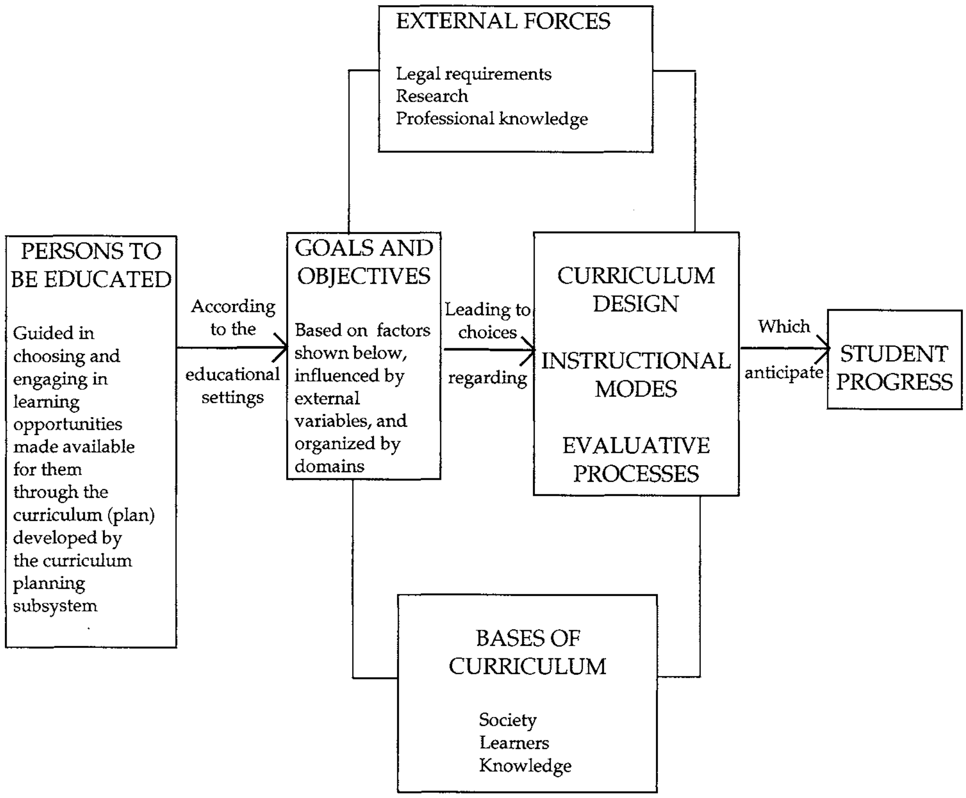

FIGURE 6 Main elements of a curriculum system (Saylor, Alexander & Lewis 1981, p. 28)

In the model, society, learners and know-how form the basis of the curriculum. In this context know-how can be regarded as technological know-how, technological general education, technological literacy or technology competence.

Raivola's (1984, pp. 133 - 135) classification is similar, except that in Raivola's model the education system is in interaction between the society and the individual.

SOCIETY--------------EDUCATIONAL SYSTEM---------------INDIVIDUAL

FIGURE 7 Interaction between society, educational system and individual as a study problem of comparative education (Raivola 1984, p. 133)

Tanner and Tanner (1980, pp. 148 - 149) discuss the issue of whether society affects the change in the operations of school. Should the curriculum concentrate on preserving and transmitting the cultural heritage or should it concentrate on developing the basic skills? Should the curriculum be aimed at personal development or should it concentrate on the development of social growth? Should the main emphasis of the curriculum lie on promoting the academic scholarship or should it be guided to improve justice in society? They also consider the problems of a child-centered school (ibid. pp. 294 - 309), and, on the other hand, the division of compulsory education into separate subject areas (pp. 459 - 514). They conclude by introducing a graphic model of a core curriculum.

The above models can be regarded as representatives of the behaviorist era. In a constructivist model the arrows, instead of showing one way of communication, would be two-way arrows, or the elements would be connected with each other in a circular or spiral form, to describe the ever-changing state of the curriculum.

A fresher but still a very generic definition of the curriculum is presented by Marsh (1997a):"curriculum is an interrelated set of plans and experiences which a student completes under the guidance of the school". This definition includes elements of plans (refers to planned activities), experiences (unplanned events), and school (refers to all persons associated with the school). One part of the school is also the physical learning environment. At the center of the curriculum is the learner. In this model, too, the arrows could, and should, be two-way arrows. Naturally the way in which students act affects the learning situation (plans, teachers behavior, and the society around). Society can also be considered to affect at the background of the model. An illustrative definition of the curriculum is presented in Figure 8.

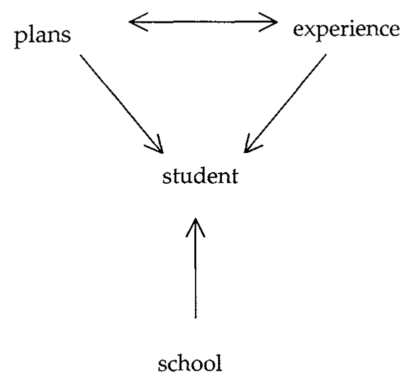

FIGURE 8 An illustrative definition of curriculum (Marsh 1997a, p. 6)

Leimu (1985, pp.21 - 22) has outlined the different stages of curriculum planning on the basis of the Stufflebeam CIPP (Context, Input, Process & Product) model. According to this, the approach to curriculum planning is divided as follows:

1 The curriculum is introduced as a *frame for action* (context) where different effects of educational objectives are introduced. In this case the curriculum is described by different determinants (student, study subject, society) (Hirsjärvi 1982, p. 132; Malinen 1992, p. 23; Saylor & Alexander 1966, p. 45) or by codes of the curriculum (societal background factors). In the frame of action the educational general objectives are determined.
2 The curriculum is introduced as *inputs* which are used to implement the education of the school. The curriculum in this case mainly concentrates on the means to achieve the objectives, such as contents and methods.
3 The curriculum is introduced as *processes*. In this case the learning transaction and the way in which teaching is carried out are important. In drawing up the curriculum the emphasis is on learning experiences (processes).
4 The curriculum is introduced as *outputs (products)* to be achieved. These can be for example graduation from upper secondary school or vocational school. (Leimu 1985, pp. 21 – 22.)

Marsh (1997b) describes different models in planning the syllabus and also the implementation of these plans. In Tyler's model (as quoted by Marsh 1997b) the aim is to do planning in a 'rational-linear' way. The planning process proceeds from objectives, selection of learning materials and organizing learning materials to evaluation (ibid. p.122). Marsh sees many advantages in the model but also many disadvantages, which are caused by the linear approach. Walker's starting point, on the other hand, is not to identify the linear way of planning but rather to study what happens in the curriculum planning process. Marsh calls this method 'Walker's deliberative approach to planning' (ibid. p. 129). Walker is interested in how the curriculum developers perform their task, rather than how they should perform, as is the case in Tyler's model. During a period of three years Walker was able to follow the Kettering Art Project, and develop through his notes and observations a model for curriculum planning, which is called a 'naturalistic model' (Marsh 1997b, p. 130). His model is divided into three sequential steps: platform, deliberation and design. This model can be used both in small-scale and large-scale projects.

In the beginning of the curriculum planning process different parties bring their own ideas of the curriculum to the platform. The platform consists of various conceptions, theories, aims, images, and procedures. The various stakeholders who want to contribute to the curriculum planning process, have certain perceptions of what should be included in the curriculum and bring in their own beliefs and values. At platform stage the ideas are presented, defended and argued. After the platform stage, whether there exists much or little consensus about the contents of the curriculum, planning gradually moves to the next phase, namely deliberation.

During the deliberation phase the move is from beliefs towards practical considerations and the aim is towards achieving consensus. When sufficient consensus is achieved deliberation finally leads to decisions of action. This is called the design phase.

4.5.2 Model for analysis in the present study

One of the objectives of this research was to look for suitable components for the Finnish framework curriculum and for the curricula of municipalities and single schools. For this reason I have drawn up a model suited for this purpose by applying the curriculum theories above. With this model the purpose is to look for elements from the curricula of the different countries as far as they clearly refer to one of the three levels of the curriculum:

- society (global, state, municipality)
  - for example, technology as part of society, technology and the environment, relationship between the industry and school, needs of society and people, technological professions;
- school (teacher)
  - for example, interaction between the school and the environment, technological know-how, learning environment, integration between different subject areas;
- individual (student)
  - for example, technological literacy, interaction between technology and individual, environmental balance, ethics of technology, technological skills and knowledge, interestedness.

All of the above mentioned levels are studied in this report from the point of view of objectives, methods and content.

The analysis of the curricula of the various countries is carried out considering these different background levels. Society in this study can be regarded as a macro-level term which includes curricular materials connected to global technological subject matters (for instance the effects of technology on the environment), but also, to relatively local problems and matters. School is the level where the curriculum is implemented, and the implementers are most often the teachers. This is the second perspective of the analysis. The third perspective of the analysis is the individual, in this case the student.

The three levels of the curriculum are studied from the perspective of the internal elements of the curriculum: objectives, methods and content. Thus the analysis is in a way three-dimensional or at least conducted at three different levels, where the first level is formed by the background (society, schools and individual) which is represented by the globe, states, municipalities, teachers and students (the second level), and the third level is the level of elements, i.e. objectives, methods and learning content.

Each one of the three background levels (society, school and individual) can be regarded as a very extensive and diversified concept. For example, society as a background level could be studied from the political, religious, or social viewpoint. In this study only such social aspects which deal with technology, such as production, industry and trade, are examined.

Figure 9 clarifies the model of analysis used in the present study.

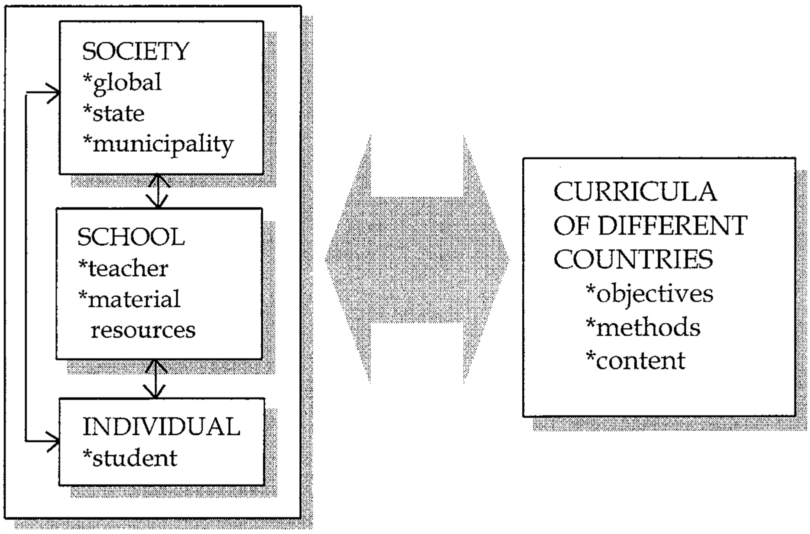

FIGURE 9 Model applied in this study to analyze the technology education curricula of different countries

4.6 Systematic analysis

The systematic analysis was chosen as the method for the qualitative part (analysis of the curricula of different countries) of the study. In this research systematic analysis means methods by which factors connected to a certain theory or idea are clarified. In other words, one method is not used alone, but rather a "method-family" which is usually identified with philosophy-type research has been applied here (Scriven 1988, pp. 131 - 149; Jussila, Montonen & Nurmi 1992, p. 157). The analysis itself includes a qualitative specification of the contents where a certain limited text is under examination. In this case the objects of the analysis were the technology education curricula of six different countries. The systematic analysis differs from mere content analysis in that the aim is to penetrate the world of ideas expressed linguistically. The analysis travels by means of thought within a system of the literally expressed world. The aim is not to search for and present statistically representative samples, but to raise forward the essential ideas from the point of view of thinking-structures, in order to make it possible to clarify the original entity of thoughts and to make it possible to develop this if needed (Jussila et al. 1992, p. 160, see also Alasuutari 1993; Pyörälä 1995).

In the systematic analysis, logical and conceptual entities are brought up through theoretically-oriented exploration. The task of the researcher is to look for fundamental questions from within the content of the text and to outline and examine the text in order to discover even the hidden core ideas. This means that a mere description of the expressions presented is not sufficient in this type of analysis (Jussila et al. 1992, p. 174).

The systematic analysis was applied in this research from two different perspectives. Firstly the curricula were examined from the similar point of view as the survey findings, that is, from the point of view of objectives, methods, and learning content. This perspective was widened by taking into account the three determinants of education: society, school and individual. Secondly the information in the six curricula was synthesized and presented in table format to make it easier for the readers to familiarize themselves with the different curricula (see tables in chapter 4.4). In this table-form presentation the information was classified under learning objectives, the national status of technology education, and integration with other school subjects. In addition, some other observations important for understanding the curriculum in question, were included. This form of analysis is close to ethnographic analysis, because the intention is to look for certain regularities, elements and their relationships (Hirsjärvi, Remes & Sajavaara 1997, p. 167, see also Arvidsson 1990).

5 RESEARCH FINDINGS

In the following the analysis of the technology education curricula of six different countries and the findings of the survey based on a questionnaire sent to Finnish experts are presented. Some summing up is done in this chapter already, but most of it comes in Chapter 6 where the results of the qualitative and the quantitative study (the data from abroad and from Finland) are discussed.

5.1 The curricula of different countries from the perspective of society, school, and individual

In this chapter the curricula of six different countries are analyzed from different viewpoints. First, the development stages of the curricula and the educational aims of different countries are discussed. After this the curricula are systematically analyzed on the basis of the frame of reference introduced in Chapter 4.5.2. The exact references for all the sub-chapters below are the curricula listed in Chapter 4.4. The special features and countries with these features will be brought up, and if some features are not present in certain curricula this will also be noted. The sub-titles written in *italics* result from the analysis and are shortenings from the actual text. This chapter addresses the second research task (i.e. How have Australia, England, France, the Netherlands, Sweden and the USA organized the technology education in their schools?).

5.1.1 Present state of curriculum development in the six different countries

Technology education is no more than a little over ten years old as a school subject, even from a global perspective. Therefore, the subject area does not have similar traditions to, for instance, mathematics, science or handicrafts. The development stage of the subject area is quite different between the countries under study in this report.

From the global viewpoint England has the longest tradition. There, design and technology was introduced in the late 1980's, and it is one of the core subjects to be studied both in primary and secondary schools. Design and technology is also one of the subjects where pupils sit national examinations. Even previously, secondary school pupils have studied craft, design and technology, but there has been nothing comparable in primary schools. The development of the name of the subject also illustrates the development of its content. The mere copying of teachers' examples and manual practice of the early years has developed into creative problem-solving processes and getting acquainted with modern technology. Learning by doing and by applying hands-on methods is still an important part of the learning process.

Also in United States of America the history of technology education starts from handicraft studies. Particularly in high school, industrial arts offered pre-vocational education and prepared students for future professions. Today, technology education is regarded as part of general education for everyone and not as pre-vocational study. Especially in those states where universities training technology teachers are located, the implementation of technology education has succeeded according to the new plans devised. Technology for All Americans Project published A Rationale and Structure for the Study of Technology in 1996, which was followed by Standards for Technological Literacy: Content for Study of Technology at the beginning of the year 2000. These standards describe what the content of technology education should be from kindergarten to grade 12. The standards set a coherent content for technology education in schools around the country and serve as a basis for curriculum planning in states, provinces, school districts, and schools. National standards have been published earlier in many other subjects with a longer history as school subjects.

In Australia, a very extensive national curriculum planning project on technology education was accomplished in 1994. The curriculum consists of three parts. The general part is "A statement on technology for Australian schools". The more detailed curriculum is described in "Technology – a curriculum profile for Australian schools". The third part is a CD-ROM which supports the two printed documents, and gives detailed information for individual teachers and students on how to conduct technology projects.

In the Netherlands and France technology education is a relatively new school subject. It is studied both at the primary and secondary level. In both France and the Netherlands a specified curriculum exists only for the secondary school. For primary school technology education there are only some general references in the general curriculum, and the actual technology education curriculum is still to be written. In both countries the secondary-level technology education curriculum was revised at the end of the 1990's.

The Swedish school curriculum does not actually include a subject called technology education. Representatives of both crafts (slöjd) and technics (teknik) education have attended the international technology education conferences. There are many technological elements in the crafts curriculum, but the curriculum of technics includes clear technology education contents. Therefore, in this study the technics curriculum was chosen to represent the Swedish technology education curriculum. At the moment Sweden is following a national curriculum, where technics is one subject area to be studied. This document was approved and put into practice in 1994.

The previous paragraphs show that technology education is a very new field of study in schools and that it is in a continuous process of development.

5.1.2 Educational goals in the six countries

None of the technology education curricula under study here define directly what the philosophical points of departure are, what the human perspective is, or what the learning concept behind the curriculum is. They do, however, offer brief statements on the importance or rationale for the study of technology.

The document Technology for All Americans: A rationale and Structure for the Study of Technology (International Technology Education Association 1996, p. 1) states in its preface that technology is "vital to human welfare and economic prosperity". It goes on by stating that the purpose is that "every American can understand the nature of technology, appropriately use technological devices and processes, and participate in society's decisions on technological issues". "Through technology, people have changed the world. In the drive to satisfy needs and wants, people have developed and improved ways to communicate, travel, build structures, make products, cure disease, and provide food. This has created a world of technological products and machines, roadways and buildings, and data and global communications. It has created a complex world of constant change." (Technology for All Americans Project 1996, p. 2.)

In Australia the justification for the study of technology is that 1) people come into daily contact with a wide variety of both simple and complex technologies, and 2) technology contributes to cultural, social, environmental and economic changes (A statement on technology for Australian schools, 1994, p. 3). The justifications for the study of technology in the other four countries included in this study are similar to the Australian and American views.

An analysis of the curricula reveals that a common rationale can be discovered behind the curricula of all six countries. One important reason for technology studies is preparedness for the rapidly changing world. This can be seen as an objective from the individual perspective, but it also has strong connections with the societal perspective. Emphasis is on learning the planning and production cycle, on becoming discriminating and informed users of technology, and on becoming innovators. Understanding social, aesthetic, and environmental issues are also considered essential.

The approach in the curricula is clearly hermeneutic. The objective of knowledge is to learn about nature and human being (the world developed by human beings). In the background is an interpretative human concept. Humans are regarded as goal-oriented, intentional, active beings; individuals format the social systems, and they have to learn to make free and justified choices at school. The phenomena are studied as phenomena in themselves, i.e. their essence and character are considered, and not only the matters influencing in the background. Thus, they are also of phenomenological nature. For example, one objective could be to learn planning, making and evaluating. The object of interest is, then, planning, making and evaluating; and not for instance the way in which the brain controls the planning process or what factors affect the eye-hand coordination.

5.1.3 Analysis of the curricula from society's perspective

One of the three categories for the study of technology stated in the general part of the curriculum in the Netherlands is technology and society. Similarly, the general part of the curriculum of Australia and the United States refers to cultural, social, environmental and economic changes. In the curricula of the other three countries the background elements and theories are not clarified in the general introduction. Instead, these curricula go directly to describe the attainment targets.

5.1.3.1 Objectives from society's perspective

Relationship between society and technology
One of the general objectives in the Netherlands is to become familiar with such technological viewpoints that are substantial for a profound *understanding of culture, of the way in which pupils act in society, and of the issues which are important for the future technical development of the pupils.* In Sweden one of the objectives is to add understanding on *how production circumstances, society, physical environment and, through these, our living conditions change.* Technical know-how is seen more and more as a prerequisite for that *the technics* around us *can be controlled and used.* The Swedish curriculum is the only one in which the recognition of *the history and development of technical culture* is emphasized.

Human needs and technology
In France technology education aims to clarify the interconnections between *work, products and human needs,* and through this, the *effects of technology on society and culture.* In the same way, the objective in the Netherlands is to gain information and understanding on the close connections between society and technology. This is linked with the following: development of technology (negative and positive), how humans and situations affect the rise of a new

product, forming one's opinion on technical development, attention to be paid to norms and values. Furthermore, the curriculum states that students should be informed about industry, professions, and the effects of technical development on the environment.

Balance between technology and the environment
From the global viewpoint the highest emphasis in the study of the relationship between the environment and technology can be found in the general objectives of the Australian curriculum. According to it students should develop a global understanding and care of a *balanced development of the environment.* The effects of technical development, taking care of the environment and nature are also emphasized in the curriculum of the Netherlands, as well as Sweden. The Australian curriculum states yet another global objective: To develop students' ability to express their standpoint in matters dealing with moral matters, ethical matters, and social justice.

Technological professions and co-operation with production life
Getting acquainted with the professions in the field of technology and *building connections between schools and the production sector* are objectives in the curricula of France, the Netherlands and Sweden. Likewise, the Australian curriculum emphasizes the development of skills that allow students to become as *flexible and adaptable* as possible in their future professions. In the curriculum of England and in the American documents there are no direct references to the objectives related to the relationship between schools and the production sector or choosing one's career.

5.1.3.2 Teaching methods from society's perspective

Co-operation projects
Co-operation between schools and the society around schools is an approach directly related to society. According to the French curriculum students should study production, marketing, needs analysis, and the industrial and service professions of the region where the school is located. The aim is to use three fifths of the time on production and hands-on projects. The curricula of the other five countries do not directly refer to co-operation projects with the industry or service industries.

Attitudes towards technology professions
According to the curricula of France, the Netherlands, and Sweden such approaches should be pursued that would change people's *attitudes towards technology professions in a more positive direction.* The Australian curriculum emphasizes also conscious study of how to tolerate uncertainty.

5.1.3.3 Learning contents from society's perspective

In the Australian and French curricula the contents of learning are presented as chapters of their own. In the curricula of the other four countries the contents are presented under such headings as objectives, description of the nature of the subject, study field of the subject or other similar headings.

For girls and for boys
According to the curricula of all six countries *both girls and boys should study similar contents*. Technology for All Americans: A Rationale and Structure for the Study of Technology (1996) supported by Standards for Technological Literacy: Content for the Study of Technology (2000) present the broadest demand in this respect. According to these documents technology should be a core curriculum subject from kindergarten to senior high school and even beyond.

Systems and structures of technology
According to the French curriculum the student should become acquainted with technological systems, their implementation and use. In Australia, students should familiarize themselves comprehensively with the technological applications and processes. In England, *mechanisms, constructs, products and their applications* are studied, and in the Netherlands the focus is on the applications of technology. The Swedish curriculum points out that the function of technics is to *alter, store, control, and regulate.* In England technological systems and control technology are studied in the upper classes, starting from grade 7. In France the students familiarize themselves with special technological methods and production of energy. The English curriculum is the only one emphasizing the increase of knowledge and understanding of the *quality* of products and services.

Industry and technological professions
In the Dutch curriculum the different stages of a production process, working conditions, quality control, and division of work between gender and different ethnic groups are studied. Also technical instruments used by different professionals and changes in different professions caused by the technological development are among the focuses of study. The French and Swedish curricula also state clearly *the connections between trade and industry and technological professions*. The Australian and American curricula, on the other hand, do not include references to professions. The reason behind this may be the previous pre-vocational nature of the school subject. In today's general education these countries are making a conscious effort to free themselves from the burden of the old school system.

Safety and ergonomics
Only France and the Netherlands emphasize the importance of *safety* and *ergonomics* during technology lessons. The Dutch curriculum additionally

points out that students should learn how to use the products of technology in a safe manner.

5.1.4 Analysis of the curricula from the school's perspective

School consists of many elements: the building, the furniture, the equipment, school yard, the world outside the school fence, staff (from kitchen staff and care taker to teachers) etc. The analysis here mainly concentrates on issues dealing with teachers.

5.1.4.1 Objectives from the school's perspective

Objectives cannot be analyzed separately from society and the students, i.e. merely from the viewpoint of the school and the teacher. All stated objectives deal with the school and guide the teacher's activities. In the following, such objectives which affect to a considerable degree the teacher's activities are brought up for consideration.

Technology and society

One of the general objectives in the curriculum of Sweden is to explore how technics affects society and nature. In Australia students should develop along with technological skills an understanding of *the role of technology in society.* Likewise, in the Netherlands students should be informed about the close linkages between technology and society. In England trade and industry have financially supported many educational experiments, and co-operation projects between educational institutes and the industry are continuously in operation and being developed. These objectives bring teachers face to face with many new situations which demand fresh approaches and which are different from the old and familiar modes of action.

Different skills

In England pupils are taught *planning skills; making skills; knowledge and understanding* of mechanisms, structures, products and their applications, quality, health, safety, and vocabulary. Similar types of objectives of learning different skills can be found in the curricula of all the countries under analysis. In the Netherlands, the human needs behind the planning and solutions are emphasized. Also *evaluation skills* should be studied (Australia, the Netherlands, Sweden). In the Australian curriculum, in particular, also *social skills* are emphasized. Schooling should develop such skills that students will be able to become as flexible and adaptable in the working life and other fields of life as possible. Students should also develop the skill to express their views on questions related to *moral and ethic* justice (Australia, Sweden).

Integration and learning environments
The objectives of *integrating* the technology programs of the primary, junior secondary, and senior secondary levels and, on the other hand, the objective of studying technological learning contents during the lessons of various subject areas demand quite a great deal from the school, and particularly the contribution and co-operation of different teachers. For planning and hands-on activities the technology rooms at the schools have to be very well equipped. All six curricula include references to the equipment needed for effective learning, although no mentions about the technology rooms. The equipment listed includes tools, machines (including computers), equipment needed for studying electronics, pneumatics, hydraulics etc., as well as equipment needed to study control, computer-aided design (CAD) and computer-aided manufacture (CAM).

5.1.4.2 Methods from the school's perspective

The curricula of Australia, England, and the United States give rather straight-forward advice on the learning methods. In the case of the other three, the methodology is to be established for instance within the learning contents themselves.

Integration
The curricula of all the countries in question encourage *integration* between various subject areas. Australia goes furthest by presenting that technology programs can be constructed and carried through as programs of their own or they can be connected together with other issues to be studied. The most important subjects to be integrated with technology education are science (Australia, England, France, the Netherlands, Sweden, and the United States of America), mathematics (England, the Netherlands, and the United States), history and social sciences (France, the Netherlands, and Sweden), languages (France), and arts (England). The Australian curriculum also mentions different engineering sciences and the outside world of trade and industry. The French curriculum emphasizes the connections of technology education with computing. In the Netherlands the aim is to work on a thematic basis, which is seen as a way of increasing integration between different subjects.

Planning skills and flexibility
The decisions on what learning methods are chosen by the schools are affected by the demand of co-operation between technology studies and society (Australia, France, the Netherlands, Sweden, and the United States), as well as the different learning objectives set. These objectives are, for example, similar to what is one of the general objectives in England: Pupils should be taught how to develop their design and technological skills by combining their planning and making skills to *knowledge and understanding of design and making of products;* or one of the general objectives of Australia: Develop such skills that allow the

pupils to become as flexible and adaptable as possible in their forthcoming jobs and other fields of living.

Learning by doing
The balanced combination of practice and theory and *learning by doing* (Australia, England, France, the Netherlands, Sweden and the United States) together with making a design, learning to learn, learning communication and reflection are objectives that give direction to the activities and methods of the teacher.

Pre- and in-service education of teachers
As has been noted above, technology education is a new subject area in all six countries, and most curricula have also been revised over the past decade. The teachers who were educated more than ten years ago may not have sufficient know-how on how to go about teaching technology. How well both in- and pre-service education of technology succeed affects the approaches and activities of the school concerned. The methods learned during teacher education will be reflected in the technology room.

Assessment of national learning outcomes
The national examinations which English students have to sit most probably affect the choice of study methods promoted by the teachers. The way in which the tests have been planned, whether they are theoretical, practical or a combination of the two or something completely different have considerable influence on the methods of learning and teaching at the school level.

5.1.4.3 Content from the school's perspective

The objectives and methods discussed above naturally determine a great deal of the content to be covered. The six curricula also differ in this respect a great deal from one another. The Swedish curriculum, for instance, is very general, whereas the Australian and the English curricula go as far as to provide rather ready-made schemes of work (plans for a project) for a variety of technology projects.

Planning, making, assessing; information; materials; and systems
The Australian curriculum is divided into four interdependent categories (strands) of study: *1) designing, making and appraising; 2) information; 3) materials; and 4) systems.* This grouping lays the foundation for checking, rearranging, and revising the technology programs. Furthermore, the contents of learning at schools are organized on the basis of the four strands. The Australian system serves here as a good example of learning contents from the school's point of view. The contents are rather similar in the curricula of the other countries as well.

Systems and control, constructions, processes, communication, information, energy and power, materials, and safety
The curriculum of the Netherlands states out clearly the content to be studied in this area. The curricula of the other five countries list these under, for instance, the attainment targets or schemes of work. The content important from school's perspective have been dealt with in the previous analysis already, in connection with the contents from society's perspective. An important list of content from the school's perspective, thus, is to be found in the curriculum of the Netherlands. According to it technology studies should progressively develop the learners' know-how on *systems and control, structures, processing, communication, information, energy and power, materials, and safety.*

5.1.5 Analysis of the curricula from the student's perspective

The aim of going to school is to learn. School aims to change the learner; she or he should become more skillful, knowledgeable, and develop certain kinds of attitudes. The school and society, then, are changed by individuals. The final target of the curriculum is the individual, the student.

5.1.5.1 Objectives from the student's perspective

In the previous chapters the objectives have been analyzed from society's and from the school's viewpoint. When analyzing the objectives from the student's, school's, or society's point of view one realizes that they are in many ways congruent and overlapping. The objectives in this respect have also been expressed in quite different ways, and the approach varies in the curricula of the six countries.

Technological literacy
The general aim of becoming *technologically literate* emphasized by the United States can be regarded as an objective of all the six countries. According to it students should achieve *an ability to use, control, and understand technology.* All the six curricula state out the importance of learning the use and understanding of technology. The ability to control technology is not clearly written out in the English curriculum.

Problem-solving ability, role of technology, environmental balance, ethics of technology
The general objectives in these areas are stated out explicitly by Australia and the Netherlands. The specified objectives are relatively clearly expressed in all the six curricula. In Australia schools should develop in students the ability to *analyze and solve problems,* process information and use computers; together with science and technology, the ability to *understand the role of science and technology in society;* to understand and take care globally of *the balanced development of the environment;* the ability to express their opinions in matters dealing with *moral,*

ethic and social justice. Also in Sweden the students' ability to evaluate and valuate the consequences of different technical choices for humans, society and nature are emphasized.

Applications of technology and the personal characteristics of students
In the Netherlands students should actively *familiarize themselves with the applications of technology and learn to plan and solve on the basis of human needs.* In Australia the aim is that students become more and more *innovative, knowledgeable, skillful, adjustable, and enterprising.*

5.1.5.2 Analysis of methods from the student's perspective

The objectives, contents, and teacher education among many other factors affect the methods used during technology lessons. In addition, the degree and depth of integration between subject areas affect the choice of methods and pedagogical approaches.

Planning, co-operation, and networks
A very thorough list of various teaching and learning methods is introduced in the Australian curriculum. According to it students should use *creative means of inventing ideas* and putting them into practice, change ideas to useful products, concentrate on *designing* the products, learn tolerance of uncertainty consciously, *co-operate* in flexible *teams,* as well as *use* local, regional and international *networks.*

Practical work, experiments, observations and constructions, design and evaluation
In the Swedish curriculum the learning methods are divided into three parts 1) *practical work and research,* 2) *experiments, observations, and constructions,* 3) *designing, building, and evaluating.* It is particularly the third part that is clearly expressed also in the curricula of England, France and the Netherlands. The French and Dutch curricula also place emphasis on *getting familiar* with the special methods of technology.

Hands-on methods
From the pupils' perspective a very significant emphasis is that on *active, practical, hands-on methods.* The French curriculum gives time allocation for hands-on activities. The other five countries do not give exact time spans for practical activities, but learning by doing and production activities are still the methods to be implemented according to the curricula of all the countries under study here. Furthermore, *safety precautions* are paid attention to in all six countries.

5.1.5.3 Content from the student's perspective

It is important to realize that analyzing the content from the students' perspective only is not possible, or even appropriate, without taking note of the content from the society's and school's viewpoint. There is naturally a great deal of overlapping, and therefore it is not possible to avoid repeating the previously mentioned learning content.

In Australia four different domains (strands) regulate the learning content. These are: designing, making and appraising; information; materials; and systems. These sub-areas are to be found in the curricula of the other five countries as well, although grouped in a slightly different way or presented in different connections.

Technology, society, history, and functions of technics

The general aim of Swedish technology education is to achieve competence in the basic know-how of technics. This competence includes the following components: *the role of technical development; the historical perspective; the solution of technical problems, analysis and valuing of the relationship between human – society – nature; the effects of technics on nature.* Additionally, it includes the study of the functions of technics (*alter, store, and control*), the component-system perspective, and process work (*identification of the problem, construction, and evaluation)* are mentioned. In England and the Netherlands *information, energy and power, materials, and safety* are added into the contents. Also, one area of evaluation in the French curriculum is *marketing* as one of the content fields.

5.1.6 Synthesis of analysis results

In this chapter the results of the systematic analysis reported in the previous pages are synthesized in the form of a table (Table 8). The objectives, methods and contents presented in the table are not in any special order of, for instance, importance, but presented in the order they appear in the previous pages.

TABLE 8 Objectives, methods and contents of technology education in the six countries from society's, school's and student's perspectives

OBJECTIVES	METHODS	CONTENTS
From society's perspective	**From society's perspective**	**From society's perspective**

• technology and society
• human needs and technology
• balance between technology and nature
• jobs in technology, and co-operation between school and enterprises
	• co-operation projects between school and surrounding society
	• preparing oneself for life after school:
	  • teamwork
	  • analyzing
	  • inventing
	  • producing ideas
	  • evaluating
	• adopting positive attitudes toward professions in technology
	• studies to tolerate uncertainty
		• for girls and boys
		• systems and structures of technology (mechanisms, structures, products and their applications, transfer, storage, control, regulation, processing, communication, information, energy, power, quality)
		• trade and industry and professions in technology (production process, working conditions, control of quality, sharing of work, technical appliances used by different professions, changes in different professions)
		• safety precautions and ergonomics

From school's perspective	**From school's perspective**	**From school's perspective**
• role of technology in society • different skills (planning skills, making skills, knowing and understanding, evaluation skills, social skills, moral and ethical skills) • integration • learning environments	• integration • planning skills and flexibility • learning by doing • teacher education and in-service development • national examinations	• planning, making, evaluating • information • materials • systems • control of systems • structures • processing • communication • energy and power • safety
From student's perspective	**From student's perspective**	**From student's perspective**
• technological literacy (ability to use, control, and understand technology) • problem solving skills	• planning, co-operation and networking • practical work; experiments, observations and building; planning and evaluating	• role of technological development • history of technology • solving technological problems

(continues)

TABLE 8 (continues)

• understanding the role of science and technology in society • developing technology in balance with the environment • moral, ethic, and social justice • know-how, skills, values • adopting critical attitude • applications of technology • planning and solutions from human viewpoint • students should become more innovative, conscious, skillful, flexible, and enterprising	• learning by doing • safety	• evaluation and valuation of the relationship between humans, society, and nature • effects of technology on nature • functions of technology (alter, store, control, and regulate) • process work (identifying, constructing, and evaluating) • information • energy and power • materials • safety • marketing

Although the format and approach in the six curricula under study here differ from one another in many ways, considerably many common features can also be found. At the same time, there are only very few objectives, methods or contents which appear in the curriculum of only one specific country. There are no contradictions between any elements of the six curricula, nor are there big differences in the emphasis given to the various sub-fields of technology studies. It seems that in the French curriculum computing is probably given more space and attention than in the curricula of the other five countries, where computers seem to work more as one of the tools for technological studies.

As the table above shows, there are many overlapping elements, regardless of whether the table is studied horizontally or vertically. In any case, however, the table shows that technology is seen as a significant part of human life; it affects the routines of individuals, schools, and the whole society from local municipalities to global organisms. It is considered important to realize the history and development of technology and its effects on human beings and the environment. Technology is not seen as something which is good, and has to be accepted as it is, nor is it seen as something bad that has to be denied or ignored. Technology is around us, whether we want it or not. Therefore, students should be educated to cope and deal with technology, to develop it in balance with the environment, and with a realistic and, at the same time, critical approach.

5.1.7 Degree of success in the implementation of the curricula

Above the written curricula of the countries selected has been discussed. There are several means of finding out and trying to ensure how well a written curriculum is put into practice (Malinen 1992, p. 24), and whether it is interpreted in the intended way by the teachers. During teacher education the curriculum is studied and applied with the students. In the case of a new subject, like technology, the information on how to go about learning and teaching it, is learned during in-service courses. At the first stage of introducing technology education in England, the training component was not sufficiently connected with the implementation of the curriculum area. Lack of information on how to go about teaching the new subject caused a lot of confusion among teachers. This was a lesson to England, and today there is a well-established pre- and in-service programs service in the whole country. (Benson 1999, p. 117 – 121.) In Australia and the Netherlands a systematic in-service program was conducted simultaneously with introducing the new technology education curriculum. Pre- and in-service education are the key determinants for an appropriate implementation of study programs. A national or regional network of supervisors or inspectors assists in ensuring that the plans are followed in a proper manner. This type of a system also gives feedback to the planners on how well the curriculum works in practice. Furthermore, the results of examinations provide information on how well students have acquired the content they have studied.

Before a new subject is introduced an extensive public debate is normally taking place. In the Netherlands, for instance, the discussion lasted for about eight years, but during it the necessity of having technology as a new subject was seldom attacked. In England the discussions went on from 1986 to 1988, and ended in a report by Lady Parker's committee. In the United States the standards were developed through a very extensive consensus-reaching process which involved hundreds of people from within and outside the field of technology education.

As stated above, technology education is a newly introduced subject in all the countries under study. In France and the Netherlands the curriculum for the primary school is still under development. In England the curriculum for the primary level was introduced gradually over a three-year period starting from 1990. Prior to this there was craft, design and technology education for secondary level, but nothing for the younger pupils (C. Benson, personal communication, 12 June, 2000). In the United States the newly published standards start from kindergarten, but in the past years the elementary level curriculum has been the least developed (J. LaPorte, personal communication, 24 July, 2000). Also in Australia and Sweden, technology education has been part of the primary curriculum only for a few years. Thus the development work in technology education has started mainly at the secondary school level in all countries concerned.

The inspection authorities would have data on how well the curriculum is put into practice in particularly those countries where centrally set examinations are used. This is not the case in all the countries under study. In order to get an overall picture of how well the implementation of the curriculum has succeeded, a questionnaire was sent to teacher educators of the above six countries.

In Australia (where national guidelines were published already in 1994) the implementation has succeeded well at all levels of education, from pre-school and primary to senior secondary. Naturally there are variations depending on the teacher and school (M. Hulsbosch, personal communication, 13 June, 2000).

In France technology education is a compulsory subject for four years, from grade six to grade three (11 to 15 year old students). The subject is not regarded as a difficult school subject. Rather, the students find it quite easy to pass technology courses. However, as a new subject it is still looking for its status within the school curriculum. Eleven- to twelve-year old (grade six) students regard technology studies as the third most interesting subject after sports and mathematics. This interest in technology, however, declines gradually year after year (Andréucci & Ginestié 1997, pp. 98 – 99). On the other hand, students think that the time for certain technology studies is too short. They would like to spend more time on making items individually, repairing devices, applying high-tech, using tools and computers (ibid. pp. 100 - 102). Getting high marks easily does not motivate the students to learn technology. Therefore, in France the issue is to develop an attractive curriculum, which would be demanding enough, and where the emphasis is on challenging and modern contents and methods of learning.

The inspection office (OFSTED) in England monitors the implementation of the curriculum and reports through Her Majesty's Stationery Office (HMSO) annually. The latest report shows that technology education is well implemented for the three- to seven-year old pupils, dips at key stage 2 (seven to nine years), picks up with nine to eleven year olds, dips again with 11 – 13 years and then picks up again. (Benson, 2000.)

In the Netherlands the primary curriculum mentions elements of technology, but no systematic effort has been made to implement those. How well technology is taught at the primary level depends much on the individual teachers. Also, the institutes training primary school teachers do not systematically deal with technology education. For lower level secondary schools there exist textbooks which have been specially developed for technology education and special classrooms with basic equipment. In the senior secondary the curriculum has several elements of technology in connection with science education. There was a special project (Techniek 15+) that produced materials for those grade levels, but no systematic introduction took place in teacher training institutes or in schools. The first substantial review of practice in lower secondary education revealed that technology education is still struggling with several problems (e.g. pedagogy, content coverage), but that generally speaking it is well on its way. (M. deVries, personal communication, 9 August, 2000).

In Sweden primary teachers tend to adapt more easily than secondary level teachers to changes in the curriculum. However, not much technology teaching is going on in the Swedish primary schools (grades one to six). The reasons for this are that there are no clarified national instructions about the teaching of technology, and class teachers do not feel confident about teaching the subject. Many secondary teachers, on the other hand, have studied technology-related subjects during their school years, but do not realize that the subject has changed through the 1994 national curriculum. This leads them to concentrate on practical work only without any theoretical discussions. They are also in many schools a rather isolated group and feel insecure about the new curriculum. An extensive in-service program should be organized both for primary and secondary teachers, for a better implementation of the curriculum. (Schoultz & Ehrnborg 1997.)

In the United States the upper primary and secondary school (high school) level have the longest traditions in technology education. For this reason, curriculum implementation has best succeeded in the middle school (grades six to eight), secondly best at high school level (grades nine to twelve), and to the lowest degree at elementary level (grades kindergarten to grade five). However, much work in technology education at the elementary level seems to be taking place at rapidly increasing rate and many interesting developments have occurred. One of the fundamental principles of education in the United States is local control. Most states have a curriculum which is recommended for schools. The actual curriculum, however, is up to the local school district, and as a result, there is a lot of variation in the curricula. Some programs are influenced by the British approach, others are based on communication, construction, manufacturing and transportation, some still have a pre-vocational approach, and a few still emphasize the learning of manual skills. (J. La Porte, personal communication 24 July, 2000).

What is described above indicates that there is still a long way to go before technology education is implemented at all grade levels. The policy of all countries concerned is that technology should be studied from the elementary level up to the senior secondary level and even beyond. The best established situation in most of the countries discussed is at the junior secondary level.

Lessons to be learned for Finland here are numerous. When introducing a new subject area, a wide and thorough debate should occur. This should involve not only educational authorities but also parents, pupils, teachers and teacher educators, trade and industry, and other stakeholders. The implementation of a new curriculum involves, among other things, development of learning materials and teacher education (pre- and in-service). The whole system, from pre-school to upper secondary, should be considered and involved simultaneously. The place and status of the subject should be clarified with respect to other subject areas. (see e.g. Nevalainen, Kimonen & Hämäläinen 2000; Webb et al. 1997.)

5.2 Expectations of trade and industry and technological universities

The various interest groups of society have their own expectations from the school system. In this study the aim was to seek for clarification on what trade and industry in the field of technology and the institutions offering training in the field of technology expect from general education. This part of the study addresses the third research task, namely the question of how Australia, England, France, the Netherlands, Sweden, and the United States have organized the technology education in their schools.

To begin the exploration the Central Finland Chamber of Commerce was contacted to obtain addresses of companies of different sizes operating in the field of technology. According to the Chamber companies are reluctant to answer all the research questionnaires sent to them because they receive far too many of them. Following the advice from the Chamber of Commerce headquarters of the Federation of Finnish Metal, Engineering and Electrotechnical Industries (Metalliteollisuuden keskusliitto, MET) was contacted. It provided a list of small, medium-sized and large companies which had actively responded to previous inquiries. On the basis of this 36 companies of various sizes from different parts of Finland, representing different fields of technology were chosen in a discretionary manner.

The addresses of the educational institutions were found in the guidebook published annually by the National Board of Education (Yliopisto-opinnot 1996 – 1997). The questionnaires were sent to 36 polytechnics and technical universities in different parts of Finland. The basis for choosing these particular institutions was to reach the various fields of technology from the various parts of the country.

The survey questionnaire was prepared in three phases. The first version was used to explore the needs of students to study the contents, objectives, and methods of technical work and technology. The purpose was for students to evaluate the needs for developing technology education. The students were also asked to comment on the questions and to suggest alterations and additions freely. This process served to examine the comprehensibility and clarity of the questionnaire. The observed weaknesses were then handled. This pilot questionnaire tested with students served as the basis for the questionnaire which was prepared jointly with lecturers of technical work at the teacher education departments in Jyväskylä, Hämeenlinna and Savonlinna in 1997. This second version of the questionnaire was sent to the parents of pupils in comprehensive school. As before the parents were given a chance to comment on the questions. The final survey questionnaire (Appendix 2) was prepared on the basis of the previous ones, improving it along the lines of the comments and suggestions given. This work was mainly done by the lecturer in the didactics of technical work, Matti Parikka, at the University of Jyväskylä. The same questionnaire, which was used in this study, was also used in Parikka's (1998) research on technology competence. Because the study at hand is part of a larger project it was justified to use a uniform research instrument, which would allow a reliable comparison of the findings.

The survey questionnaire consists of five sections. The first section covers the background information of the respondent, the three following ones are structured, and the last one gives an opportunity to open answers. There are 18 items in the second section for the evaluation of the objectives of learning. The third section includes 12 items for the evaluation of the methods, and 11 items in the fourth section deal with the evaluation of content. The answers to the second, third and fourth sections were given on a five-point Likert scale. It was also possible to strike out those parts which were not considered relevant from the respondents' point of view in the domain of learning contents. In the fifth section the respondents were requested to give their views about the future development of technology, the possibilities of promoting technology education in schools, and the need for developing the organization of teaching. This last section was composed of open questions. The second, third and fourth section of the questionnaire also included an open question for further comments.

All those involved in the planning process of the questionnaire are experts and students of technical work/technology education. The educational background and extensive professional experience of the designers in this field have most obviously affected the contents of the questionnaire. If the research instrument had been designed by a group of representatives from some other field of education or by representatives of a completely different discipline, the contents might have been formulated differently. On the other hand, comments and improvement suggestions were asked from several people during the process of planning the questionnaire. The study at hand, as well as Parikka's study, are part of a technology education experiment which has lasted for almost ten years already. The other reports published during the project have also been commented upon at both the draft stage as well as after publishing, and these comments were also taken into account in the design of the questionnaire. The aim was to approach the field of technology education in as broad a manner as it is also internationally understood.

5.2.1 Survey procedure and findings

The survey questionnaire was sent to the technological training institutes and representatives of industry by mail. In the structured part the respondents were asked to comment on the learning objectives, methods, and contents of technology education. In the open part four questions were posed: 1) How do you see the development of technology in the decades to come?, 2) How should comprehensive school and upper secondary school be developed to promote technology education?, 3) How should technology education be taught in the comprehensive and upper secondary school?, and 4) How should technology studies be placed? The questionnaire was sent to 36 technological training institutes (technical universities and polytechnics) and 36 companies of technology industry. The questionnaires were returned evenly from the different parts of Finland. The response rate was 42 returned questionnaires (58%), including 19 (53%) from the training institutes, and 23 (64%) from industry. The non-response rate may cause some problems in interpreting the results because the persons who do not answer may be selected in one way or another (Nummenmaa, Konttinen, Kuusinen & Leskinen 1997, p.22). The respondents were in this case representatives of technological training institutions and industry. It can be assumed that even if all questionnaires had been returned, the information in the responses would not have differed significantly from what was obtained now. The response rate was sufficiently high for statistical purposes and questionnaires were returned evenly from both universities and polytechnics. Also, industrial enterprises of various sizes are represented in the data. Since all respondents did not want to have their organizations identified, the names of the institutes and enterprises are not published in this report. Furthermore, this information would not have given any added value to the research.

In the domain of learning content it was possible to strike out content which the respondents did not regard as important. Five respondents from the industry and four from educational institutes took advantage of this possibility. Only one of these nine deleted the whole item of hobby work. In the statistical treatment this was given the score 1 (not useful or important). Other deletions were only a very few parts of a longer list of contents (e.g. such as sawing, chiseling, carving in the item of wood work, where the list consisted of 12 different woodworking techniques). After indicating the deletions the respondents gave their scores on the importance of the item in question. Because they did not delete the whole item their answers were statistically treated as all the other answers. Thus deletion of a few techniques did not affect the final scores.

To establish the common views, the answers and evaluations were analyzed with the SPSS program, version 6.1 for Windows, and the frequency distributions of means and standard deviations were calculated for all items (Appendices 3, 4, and 5). All the respondents have got technical training and have been working with technology for several years. When calculating the mean values and standard deviations, the training institutes and enterprises were first kept in separate groups. In the following graphs the training institutes and enterprises are presented separately.

The numbers on the horizontal axis refer to the numbers of the items in the questionnaire (Appendix 2). The items are explained below in 5.2.1.1 because the two groups (industry and training institutes) have been combined in the final analysis. The reason for combining the two groups becomes apparent in the following.

The scale (vertical axis) used for evaluating the importance or usefulness of the different items varied from one to five:

1 not useful or important
2 only a little useful or important
3 useful or important
4 very useful or important
5 most useful or important

Figure 10 below shows that the views of the respondents from both the training institutions and the industry are very similar as regards learning objectives. There is a slight difference only in item 4 (study of natural phenomena and science and their technological applications, for instance applications of lever)

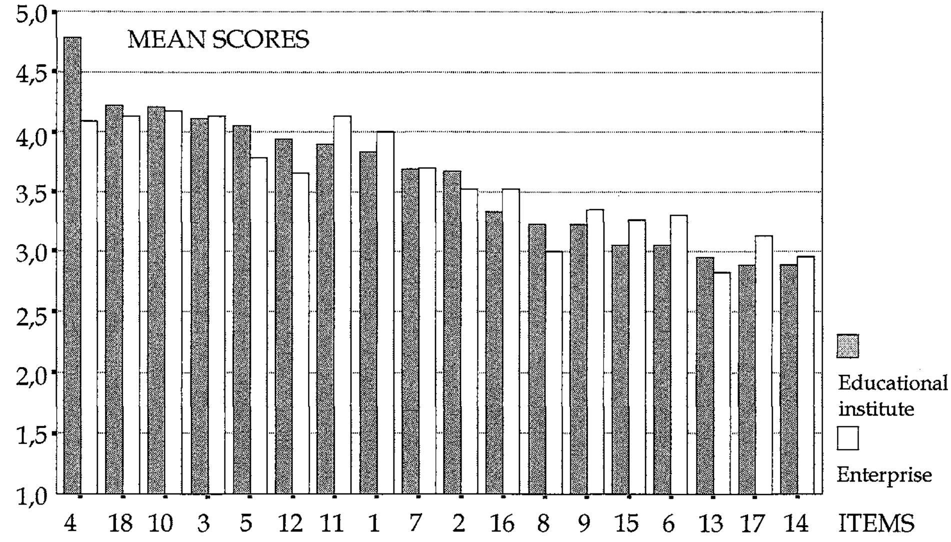

FIGURE 10 Evaluation of the importance of various learning objectives

As regards the methods (figure 11) there are no differences between the industry and educational institutes except in item 11 (serial work). This method was seen, however, as the least important in both groups.

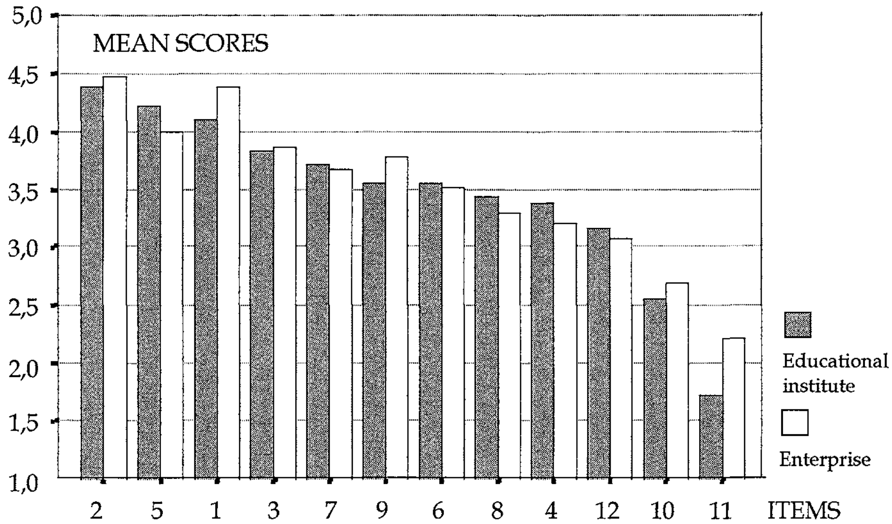

FIGURE 11 Evaluation of the importance of various learning methods

The representatives of the industry regarded maintenance and fixing of hobby equipment (item 11) as a more important content area than the representatives of training institutions, who in turn regarded mechanics, wood technology, and metal technology (items 7, 1, and 2) as slightly more important contents than did the representatives of industry (Figure 12).

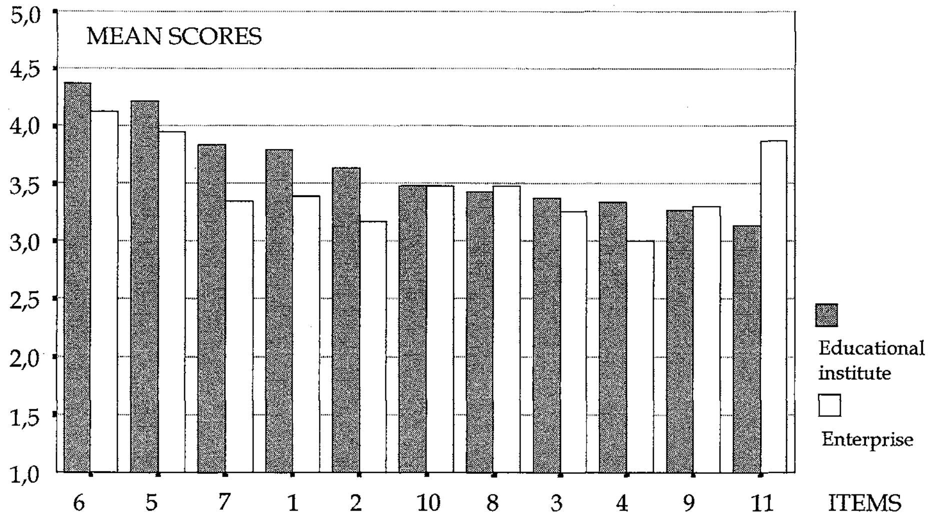

FIGURE 12 Evaluation of the importance of various learning contents

There were no considerable differences in the results of the two groups. Only in the contents part in item 11 and the objectives part in item 4 the difference is 0.7, well under one. In all other graphs the mean scores from the two groups follow a common line (difference well under 0.5). For these reasons, the views of the training institutes and the industry are treated together in the forthcoming discussion.

5.2.1.1 Respondents' evaluations regarding learning objectives, methods, and contents

The learning objectives

The learning objectives were studied by means of the following items:

1 Students learn systematic working skills, e.g. how does a professional worker or repairer work
2 Students learn basic technical know-how and basics of safety precautions
3 Students practice technical thinking and innovation skills (from idea to product)
4 Students explore natural phenomena and science and their applications, e.g. the applications of a lever
5 Students familiarize themselves with practical technological systems, e.g. the functions of heating, water, sewage, and air-condition systems
6 Students learn technological concepts and technical drawing

7 Students familiarize themselves for the sake of sustainable development with the properties of materials, their circulation and recycling
8 Students familiarize themselves with the history of technology and its effects on culture
9 Students evaluate the development of the technological world (what is right, what is wrong) and express their opinion on its societal consequences
10 Students learn to use computers in many types of tasks
11 Students familiarize themselves with entrepreneurship, production life, and industrial ways of action
12 Students learn handicraft skills, students learn how to make various articles with hand tools
13 Students practice the non-regulated electrical work of home
14 Students study how to service and repair home utensils
15 Students study how to do small repairs of home (e.g. painting and papering the walls)
16 Students study how to service skis, bicycle, motorbike etc.
17 Students familiarize themselves with various technical hobbies e.g. constructing model airplanes
18 Students study how to set their own learning objectives and how to evaluate their own study progress.

Only two of the learning objectives scored slightly under three (2.88 and 2.93). The highest mean value was 4.41. The difference between the lowest and highest mean value was 1.53 points. Out of 18 items 16 scored over three on a scale from one to five (they were considered at least useful and important). The standard deviation was at its highest 1.07 and on its lowest 0.76. The mean value of the standard deviation was 0.93. For this reason it can be concluded that the respondents were relatively unanimous. Figure 13 presents the mean values of the respondents' views of the importance of the various learning objectives in a graphic form.

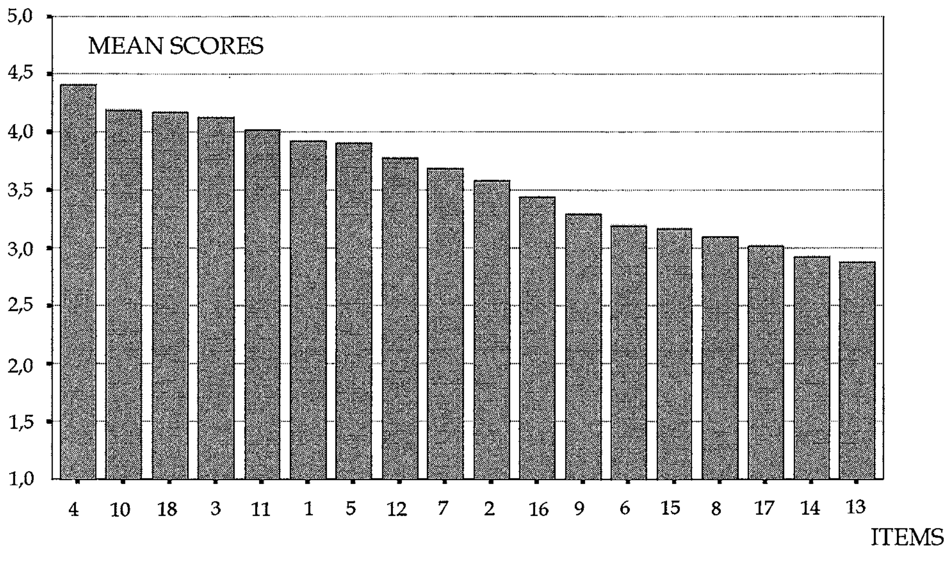

FIGURE 13 Preferred learning objectives

The learning objectives can be categorized in four groups in terms of their content. Five objectives were classified as the most useful or important (mean value over 4). These are (here the statements have been shortened from the original statements):

4 technological applications of science
10 use of information technology
18 personal learning objectives and self-evaluation
3 technical thinking and innovation skills
11 entrepreneurship, trade and industry

This group can be named the group of *applications of science, information technology, and technology; and innovative and individual learning methods;* and *trade and industry.*

The following objectives scored over 3.5 (shortened from the original statements):

1 systematic work
5 technological systems in practice
12 handicraft skills
7 sustainable development and recycling
2 technical know-how and safety

In this group are the items referring to *practicality* (items 5, 12, 2, also item 1 can be regarded as belonging to practicality), and *sustainable development.*

The third group is formed of items which are regarded as useful or important (mean value over 3):

16 service (skis, bikes, motorbikes)
9 development of technology and its societal consequences
6 technological concepts and technical drawing
15 repairs of home
8 history of technology and it's cultural effects
17 technical hobbies

This group includes the items referring to *technical service, repairs and hobbies* (16, 15, and 17), and interaction between *technology and society* (9 and 8), and also *technological concepts* (6).

The two items which scored under 3.0 form group four. These are:

14 repairing the devices of home
13 non-regulated electrical work

Both items in this group refer to *fixing equipment at home.*

The objectives described in items 13 - 17 can be regarded as minor objectives, compared to the other ones which are very comprehensive. These objectives also achieved low scores.

In the open part the respondents expressed their views of the importance of the following objectives:

- *students learn different methods of finding information*
- *students learn a model of team-work*
- *students learn to understand the effect of entities and parts on the whole system*
- *students learn how to apply theories in practice*
- *students learn to understand the advantages and disadvantages of technology.*

The learning methods

The learning methods were specified with the following items:

1 Working as a group, social or co-operative methods, e.g. project and team work
2 Looking for information independently and evaluating the significance of issues, e.g. use of libraries and internet
3 Taking own responsibility of distant work, e.g. doing learning tasks, getting information by interviews, computer aided design
4 Working with operating instructions and manuals
5 Studying through a foreign language, learning foreign language in an active and functional context
6 Studying and exploring, e.g. experiments with strength or glues
7 Active study tours to enterprises (during the study tour students work on something concrete instead of mere walking with the guide)
8 Partnership between school and enterprises
9 Evaluation of own work and learning activities, and proposals for improvement of learning organizations
10 Training oneself to copy models
11 Training oneself in serial work (line production)
12 Taking part in competitions and shows (at international, national, regional, and school level)

The lowest standard deviation was 0.67 and the highest 1.05 in the methods domain. The mean value of the standard deviation was 0.92. A conclusion that the respondents were quite unanimous in their views can be drawn from this. The highest mean value was 4.44 and the lowest 2.00. The difference between the highest and the lowest mean value was 2.44. The mean value of two items remained clearly under 3.00 (items 11 and 10). Figure 14 illustrates the mean values of the items regarding methods in a graphic form.

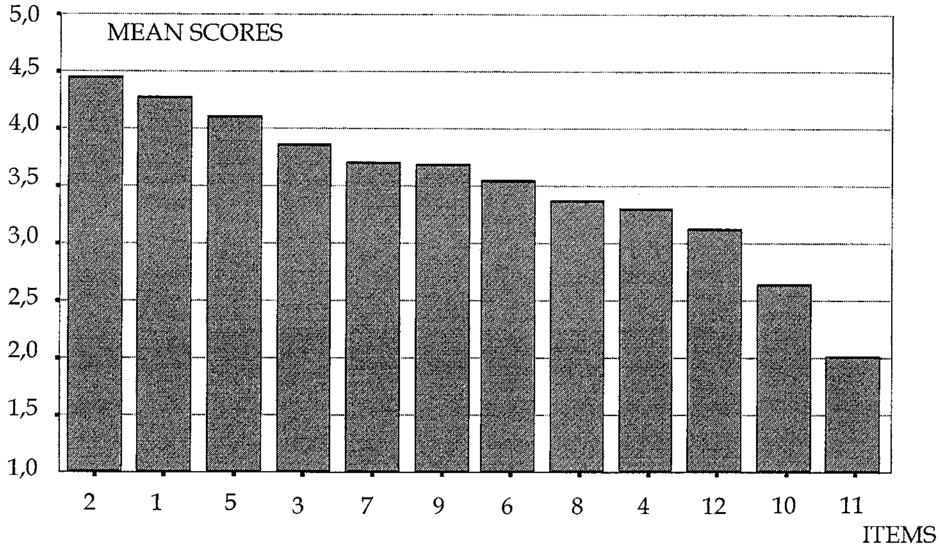

FIGURE 14 Preferred learning methods

In the same way as was the case with the learning objectives, the items referring to the learning methods can also be organized into four groups.

The first group is formed of items which are regarded as the most useful and important and very useful and important (mean value score over 4) (the original statements are shortened here):

2 finding out about issues
1 team work
5 studying through a foreign language

In this group *social*, and on the other hand, *individual* learning methods are emphasized. Additionally *learning languages in active and functional connections* is considered important.

The second group is formed of items which scored over 3.5. This group incorporates the following methods:

3 self-directed distance education
7 active study tours
9 evaluation of one's own work and learning activities
6 studies and explorations

The study methods in this group all refer to own responsibility, active studying, and self-evaluation.

The third group is formed of items which are considered useful (score over 3):

8 partnership activities between school and enterprises
4 working by following written instructions
12 taking part in competitions and shows

The fourth group is formed of methods which are not found useful (score under 3). These are as follows:

10 copying of models
11 serial work

Both methods in this group refer to *the copying method*, which is not regarded as an important method.

In the open question section concerning the methods only three respondents gave answers. One suggested that the methods in value education in the primary school could be plays and games, as well as moral education. Two of the experts emphasized the importance on learning by doing, because through practical exercises students will also become enthusiastic about studying theory. In short:

- *plays and games*
- *sports*
- *morals and education to the values of working life*
- *practical work (also leads to interest in theory)*

The learning contents

The learning contents were evaluated through the following items:

1 **Wood technology**, e.g. measuring and marking, sawing, drilling, planing, chiseling, carving, turning wood, making joints, surface treatment, knowledge of materials
2 **Metal technology**, e.g. sawing, filing, drilling, soft soldering (e.g. with tin soldering), hard soldering (e.g. silver soldering), gas, arch and mig welding, embossing (e.g. forming a copper sheet with an embossing hammer), riveting, surface treatment, knowledge of materials
3 **Plastic technology**, e.g. bending, gluing, surface treatment, different types of plastics, knowledge of materials
4 **Hobby crafts**, e.g. building miniature models, model planes, kites, hot-air balloons, knowledge of materials
5 **Electricity and electronics**, e.g. basics of electrical phenomenon, batteries, sun elements, electronic components, building electronic devices (e.g. blinking light)
6 **Information technology**, e.g. use of drawing programs, use of spreadsheet programs, computer aided design (CAD), CNC-technology (using machines which are controlled by computer), control technology, mechatronics
7 **Mechanics**, e.g. inclined plane, lever, axles and bearings, transmission of power and gears, building construction (e.g. out of assembly kits buildings, bridges, cranes, vehicles etc.)
8 **Non-regulated electronical work,** e.g. changing a bulb, changing a fuse, changing a lamp, fixing a socket, making an extension cord, mounting a TV or radio aerial, electrical safety
9 **Repairs of furniture and home**, e.g. glueing wood, renovating, upholstering, painting and papering walls, procurement of materials, preparatory work (e.g. cleaning and protecting the surfaces, preventing the effects of dust, dangers of dissolvent, precautions and protection)
10 **Other work at home**, e.g. service of locks and hinges, changing gaskets to a tap or washing machine, service and adjustment of toilet-equipment, hooks and plugs for different materials, sorting waste and recycling, sharpening of tools e.g. scissors, knives, axes and saws
11 **Repairs and service of hobby equipment**, e.g. adjusting and changing the cables of a bicycle, mending a tube, servicing skis and fixing bindings, repairs and service of fishing equipment

The lowest standard deviation was 0.72 and the highest 1.15. The mean value of the standard deviations was 0.95. This leads to a conclusion that the respondents' opinions were again parallel. The highest mean value was 4.24 and the lowest 3.15. The difference between the lowest and highest mean values was 1.09. Grouping of the learning contents is not as clear as grouping the variables dealing with objectives and methods, because all these variables scored over 3 (were seen as useful or important, or higher). Two items (6 and 5) scored over 4 (very useful or important), and 11, 1, and 7 scored over 3.5. These results are presented in graphic form in Figure 15.

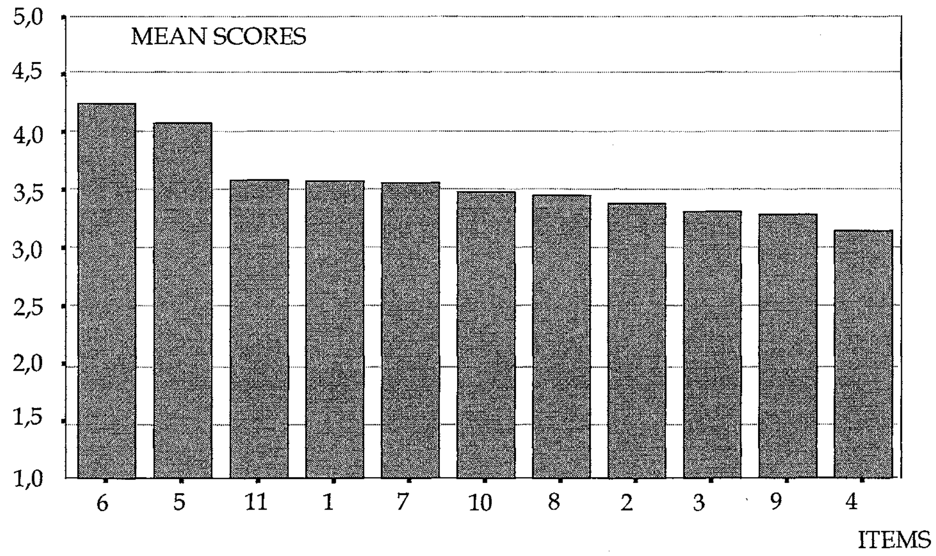

FIGURE 15 Preferred learning contents

The items that were considered the most important (mean value score over 4) were:

6 information technology
5 electricity and electronics

Both of these items refer to *high tech.*

The following three items scored over 3.5:

11 repair and service of hobby equipment
1 wood technology
7 mechanics

There is no common feature between the variables in this group, although *service of hobby equipment* could be seen to incorporate contents of wood work and mechanics.

The third group consists of the items which were regarded as useful or important (mean value score over 3). These are the following:

10 other work at home
8 non-regulated electrical work
2 metal technology
3 plastic technology
9 repairs of furniture and home
4 hobby crafts

Four of these items (10, 8, 9, and 4) are connected with *work at home*. Additionally there are topics related to metal and plastic technology.

5.2.1.2 Summary of the findings based on the analysis of mean values

In the category of learning contents none of the topic areas (items) presented were regarded as only a little useful or important, and the means in the categories of learning objectives and learning methods followed the same course. In the group of learning objectives only two items were rated as only a little useful or important; namely fixing the equipment of home and doing non-regulated electrical work. This category can be given a common name of fixing equipment at home. Similarly, in the group of learning methods only two items were regarded as only a little useful or important. These were copying of models and serial work. They can be given a common name: copying method.

Instead, studies of technological applications, integration between technology and science, and applying information technology were regarded as very useful of important in both the category of learning objectives and that of learning content. In the category of methods team work, independent skills to look for information and innovation skills were regarded as very useful or important. Studying through a foreign language was also considered very useful or important. This was also emphasized in the open sections concerning learning methods. Independent work (looking for information) and innovation skills were considered very useful or important also in the category of learning objectives.

Practical (handicraft) skills were regarded as useful or important. Although this learning objective was not ranked at the level of very useful or important its mean value score was relatively high 3.8. Also many open section answers emphasized the importance of learning by doing and applying practical skills.

The results on the basis of mean values are presented in the form of a table (Table 9) below. The domains presented in the table are the names which were given to the groups derived from the analysis above. The names of the categories do not follow the scale used in the questionnaire. The scores in learning objectives, learning methods, and learning contents varied from 2.00 to 4.44. "The most useful and important " has been dropped out and in between useful and important and only a little useful or important a new category was created, namely "quite useful or important".

TABLE 9 Groupings derived from analysis of mean values

OBJECTIVES	METHODS	CONTENTS
Very useful or important • applications of science, information technology and technology • individual learning (learning to find out things, look for information) • innovation skills • entrepreneurship, and trade and industry	**Very useful or important** • social methods • individual methods (finding out things individually, looking for information from different sources) • learning through a foreign language in active and functional situations	**Very useful or important** • high tech (using information technology, electronics)
Useful or important • practical (handicraft) skills • sustainable development	**Useful or important** • taking responsibility for one's own studies • active studies • self-evaluation	**Useful or important** • service of hobby equipment • wood technology • mechanics
Quite useful and important • technical service work and hobbies • interaction between technology and society • technological concepts	**Quite useful and important** • studies similar to entrepreneurship	**Quite useful and important** • work at home (electricity, repairs, hobbies etc.) • metal technology • plastics technology
Only a little useful or important • repairing the equipment at home	**Only a little useful or important** • copying method	**Only a little useful or important** • nil

5.2.1.3 Factor analysis of survey data

One of the aims of this research was to establish some elements of future technology education curricula. Therefore, it is justified to first aim at finding general concepts and then to narrow down the lists of objectives, methods and contents, by for example studying the variables which correlate with one another. Factor analysis may reveal groups of variables which assist in describing the concepts in a more synthesized format. The correlation structure of the variables is described and explained by means of a factor model. For these reasons exploratory factor analysis has been used here (Nummenmaa et. al. 1997, pp. 241 - 262). It has to be noted that the sample is only 42 persons. Due to this, the aim is not to draw any statistically significant generalizations, but only to provide more focus to the extensive expressions dealing with objectives, methods, and contents. The use of factor analysis can also be argued from the point of view of reliability. In this study the factor analysis supported the interpretations drawn from the mean values.

The correlation matrices of the objectives domain, methods domain, and contents domain were firstly written out using the SPSS program (Appendices 6, 7, 8). After this, the forming of three, four, five and six different factors were tested. This was justified because the eigenvalue of six factors passed value one (1) in the domain of objectives. Finally a grouping of variables was performed: the domain of objectives got five groups, the domain of methods four, and the domain of contents three groups. This was because the different variables formed most clearly five groups in the domain of objectives, four in the domain of methods, and in the domain of contents only three factors came out of the analysis. Both rotation Varimax and rotation Oblimin were tested. Both of them indicated parallel results, but rotation Oblimin provided more clear results for interpretation. Therefore, it was used when formulating the final factors.

Factors in the objectives domain

Table 10 presents the results of the final factor analysis. The 18 statements of the objectives form five groups.

TABLE 10 Factors and communalities of learning objectives

Variable	Factor 1	Factor 2	Factor 3	Factor 4	Factor 5	Communality
13	.88	.07	-.03	.23	-.30	.86
15	.83	-.13	-.09	-.21	.11	.78
14	.80	-.02	-.17	-.08	-.17	.72
16	.64	-.47	.29	-.12	.02	.79
5	.61	.21	.25	.16	.03	.49
18	-.17	.63	.06	.13	-.03	.43
8	.12	.52	.23	-.37	-.08	.64
11	.24	.48	-.21	-.48	.12	.65
3	-.03	.45	-.05	-.13	-.33	.40
1	.26	.44	.09	-.10	.08	.31
4	-.04	.17	.76	.17	-.03	.62
12	.08	-.21	.63	-.38	-.13	.69
9	.01	.33	-.03	-.60	-.26	.68
10	-.03	-.03	-.03	-.60	-.02	.34
17	.39	-.03	.09	-.45	.03	.47
7	-.03	.02	.22	-.24	-.09	.13
2	.14	-.09	.21	.19	-.75	.69
6	.07	.06	-.10	-.32	-.73	.76
Eigenvalue	4.88	2.27	1.49	.99	.84	
% of total variance	27	13	8	6	5	

Naming the first factor was very unambiguous. This factor was called *the factor of studying home technology.* It was formed of the following objectives:

variable		loading
13	Study of non-regulated electrical work of home	.88
15	Study of small repairs of home	.83
14	Study of fixing equipment of home	.80
16	Study of repairing and servicing skis, bikes, motorbikes etc.	.64
5	Familiarizing with practical technological systems, e.g. function of heating, water, sewage, and air-conditioning at home	.61

Naming the second factor was not as straightforward as was the case with the first factor. Different ways of studying were clearly to be found. Although the domain under discussion here was objectives, the second factor was named as *the factor of studying study methods.* Here the question was about an objective of studying different learning and studying methods. It was formed of the following items:

variable		loading
18	Studying to set personal learning objectives and evaluating own studies	.63
8	Familiarizing with history of technology and its cultural effects	.52
11	Familiarizing with entrepreneurship and work methods of trade and industry	.48
3	Practicing technical thinking and innovation skills	.45
1	Studying systematic working skills	.44

Variables 18, 3, and 1 refer directly to different study methods. Variable 3 emphasizes the various working methods linked with technology studies in particular. Variable 11 can also be considered to refer to learning methods, because the connections between school and industry are a certain method to study life outside school. Although familiarizing with the history and cultural effects of technology (variable 8) are in a way learning contents, they certainly direct the choice of learning methods.

The third factor supports the often presented idea that studies of handicraft and technology are not contradictory to one another (Parikka & Rasinen 1994, p. 19). This factor was named as *the factor of handicraft (hands-on) and technological applications.* It was formed of the following objectives:

variable		loading
4	Exploring natural phenomena and science and their technological applications, for instance applications of lever	.76
12	Study of handicraft skills or study of making different products with hand tools	.63

This factor supports the view that technological innovations cannot be put into practice without hand skills (see e.g. Dyrenfurth 1991, 31). The first human technological inventions were generated well before science has observed or explained them (e.g. stone ax, wheel, electricity). On the other hand, by applying science, technology can be developed.

Giving a name to the fourth factor, then, was not quite unambiguous. Since a social loading was, however, so much connected with all the variables that this factor was named *the factor of interaction between technology and society.* It is formed of the following objectives:

variable		loading
9	Evaluation of the development of technological world (what is right, what is wrong), and presenting one's opinion on its social effects	-.60
10	Study of how to use computers in various jobs	-.60
17	Familiarization with different technical hobbies	-.45
7	Familiarization with qualities of different materials and their recycling to promote sustainable development	-.24

The loading of all the variables was negative. If the loading within the same factor is fully negative, the negative sign does not affect the interpretation. The signs can be changed from positive to negative. If this is done all the signs of the loading in the same factor should be changed (see Nummenmaa et. al. 1997, p. 246). The signs of loading in this factor were not changed, but they were treated as if the sign had been positive. This method was applied also in the forthcoming factors, if all the signs in the same factor were negative.

Variables 9 and 10 scored the same loading. The factor was named mainly after variable 9. Variable 10 which received an equal loading would have given reason to rename the variable. Yet, variable 7 supported the societal viewpoint, although its loading was only -.24 and communality only .13. On the other hand, it can be thought that the use of computers and technical hobbies also describe interaction between society and technology. Also the high negative loading of variable 11, -.48 (intercorrelation), supports the idea of giving this factor the name of the factor of interaction between technology and society. This factor and variable 2 in factor 3 in the learning contents were the only variables which intercorrelated highly outside the variables within the factor concerned as regards the factor analysis of objectives, methods, and contents.

The fifth factor was clearly *the factor of basic technical know-how.* Its content was as follows:

variable		loading
2	Study of basic technical skills and basics of safety precautions	-.75
6	Study of technological concepts and technical drawing	-.73

Both variables had a negative loading. The variables refer clearly to studies of basic technological skills and concepts.

The first factor explains 27 % of the whole variance, the second 13 %, the third only 8 %, fourth 6 %, and fifth only 5 %, with an overall total of 59 %.

Factors in the methods domain

Table 11 presents the final results of the factor analysis in the methods domain. The given 12 questionnaire items form four groups.

TABLE 11 Factors and communalities of learning methods

Variable	Factor 1	Factor 2	Factor 3	Factor 4	Communality
7	.77	-.01	.04	-.01	.58
8	.58	-.16	-.11	-.26	.55
12	.47	.07	-.03	.02	.24
3	-.10	.75	.01	-.05	.57
4	.04	.65	-.36	-.06	.64
5	.16	.61	-.03	.16	.39
2	-.13	.45	.10	-.33	.36
11	-.01	-.03	-.86	.07	.74
10	.12	.23	-.69	-.20	.73
9	.01	.00	-.00	-.76	.58
1	.10	-.10	-.12	-.52	.32
6	.19	.22	.19	-.45	.40
Eigenvalue	2.93	1.42	1.25	.51	
% of total variance	24	12	11	4	

The first factor was named *the factor of co-operation between school and industry.* The two variables which had the highest loading refer directly to methods where the school and enterprises co-operate. The items of the first factor are the following:

variable		loading
7	Active study tours to enterprises	.77
8	School – enterprise partnership activities	.58
12	Competition and show activities	.47

Competition and show activities are not directly the same as co-operation between the school and enterprises, but in many cases they could easily refer to that. Although the loading of variable 12 was only .47, it was still quite natural to interpret it as belonging in this factor.

The second factor was without any hesitation named as *the factor of independent work.* The methods in this factor are as follows:

variable		loading
3	Distance work at one's own responsibility	.75
4	Working with operating instructions and manuals	.65
5	Studying through a foreign language, learning language in active and functional context	.61
2	Looking for information independently, and evaluating the significance of issues, e.g. use of libraries and internet	.45

All the variables in this factor clearly stressed independent study methods. Only variable 2 got a loading which is a little under .50.
The third factor was named *the factor of copying method.* The items in this factor are the following:

variable		loading
11	Serial or line production type of work	-.86
10	Copying models type of work	-.69

Both variables had a strong negative loading. The variables of this factor were regarded as the least important learning methods (Figure 14).

The fourth factor was named as *the factor of evaluating one's own and group's work.* It consisted of the three following methods items:

variable		loading
9	Evaluation of own work and learning activities, and proposals for improvement of learning organizations	-.76
1	Working as a group, social or co-operative methods, e.g. project and team-work	-.52
6	Studying and exploring, e.g. experiments with strength or glues	-.45

All of these variables are connected to evaluation of learning. This can be in connection with a single student (variable 9), a group of students (variable 1), or for example a phenomenon under study (variable 6).

The explanatory percentages here are the following: first factor 24 %, second factor 12 %, third factor 11 %, and fourth factor only 4 %, altogether 51 %.

Factors in the contents domain

The results of the final factor analysis in this domain are presented in Table 12. The 11 items describing different contents form three groups.

TABLE 12 Factors and communalities of learning content

Variable	Factor 1	Factor 2	Factor 3	Communality
1	.81	.03	-.20	.63
5	.74	-.20	.14	.62
4	.71	.11	-.00	.53
3	.67	.04	.31	.64
2	.65	-.00	.53	.86
10	.03	.90	-.09	.84
8	-.13	.88	.33	.78
9	.02	.77	-.08	.62
11	.35	.57	-.39	.65
7	.12	.20	.62	.45
6	.07	-.20	.53	.36
Eigenvalue	3.43	2.60	.94	
% of total variance	31	24	9	

The three factors formed very clear groups. There were no difficulties in giving appropriate names to the factors. The loading of all items was over .50.

The first factor was named as *the contents of technical work* (name for a subject area in Finnish schools). The content areas were the following five:

variable		loading
1	Wood technology	.81
5	Electricity and electronics	.74
4	Hobbies, building miniature models	.71
3	Plastic technology	.67
2	Metal technology	.65

All of these variables belong to the content of the present subject area technical work in Finnish primary and secondary schools.

The second factor was named as *the factor of repairs and service of home.* Its content areas were the following four:

variable		loading
10	Work at home, e.g. service of hinges, locks, changing gaskets, plugging, sharpening tools	.90
8	The non-regulated electronical work, e.g. changing bulbs, fuses and lamps, fixing sockets, making extension cords, mounting aerials, electrical safety	.88
9	Repairs of furniture and home, e.g. glueing, painting, upholstering, papering walls, procuring materials	.77
11	Repairs and service of hobby equipment (bike, skis, fishing equipment	.57

All the items within this factor clearly belong to the factor of repairs and service of home.

The third factor was named *the factor of* (the contents) *of high tech.* The items of this factor were the following two:

variable		loading
7	Mechanics e.g. inclined plane, axles, bearings, transmission of power and gears, building constructions	.62
6	Information technology, e.g. drawing programs, spreadsheet programs, technical drawing (CAD), CNC technology, control, mechatronics	.53

The variables in this factor related to the applications of science which technology is using. Out of all the factors in the field of content the contents dealing with high tech were clearly emphasized in this factor. The high loading of item 2 (.53) can be explained by the fact that metal technology has been understood as high technology.

Factor two explains 31 % of the total variance, factor two 24 %, and factor three 9 %, totaling to 64 %.

5.2.1.4 Results of the factor analysis in a condensed form

The factors described above can be condensed in a table format as follows:

TABLE 13 Results of the factor analysis in a condensed form

Objectives
- factor of studying home technology
- factor of studying learning methods
- factor of hand skills and technological applications
- factor of interaction between technology and society
- factor of basic technical know-how

Methods
- factor of co-operation between school and industry
- factor of independent work
- factor of copying method
- factor of evaluating one's own and group's work

Contents
- factor of the contents of technical work
- factor of home repairs and service
- factor of high tech

The factors that turned up in the analysis can act, for instance, as a point of departure for curriculum development for technology education. They can be considered as they are, but, rather, they should be critically analyzed from the point of view of the curriculum writer(s) and then rewritten. In any case they serve to give some guidance as to where to start from.

When comparing the results of the factor analysis with the groupings established on the basis of the mean values, many similarities can be found. The factor analysis does not organize the items in any order of importance as is the case in the analysis of mean values. However, similarities are to be found in all the three areas of objectives, methods and contents. Comparisons of the different analyses will be done below in Chapter 6.

The items in the domains of objectives, methods, and contents became organized into factors in a logical way, and giving appropriate names to the factors was not excessively demanding. As was stated above, the results of the factor analysis support the results of the analysis of the mean values. It makes the comparison of the results of the various analyses easier and clearer for the researcher, as well as the reader, when they are presented in a compact format. The justification for doing so will be discussed in Chapter 6.

5.2.1.5 Critical comments on the questionnaire

The questionnaire was developed by experts on the learning and teaching of technical work. It would probably have been different if the designers had been representatives of some other profession. However, the open parts of the questionnaire did not offer new aspects, which implies that the questionnaire was quite comprehensive. On the other hand, some questions had several parts which did not refer to one certain concept in an unambiguous way. Therefore, it is possible that the respondents have had difficulties in answering some of the questions in a consistent manner. The fact that the questionnaire was rather comprehensive is also supported by that the domains found in the analysis of the curricula of the six countries are basically the same or very similar to the views of the Finnish experts. Communication, energy, power, and safety were domains established in the analysis of the different countries, but not directly represented in the questionnaire to the Finnish experts. All of these four domains are, however, implicitly included in the questionnaire; it is just that the experts grouped the domains in a different way.

5.2.1.6 Views of the future development of technology based on open answers

After the structured part of the questionnaire the experts were asked four open questions, which were clarified with a few short examples. In the answers, both the representatives of the industry and training institutes presented similar types of suggestions. Therefore, the groups are not handled separately. In the following, the four open questions and their answers are presented one by one. The answers have been shortened into a list and only those suggestions which appeared in most of the answers are included. A comprehensive list of the answers was presented in Rasinen 1999a (pp. 167 – 176). The purpose of the open questions was to gain information on the visions of the experts about the future development of technology. Thus in this part the questionnaire is related to futurology. In this context futurological research is not dealt with, nor are the results analyzed from a futurological point of view. The purpose here was to gain general information on the views of experts about the future. This new information can be used both when exploring the topics for future research and when analyzing the already existing data and data to be collected later.

1. **How do you see the development of technology in the decades to come?** (e.g. possible trends, change in emphasis, how design and production are placed globally)
   - development of technology will accelerate, importance of technology will increase
   - information and telecommunication technologies will develop fast
   - degree of automatization will increase
   - technology will become more and more international
   - global change in production localities (localities of high standard planning and localities of production) will take place
   - the globe will shrink
   - knowledge and understanding of languages, cultures and ethics will be emphasized
   - significance of know-how will be emphasized
   - nature of work will change (more service and planning jobs)

The answers show that the experts believe in a fast development of various technologies. Planning is done in the localities where "technological culture" exists, and less developed localities take care of production. Development of information technology and telecommunications will make it possible for work not to be tied anymore to a certain locality. Change will be continuous and rapid.

2. **How should the comprehensive school and upper secondary school be developed to promote technology education?** (e.g. co-operation between scools and trade and industry around, team work, project work, entrepreneurship, internationality)
   - meaning of technology from society's perspective (benefits and disadvantages)
   - internationalization, language studies
   - team and project work
   - co-operation projects between schools and industry
   - co-operation projects between general education schools and other learning institutes
   - mathematics, physics, electronics, handicrafts (projects)
   - sustainable development
   - entrepreneurship training

In the comments regarding the co-operation between schools and enterprises real co-operation was emphasized, as well as its continuity and also the fact that teachers should engage in work practice in trade and industry. Adopting different co-operative learning methods in comprehensive schools already was emphasized. Furthermore, learning through projects, applications, and practical experiences was recommended. Students have to become accustomed with continuous and rapid change already at school.

3. **How should technology education be taught in comprehensive and upper secondary schools?** (e.g. integration between different subject areas, particularly science, mathematics and handicrafts, increasing/reducing subject areas)
   - practical projects
   - learning by doing and by experimenting
   - applied mathematics, physics, and chemistry
   - clarity and illustrative learning
   - discovering phenomena
   - holistic views
   - understanding the meanings
   - handicraft education
   - presenting "inventions"
   - integration between different subject areas (mathematics, science, handicraft, languages)

A common feature in almost all these answers was the recommendation for learning by doing, inventing, exploring, practical approach, and applications. A holistic perspective together with integration between subject areas (especially science and handicraft) was also emphasized.

4. **How should technology education lessons be placed in the curricula?** (e.g. should technology education studies be organized annually from primary school to the end of upper secondary school, only during senior comprehensive and upper secondary, or only in upper secondary?)
   - most of the respondents would like technology education to be studied continuously from the first primary school classes up to the upper secondary, some emphasize the importance of starting in kindergarten already (development of attitudes)
   - gradual increase of concepts while students grow up
   - continuos studies, stage of development of the pupil to be taken into account
   - synchrony between theory and practice
   - to be integrated with large entities (holistic approach)
   - integration between various subject areas

Most of the respondents clearly pointed out in their answers that technology education should be a life-long process. It was seen as important to start early, because attitudes are formed in kindergarten age already. Some of the respondents suggested that studies should occur annually, but opportunities to choose from among different courses (in this case technology courses must be available all the time) and possibilities to specialize should also be made available.

Summary of answers to open questions

The ideas presented in the open questions support the findings of the analysis of the curricula of six countries, as well as the findings of the empirical study. No truly new ideas were presented, rather, there is a great deal of support to what has been presented already in the previous analysis. For this reason the results of the open part are not presented here in the form of a table as was the case with the previous analyses.

The speed of the development of technology was seen to continuously increase. Technology will become more and more international, and due to this the globe will "shrink". Specialization in certain technologies will take place, and this affects the production localities. As a consequence it will be more and more important to understand different cultures and languages. The fast development of technology also requires understanding of the benefits, but also the disadvantages of technology, which, in turn, leads to understanding the importance of sustainable development.

It was seen as important for team work and project work to be adopted at school level already. This method could be extended from schools to the environment around schools, other learning institutes, and trade and industry. Integration, both horizontal and vertical, within schools, between different subjects and the environment was also considered important. Methods of learning by doing, applying, clarifying and illustrating, discovering and inventing were considered very useful and important. Behind the studies should be an idea of understanding the meanings of issues.

The answers distinctly indicate that technology is regarded as one important part of general education. None of the respondents were against technology education, but almost all of them emphasized the importance of studying it from kindergarten onwards, or at the latest, from the lower primary to the end of the upper secondary level.

5.2.2 Summary of survey results

The survey data were analyzed using three different methods, namely, establishing the mean values of the variables, by a factor analysis and a content analysis of the answers to open questions. All of the three analysis methods support one another. Through the study of mean values various groups of objectives, methods, and contents were formed. Through factor analysis similar groups were found. Open answers also introduced similar objectives, methods, and contents. In the domain of learning objectives the applications of science and technology, independent studies, innovation skills, entrepreneurship and industry, hand skills and sustainable development were regarded as the most important objectives in the analysis of the mean values. In the domain of methods social methods, independent (finding out things independently and looking for information from different sources) methods, learning by using a foreign language, taking responsibility for one's own studies, active learning, and self-evaluation were considered important methods. The contents of high-tech supporting technology, service of leisure time equipment, wood technology and mechanics were considered the most important. In the answers to open questions the same types of objectives, methods, and contents were suggested. Undoubtedly the structured questions which were answered first have had an effect on the open answers. However, the respondents were requested to express their personal views and ideas. Because the open answers did not add anything extraordinary to what came out of the structured part, the questionnaire can be considered quite comprehensive.

6 COMMON FEATURES BETWEEN THE CURRICULA OF VARIOUS COUNTRIES AND THE VIEWS OF FINNISH EXPERTS

In the previous chapters the elements which came up in the analysis of the six countries (Table 8), and those that were raised forward in the analysis of the opinions of Finnish experts (Table 9), groupings which are a consequence of the analysis of mean values, and Table 13, the results of the factor analysis in a condensed form), have been presented. The way in which the data were collected, organized, and analyzed, and the results presented was different in the case of the six curricula from the case of Finnish experts. Because of this a comparison of the two sets of findings could be argued. However, when presenting the summary tables above the aim was to do it in such a way that their comparison would be possible and justified. In this chapter the tables are studied side by side to explore whether any uniformity is to be found in the technology education elements established through the different methods of analysis.

In the survey section of this study the same questionnaire was used as in the other studies conducted within the project. The reasons for doing so have been explained above. Therefore, the perspective in the answers of the Finnish experts has not been on society, school, and student. The variables of the questionnaire could be categorized also in this way, but it would be at least partly artificial and there would be many overlaps, as was the case when analyzing the different curricula. Therefore, it was not justified to divide the data derived from the Finnish experts into the above mentioned categories. Instead, in this comparison, the overall titles: society, school, and student can be left out, but later on, when planning the curriculum is being discussed this view can be considered again. In the following table (Table 14) the elements found in the analysis of the curricula of the six countries from society's, school's, and student's perspective are combined with the data from Finnish experts. Variables which were regarded as only little useful or important are left out. This chapter addresses the fourth research task, namely the question of what are the elements and building materials which would best suit the Finnish technology education curriculum. The same issue is also discussed in Chapter 8.

TABLE 14 Comparison of the analyses of the curricula of six countries and views of Finnish experts

ELEMENTS OF TECHNOLOGY EDUCATION IN DIFFERENT COUNTRIES	VIEWS OF FINNISH EXPERTS BASED ON MEAN VALUES	VIEWS OF FINNISH EXPERTS BASED ON FACTOR ANALYSIS
Objectives • Understanding the role of science and technology in society • Balance between technology and environment • Technological literacy (ability to use, understand, and control technology) • Other skills (planning, making, knowing, understanding, evaluating, social, moral and ethic, innovativeness, awareness, skillfulness, flexibility, entrepreneurship)	**Objectives** • applications of science, information technology and technology • independent learning • innovation skills • entrepreneurship, trade and industry • practical (handicraft) skills • sustainable development • technical service work and hobbies • interaction between technology and society • technological concepts	**Objectives** • factor of studying home technology • factor of studying methods • factor of handicraft (practical/ hands-on) and technological applications • factor of interaction between technology and society • factor of basic technical know-how
Methods • planning skills and flexibility • learning by doing • practical work (experiments, observations, making, planning, and evaluating) • preparing oneself to life after school (team work, analyzing problems, inventions, thinking up, producing, evaluating) • positive attitude toward technological professions • building tolerance of uncertainty • safety	**Methods** • social methods • independent methods • studying foreign language through active and functional learning • taking own responsibility • active studying • self-evaluation (reflection) • studying in an entrepreneurship manner	**Methods** • factor of co-operation between school and industry • factor of independent work • factor of working by copying • factor of evaluating one's own and team's work

(continues)

TABLE 14 (continues)

Contents	**Contents**	**Contents**
• technological systems and structures (mechanisms, constructions, products and their applications, transform, storage, control, regulation, processing, communication, information, energy, power, quality) • professions of industry and technology • safety precautions and ergonomics • planning, making, and evaluating • role and history of technological development • problem solving • evaluations and valuation of the relationship between humans, society, and nature	• high tech (using information technology, electronics) • servicing hobby equipment • wood technology • mechanics • work at home (electricity, repairs, hobbies, and others) • metal technology • plastics technology	• factor of technical work (the Finnish school subject) • factor of repairs and service of home • factor of high tech contents

The contents in the table above were formed as a result of analyses which differed from one another. Through various phases, which were independent from each other, the results of the analysis of the objectives, methods, and contents of the six different curricula, and, on the other hand, the results of two different types of analysis of the views expressed by Finnish experts, have been condensed in the table. For this reason, it is most interesting to observe how similar elements are to be found in the different columns. The fact that with different methods of analysis and from different sources very similar elements turn up, can be regarded as one of the essential findings of this study. In the following, the objectives, methods, and contents are discussed separately.

Objectives

The study of *science, information technology and technological applications* is regarded as the most important objective according to the Finnish experts. They also see the study of *interaction between technology and society* as an important focus area. Through the factor analysis the factor of *hand work (handicraft) and technological applications* and the factor of *interaction between technology and society* were formed. Correspondingly, in the curricula of the six countries *understanding science and technology in society* has been emphasized.

The objective of studying *the balance between technology and environment* came up in the analysis of the curricula. Correspondingly the objective of studying *sustainable development* is presented in the views of the Finnish experts. In the factor analysis this objective does not come out as a factor, but it is included in the factor of interaction between technology and society.

In the factor analysis the factor of *studying learning methods* was formed. Parallel to this is *independent learning and innovative skills* which is emphasized by the Finnish experts. The curricula present lists of different learning methods (see: other skills).

The factor of *basic technical know-how* corresponds to *practical (handicraft) skills*. In the column of different countries *technological literacy* and *other skills* contains many similar components. Also *entrepreneurship*, which is regarded as a very important objective by the Finnish experts, is to be found in the list of objectives of the curricula studied. In this context the terms entrepreneurship and enterprise are seen to refer to the same concept.

Methods

According to the Finnish experts using *social methods* when studying is the most important method. Correspondingly in the factor analysis the factor of evaluating one's own and *team's work* was formed. In the column of different countries a method of studying *flexibility and team work* can be found.

The experts emphasize the importance of *independent methods* and *taking own responsibility* for studies. In the factor analysis the factor of *independent work* was formed. Similarly, in the column of the different curricula a long list of methods referring to independent and individual methods of study is presented. *Evaluation* and *self-evaluation (reflection)* can be found in all columns.

The factor of co-operation between school and enterprise can be considered to relate to studying in an entrepreneurship manner (a method stated out by the experts) and positive attitudes toward technological professions (different curricula).

Contents

The factor of *contents of technical work* can be compared to *wood technology, mechanics, metal technology and plastic technology* (both from the experts) and to *safety and ergonomics* together with *planning, making and evaluating* (from the column of different countries).

The factor of contents of high tech is comparable to high tech (the experts) and systems and structures of technology (different countries). The factor of repair and service work of home is parallel to service of hobby equipment and work of home (the experts). Often these types of activities are connected with solving problems (different curricula).

Results in a condensed form

On the basis of what is presented above a condensed table of the most dominant objectives, methods, and contents which came out in this analysis can be presented. Originally it was of interest to also see which objectives, methods and contents might be lacking. The above analysis, however, has been so broad that, in general, such lacking domains were not to be found. There were some elements which were not mentioned in the curriculum of a certain country. These have been reported in Chapter 5.1. Similarly the questionnaires to the Finnish experts were answered at different levels of emphasis.

TABLE 15 Objectives, methods, and contents of technology education in a condensed form

Objectives	Methods	Contents
• Studies of working with hands (hands on, handicraft), science, information technology, and applications of technology • Studies of the interaction between technology and society • Studies of balance between technology and environment • Studies of different study methods • Studies of basic technical know-how and practical skills • Studies of entrepreneurship	• studies of social methods • studies of independent methods and being responsible for one's own work • studies of methods of evaluation and self-evaluation • studying methods of co-operation between school and industry	• studying contents of technical work (the Finnish school subject) • studying contents of high tech • studying how to service and repair equipment of home and leisure time

The new definition of technology education to be presented below in Chapter 8 is based on this table. This table can also serve as a basis for curriculum planning and as a checklist for how well the curricula of schools and teacher education departments are implemented (how studies are shared, integration, realization and so on).

The Framework Curriculum for the Finnish Comprehensive School and Upper Secondary School referred to and quoted in the first chapter of this study present many similar elements to the list above. These documents were criticized at the beginning of this report for not giving enough information on how to go about implementing the curriculum. Yet, here, the results of the analysis are presented in a similarly condensed and general manner. The condensed elements are the result of three different but quite comprehensive analyses. The reader has been able to follow the process of how these results were arrived at. The results of the analyses are so close to the elements of the Finnish documents mentioned that the analysis process could actually be followed in the opposite direction when planning the national, municipal, or school curricula. The information of the condensed table could be used, for instance, at the national level or for building a framework curriculum. The results of the analysis of the six curricula and the analysis of the data collected from the Finnish experts, then, could be used for curriculum and syllabus planning at the municipal level and at schools. The more detailed information available from the findings could, then, be used for drawing up the schemes of work at school and at the classroom level.

7 CREDIBILITY OF THE RESEARCH

There are qualitative and quantitative parts in this study. For this reason, the credibility of the study has to be considered from the perspectives of both qualitative research, quantitative research and a combination of the two.

7.1 Qualitative part of the study

7.1.1 Validity

Traditionally the ability of a research method to measure what it is intended to measure is called validity (Pyörälä 1995, 15). In this study the systematic analysis was used to elicit from the curricula of six different countries those objectives, methods, and contents which could be used for planning the Finnish curricula in technology education. The curricula were analyzed from the perspective of society, school, and student. By doing this, the analysis was in a way conducted from two dimensions. On the one hand, the point of departure was the didactic (objectives, methods, contents) view and, on he other hand, a social (society, school, student) view. Before the actual analysis the various curricula were grouped according to educational objectives, national status, and integration between different school subjects, as well as other observations. This angle of observation brought a third perspective into the analysis of the curricula. Thus, the aim has been as versatile an analysis (triangulation, see e.g. Patton 1990, p. 464) as possible in order to fulfill the criteria of validity.

The curricula of Australia, England, and the United States of America (in the USA the rationale and the standards) have all been written in English. In the case of the Netherlands the curriculum has been presented in the English language in several publications by both an official from the Ministry of Education and by a researcher and teacher educator. The Swedish curriculum is written in Swedish, and was translated by the author. The French curriculum was translated by a French teacher. The language of different cultures varies slightly from one another. On the other hand, the vocabulary of education and technology is relatively similar all around the world. The author has been privileged to study the English expressions used in technology education throughout the nineties by reading various publications, and attending study tours and conferences. If there has been any unclarity as to the meanings of words and terms, it has been possible to seek for clarification in international conferences and through e-mail. By these means the possibilities for misinterpretations have been minimized. It also has to be born in mind that the analysis is mainly based on the written curricula. It has not been possible to study thoroughly how the curricula have actually been implemented in the field, although, some international experts were interviewed in this concern as well. Therefore, the results can be considered valid from the point of view of written curricula. What is actually going on in schools is not necessarily what is written in the curriculum.

7.1.2 Credibility

Traditionally reliability refers to the ability of the research method to give non-random results. In qualitative research reliability refers to the trustworthiness of processing and analyzing the material (data). There are no tests for finding out the reliability and validity in qualitative research, nor to determine the significance of results. There are no ways to replicate the thoughts of the analyst. Because there are no absolute rules, the researcher just has to do her or his best to fairly represent the data and communicate its information in the best possible manner. (Patton 1990, p. 372.) According to Pyörälä (1995), the reliability of qualitative research includes two important criteria: the possibility to evaluate the analysis and credibility. The possibility to evaluate means that the reader is able to follow and criticize the researcher's reasoning. Because the criteria of reliability in the traditional sense (or in the quantitative sense) cannot be met, the term credibility is normally used in connection with qualitative research. According to Patton (1990, p. 461) the credibility of the study depends mainly on the researcher because she or he is the data collector and analyzer. Credibility means that on the basis of the report it is believable that the interpretations presented result from what has been studied and described. Also here credibility remains for the reader to assess. Both criteria of the possibility to evaluate and credibility have been followed in this research by describing the process openly and by following identical criteria when analyzing the curricula of the various countries. Progress towards final interpretations has been gradual, and the process is explicated step by step.

7.2 Quantitative part of the study

The structured part of the questionnaire formes the quantitative part of the study. The return rate for the questionnaires was 58%.

7.2.1 Validity

The validity of quantitative research is based on the representativeness of sampling and on how well the research instrument measures what is actually under measurement and under study. The questionnaire in the present study was formed of 41 different items (through item sampling). The process of developing the questionnaire consisted of three phases. In the course of this process the internal validity of the questionnaire has been tested and verified. This process was described in a more detailed manner above in Chapter 5.2. As also indicated in Chapter 5.2, the contents of the questionnaire might have been different if the developers of the questionnaire had been another group of experts (e.g. technicians instead of educators); some items could have been added and some deducted from the questionnaire. On the other hand, prior to designing the final instrument the items were tested in many ways, and international research in the field of technology education was studied. Furthermore, in the analysis of the technology education curricula of six countries no essentially different or additional domains could be found in the objectives, methods and contents, compared to the findings in the quantitative part of the study. For these reasons, the questionnaire can be considered to represent the domains that were under study.

If the aim is to find out what expectations there are for technology education at school, it is justified to wonder why ask any structured questions at all, why not just ask open questions. In this way the views of the respondents would not be limited in any way and more fresh and new views would be presented. However, that kind of an approach would mean that giving answers would be much more difficult and demanding, and interpreting the answers would also become more difficult. Structured sections and items were also used because of the fact that the risk for the open questionnaire not to be returned would have been too great. In all returned forms the structured parts had been answered, but in some of them the open questions had not been dealt with at all.

There were 19 persons from the educational institutes and 23 persons from the industry who returned the questionnaire. In both groups answers were returned from different parts of Finland. The representatives of educational institutes were from both universities and polytechnics and their different departments. The sizes of the industrial companies varied from small to large, and various fields of technology were represented. This particular study concentrated on the above target groups. Heinonen (2000) has concentrated on students and Parikka (1998) on "visionaries". The results and findings are close to each other in all these studies. This will be further discussed in Chapter 8. If the respondents had been from a completely other field, the results might have been different.

7.2.2 Reliability

In the factor analysis communality values were also written. Communality expresses the ability of the variables to measure the factors. Communalities are expressed between values 0 and 1. The higher (closer to 1) the communality the better it measures the factor structure (Nummenmaa et al. 1997, p. 244). In the domain of objectives the communality of only three variables remained under .40, and the communality of 15 variables varied from .40 to .86. In the domain of learning methods, out of twelve variables only three variables scored under .40, while the values for the rest varied between .40 and .74. In the domain of learning contents, then, communality of the variables varied from .36 to .86. On the basis of the above, the reliability level of the structured inquiry can be regarded as sufficient. In the present study the number of respondents in the quantitative part is only 42. It is not justified to try to present conclusions which would be generalizable from the statistic viewpoint, when such a small number of informants is present.

7.3 Summary of credibility

The criterion of credibility in the qualitative part is met by analyzing systematically, and in a versatile and open manner and from various perspectives the data available. The reader can follow the analysis and compare it to the shortened versions of the curricula, which have been presented in the form of tables. The reader can also observe which parts are missing from the curriculum of the country concerned. There are comments on the missing parts also in the actual systematic analysis. Doing analysis in this way is naturally subjective and may be biased according to the own interest of the one doing analysis. When the data concerned are translated from one to another language (and in this research from one to another and then to the third language, e.g. French, Finnish, English) it is possible to make mistakes or interpret the content incorrectly. However, the French curriculum was translated from French into Finnish by a language expert. Other translations were done by myself, and not by a language expert, but, I have about nine years of experience of working with education and educational materials in an English-speaking country; as well as experience in developing curriculum materials for Finland, Mozambique, Namibia, and Zambia. I have been working in the field of education for over 25 years, which is also one criterion for credibility. According to Patton (1990, p. 461) the qualifications, experience and perspective of the researcher are important criteria for credibility.

The results of the quantitative part are derived from the answers of a small group of informants. All the respondents, however, are experienced people who have been working for several years. Therefore, the responses are most obviously accurate and honest. All of the structured parts were answered. Although factor analysis was used as one method, the aim was not to make statistically generalized conclusions, but only to group variables. These results have been presented in two conferences, and their criticism has mainly concentrated on the definitions of concepts, which in this report has been paid attention to; and the small number of informants.

The aim has been to establish elements which would assist in the writing out of curricula to come. The aim has not been to make comparative research between the curricula of different countries, or to present statistically generalizable statements on the basis of the views of technology educators or the technology industry. With this study I believe to have obtained trustworthy basic information for the development of the technology education curricula of Finland. Therefore I regard the findings and results to be valid, credible and also relevant.

8 OBSERVATIONS AND CONSIDERATIONS OF THE RESULTS OF THE FINDINGS

In this study the concepts of technology and technology education have been clarified, the technology education curricula of six different countries have been analyzed, curriculum objectives, methods, and contents have been presented in a condensed form, the views of Finnish technology experts on how to organize technology education in Finnish schools have been clarified, the results of their views have been presented in a condensed form, and the analyzed data on the different countries and on the views of Finnish experts have been combined and condensed in the form a table where objectives, methods, and contents are presented. The answers to the research tasks and findings on each research are discussed above. In this chapter, particular references are made to the research tasks. Chapter 8.1 discusses the first research task: "What does technology and technology education mean, or what could it mean, in the Finnish comprehensive school and upper secondary school?". Chapter 8.2 addresses the second research task: "How have Australia, England, France, the Netherlands, Sweden and the United States organized technology education in their schools?", and Chapter 8.3 the third research task: " What are the expectations of Finnish technology experts from technology education in schools?". Finally, Chapter 8.4 discusses the fourth research task: " What are those elements and building materials which would best suit the Finnish technology education curriculum?".

8.1 Concept of technology and technology education

The professional and educational background, as well as, the experiences of the person defining a concept have an effect on how the definition is formulated (see Chapter 3). This report introduces various components (see the list above, in the previous paragraph) which will assist the reader to construct definitions of both technology and technology education. There are several approaches and several possibilities from which curriculum planners may choose to work out the Finnish curricula from national to school level. On the basis of the previous discussion, technology and technology education can be defined in various ways, therefore, a debate on this should take place in Finland. The following definition is derived from the findings of this study. The concepts which are the result of the condensed analysis were presented above in Table 15. Using these concepts the definition of technology education would be as follows:

In technology, particularly hand work (handicraft), applied science, and information technology are combined. Technology education is connected with studies of the interaction between technology and society, the balance between technology and the environment, basic technical know-how, practical skills, and entrepreneurship, by applying versatile learning and teaching methods.

Because hand work is emphasized particularly in the open answers it has been placed at the beginning of the definition. This definition is very general and combined of the components which were most predominant in the study. It has to be noted, however, that technology is regarded as an independent subject area although it incorporates different fields of study. This report contains plenty of information for the curriculum planners to formulate other types of definitions, depending on the need for accuracy, level of implementation, type of approach etc.

8.2 Organization of technology education in other countries

The six countries which were chosen to be studied in this research are at different stages of developing their technology education. Departure points for curriculum planning, planning process, and structure of the curriculum differ from one country to another. For these reasons, the analysis cannot be conducted following the same model in the case of different countries. The curricula have, however, been observed from so many different perspectives that the essentials have undoubtedly been discovered. Although the countries under study are geographically located very far from one another and their cultures are also different, there are several similar features to be found in the objectives, methods, and contents that their curricula are composed of. The most essential objectives include understanding the role of science and technology in society, balance between technology and the environment, technological literacy and other skills (e.g. planning, making, knowing, understanding, evaluating, social, moral, and ethic skills, innovativeness, awareness, skillfulness, flexibility, enterprise). The most essential methods are planning skills and flexibility, learning by doing, and practical work (team work, analyzing, inventing, producing ideas, production, evaluation). The most essential contents, then, include the systems and structures of technology; industry and professions in technology; safety precautions and ergonomics;

designing, making, and assessing; the role and history of technological development; solving problems; evaluating and valuating the relationship between society and nature. The list of contents is even in a condensed form quite vast. It is justified to ask whether it is realistic to try to cope with all that has been presented above. If the curriculum is too full, there is a danger that in-depth understanding of certain phenomena may suffer. On the other hand, it is important to study technology from all of its wide perspectives. From the Finnish point of view, emphasizing the importance of studying the professions of technology is a little strange. The task of general education is not to provide any pre-vocational skills or even attitudes.

The way in which technology studies have been organized also differs from country to country. In particularly the primary schools they are integrated with other subjects, such as handicrafts and science. Technology education is mainly taught by class teachers, therefore, it is more natural and easy to integrate it with other subjects than the case would be if the subject were taught by subject specialists. In England, where the tradition is already a few years old, technology education is an independent subject area starting at primary school already. A systematic in-service program assists the teachers to update their knowledge and skills. In junior and senior secondary schools, technology education is taught by specialized subject teachers. Although in most countries technology is taught by specialized teachers, integration between different subjects and the surrounding society is emphasized.

Views of what belongs to the concept of technology education vary slightly from one country to another. In France, for example, the contents related to computers and information technology are underlined. In Australia and England home economics, textile work, craft, design and technology, and the components of science related to these are seen to belong to technology education. In United States of America technology education has developed from a (in many cases) pre-vocational industrial arts subject into modern technology education. In the Netherlands and Sweden (teknik) technology education is an independent subject area which has been developed by integrating certain parts of the traditional crafts teaching and applied science. The French curriculum emphasizes the method of working with an entrepreneurial orientation. The curricula of other countries also advise the schools to work together with the society around them (other learning institutes, industry and trade).

Since technology education does not have a long tradition, the standards of teaching vary a lot, not only in that teachers differ but because the level of development of the subject varies from one country to another, and because this development is still very young in certain countries. In most countries under study here, the junior secondary schools are the most developed in their technology education. But also in these, there are still many obstacles to overcome before the intended curriculum is fully put into practice.

8.3 Views of Finnish experts

The Finnish experts in this study included teachers and researchers in technology universities and polytechnics and specialists of technology in trade and industry. Parikka (1998) used the same questionnaire in his study but in his research the questions were targeted at the "visionaries" of technology. There are many similarities in the mean value frequencies and factors between Parikka's study and the study at hand. The "visionaries" of Parikka's study and the experts in this study assessed the same three learning objectives (integration between science and technology, study of technical thinking and invention skills, students to set their own objectives and self-evaluation) as the most important objectives for technology education. In Parikka's study the fourth objective which was ranked as very important was sustainable development. Considering environmental issues has also been clearly stated out in all the six curricula analyzed in this report. Also Kantola (1997) emphasizes the importance of concern for nature in technological studies. The ethics of technology are also considered by for example Alamäki (1999) and Kankare (1997). Parikka (ibid. 1998) considers the ethics of technology as a fundamental domain of technology education. In the present study the fourth very important objective was the use of computers in technology studies. Service and repairs of leisure time equipment were regarded as the least important objective. As regards learning methods, then, in Parikka's research the visionaries ranked two learning methods as very important, whereas the experts in this research suggested three methods as very important. An independent way of looking for information and team work were regarded as very important in both studies. In this study studying technology through a foreign language was also regarded as a very important method. In both studies co-operation with the industry, taking part in shows and competitions, working after a model, and copying (linear) work were regarded as the least important methods. In the present study following manuals and other written instructions was also considered the least important.

In both Parikka's and this research electricity, electronics, and using computer technology were considered very important contents for technology education. In both studies the least important contents were metal technology, plastics technology, service work at home, and hobby crafts. In the research at hand non-regulated electrical repairs were regarded as the least important. In the factor analysis there were also two common factors in the domain of objectives, methods, and contents both in Parikka's research and in this research. In the domain of objectives these were studies of home technology and applications of technology, in the domain of methods independent work and co-operation between schools and industry, and in the domain of contents technical work (the present school subject) and service and repair work.

Some "visionaries" in Parikka's research were experts of technology, although mainly they were representatives of different fields of expertise. The respondents in the study at hand, on the other hand, were all experts of technology. Although the respondents in Parikka's research can be regarded as representatives of general education and the respondents in the research at hand can be regarded as technocrats, all of the respondents were asked to answer the questions from the perspective of general education. This fact partly explains the parallel results. If the respondents had been for example pupils, their parents, students in teacher education, or teachers the results might have been different. It will be interesting to see what the results will be when the already collected data from parents in different parts of Finland will be analyzed. The questionnaire in this study was targeted at experts in technology, because it was believed that they would most probably have considered these questions and met people who have passed general education. These types of experts presumably have considered more deeply the problems at hand than, for instance, class teachers in general. When preparing the curriculum, the opinions of all interest groups have to be taken into account.

8.4 How to organize technology education in Finland

According to this research, studies of hand work (handicraft) and science; studies of information technology and applications of technology; studies of interaction between technology and society; studies of balance between technology and the environment; studies of various study methods; studies of basic technical know-how and practical skills; and studies of entrepreneurship should be emphasized in the curricula. From these results such a conclusion can be drawn that students in general education should be prepared to meet today's world. Finland regards herself as a well developed high-tech country. There are many good examples, such as Nokia, to prove this. However, Sitra (Suomen itsenäisyyden rahasto, funding organization in Finland) has started a project where parallel to high-tech, also skill-tech (taitek, taitoteknologia, technology of skills) is being developed to stimulate traditional know-how and hand work (handicraft) with the purpose of making them more business-oriented and international. It is interesting to note that working with hands and high-tech were regarded as equally important for a school curriculum.

The first step in the Finnish curriculum development process should be finding a consensus on what technology and technology education mean in the context of general education. The Framework Curriculum for the Comprehensive School (1994) and the Framework Curriculum for the Upper Secondary School (1994), indicate that there is no more reason to discuss the question of whether technology education is needed at all. According to these documents "students without any regard to sex must have the chance to acquaint themselves with technology and to learn to understand and avail themselves of technology... to take a critical look at the effects that technology has on the interaction between man and nature, to be able to make use of the possibilities it offers and to understand the consequences..." (Peruskoulun opetussuunnitelman perusteet 1994, pp. 11-12), and additionally "... the capability to solve problems by making use of the possibilities technology provides... ability to use technological applications... and influence the direction of technological development"(Lukion opetussuunnitelman perusteet 1994, pp. 12-13). In the following, the more specified possibilities of organizing technology education in the Finnish school system is discussed.

8.4.1 Possibilities for integration

Marsh (1997b, pp. 95) presents many studies which are in favor of considering integrated curricula as a worthwhile alternative. He also gives good examples on how to organize multidisciplinary studies, and presents studies which support the idea of students achieving high results after taking integrated study programs (ibid. pp. 96 – 103).

Integration within school is possible particularly in the primary school (grades one to six) with present teacher education and teacher organizations. In today's junior secondary school (grades seven to nine) many present school subjects, including technical work (tekninen työ) in particular, contain plenty of technology education. Technology is also studied in connection with many other subjects (e.g. information technology, mathematics, science, textile work, home economics, history and social studies). Actual integration between different subjects is probably easiest to execute through project and thematic work. For this purpose, information flow, joint planning, and discussions between teachers of different subjects should be increased systematically. Lattu (2000) suggests that improvement of technology education in Finnish comprehensive schools could best be promoted by intercurricular activities. *Integration between school and surrounding society* is a more demanding task than integration within school, because the number of intervening factors is great. The various parties have their own tasks and their own time-tables. The general atmosphere regarding co-operation between different educational institutes, branches of industry, and schools is positive. Also in this case integration is probably easiest to organize through various projects and themes.

The idea of *transdisciplinarity* goes deeper in the creation of knowledge than just integration. The aim is to create a theoretical consensus which cannot be split into disciplinary parts. Transdisciplinary knowledge develops its own modes of practice, and diffusion is accomplished in the process of production (Gibbons, Limoges, Nowotny, Schwartzman, Scott & Trow (1994, pp. 4 – 6). Creating knowledge in a holistic manner should be aimed for in all curriculum development. Theories of transdisciplinarity should also be applied in Finnish curriculum development, but at this stage of development of technology education the first steps toward this direction have to be taken through integration.

8.4.2 Technology education as an independent school subject

In the present school system the most certain way to study a specific subject is to fit the lessons in the timetable. The experiences from so called multidisciplinary studies have often been quite negative. The subjects studied in this manner have not had a sufficiently high status within the curriculum, and they have not been taken seriously by either students or teachers. This does not mean that integration between subject areas would not be a good system. On the contrary, both in the class teacher system and the subject teacher system integration increases holistic learning. If technology education were to be integrated fully with other subjects, clear technology contents should be determined. In many industrial countries technology education is an independent subject. Parikka (1998) gives different solutions to organizing technology education, but supports the development of technology as its own subject area. This model should also be considered in Finland to ensure proper learning of technology.

8.4.3 Pre- and in-service education of teachers

When teachers in England were ordered to start the teaching of technology many of them were confused in the new situation. The contents of the curriculum were new, there were no adequate learning materials, the learning environments and tools were inadequate, and teachers lacked training in teaching the new subject. This type of proceeding may even lead to resistance of the whole reform. When reforming education, a systematic in-service program for teachers has to be introduced parallelly to the reform. Reforms often also require modernizing of learning environments or at least modernizing of learning materials, and in many cases development of totally new materials. In-service education and up-dating of learning materials are needed be the reform towards centralized or decentralized direction (see e.g. Webb et al. 1997). The curricula used in this study do not indicate what the legislation in different countries is and what the support systems for the reforms have been.

The content of the pre-service education of teachers has to change together with the new curricula, or rather, before them. In this context the content also incorporates objectives and methods. If the teacher trainees (especially those to become subject teachers) have an opportunity to internalize during their student years already the principles of integration as a natural method which is part of daily routines, putting it into practice in working life will not be as difficult as it is for those teachers who are not used to integrative approaches. The models of learning environments and the tools for the approach are learned and developed during teacher education.

8.4.4 Challenges for the development of technology education

In a closer study of different curriculum planning models Walker's naturalistic model, which was discussed above (chapter 4.5.1), turned out to suit well when considering the results of this study, as well as other recent findings. Walker's naturalistic model was modified to describe the development of technology education curricula from the perspective of the study at hand.

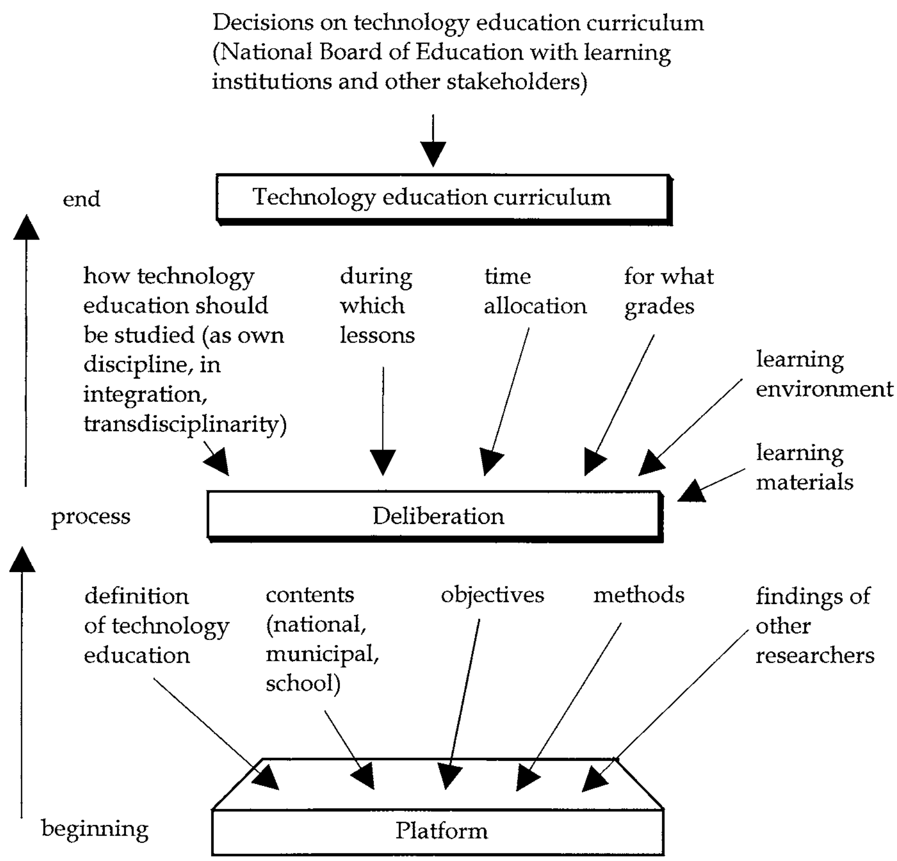

FIGURE 16 Naturalistic approach to technology education curriculum planning. Adapted from Walker's model (Marsh 1997b, p. 130) for Finnish technology education curriculum planning.

Many researchers, particularly Alamäki (1999), Autio (1997), Heinonen (2000), Kankare (1997), Kantola (1997), Kananoja (eg.1999) and Parikka (1998) have contributed to the platform stage of Finnish technology education curriculum development. In the studies of Alamäki, Autio, Kanaoja and Kankare most of technology education was seen to take place during the lessons in technical work (tekninen työ) to the extent that technical work and technology education were almost seen as synonymous. In the Finnish school system technical work has bee studied until the present day from (in most schools) grade three until grade nine (in some cases 12) only by half of the age group, mainly boys. This means that most of the girls during their nine or twelve years of general schooling have never had any chance of receiving technology education. If technology is not studied during the early ages of development of girls, the chances to stimulate their interest in technology decreases year after year. This nationally very important view has been brought to the platform by the researchers listed above. There have been many attempts to make technical professions more attractive for girls through different projects. These projects have normally concentrated on secondary level education and often in connection with the learning of science and mathematics only. The results have not been very encouraging. Obviously the attitudes towards technology are formed much earlier. Therefore, these types of projects should obviously concentrate on much younger target groups – rather, the school system should be changed in this respect. The importance of learning about technology from the first classes of schooling onwards has not yet been realized in our country.

When general education was discussed above in this study Välijärvi's (1989) six definitions of general education were introduced. Parikka (1998, p. 34) has condensed these definitions into three perspectives: historic, humanistic, and theories of learning. According to him, one part of general education for all is to understand how technology has developed in order to understand how technology affects culture and society, how ethical viewpoints should be considered when making technological choices, how learning and planning processes differ between different fields of science, and finally what learning and planning processes there are behind technological innovations. Parikka's study also defines the degree of technological competency that should be achieved in general education schools by describing its functional and conceptual structure.

Parikka (1998) emphasizes the ethics of technology as an integral element of curriculum development. Kantola (1997) also considers the ethical aspects in technology studies. He also focuses on the importance of developing the curriculum of technology education in balance with the environment in order to promote sustainable development.

Heinonen (2000) emphasizes the needs of the teachers not only to develop their own self-directiveness, but also to enable the development of self-directive and independent pupils. By giving this opportunity to students they would make it possible for students to adopt an active and responsible role in the learning process. Heinonen (2000) also presents a model of activities for self-directed studies in technology education.

The aim of this report is to contribute to the platform. As is the case with Parikka's study, also this study, deliberately, does not see technology education as synonymous with technical work. The starting point has been not to tie the concepts of technology and technology education with any existing school subject, but to openly explore how they are understood and interpreted, and how they should be included in the Finnish school curriculum.

Parikka (1998, p. 95, p. 111, p. 126) has divided technology studies into intuition and functional domains. The intuition domain should be handled through a cross-curricular approach. In this way the parts of technology education are incorporated into different school subjects, including a critical, consciously selective attitude toward technology; realization of the meaning of technology for culture and economics; understanding technological systems; and understanding the effects of technology. The functional domain can be realized during technology subject lessons. Here the study areas are skills to use information technology; skills to use everyday technical devices; technical hobbies; and gaining basic experiences of technology for possible technological professions. Similar findings have also emerged in the present study, but they have not been grouped in the manner that Parikka has grouped them.

This study presents different domains (conceptions, theories, aims, images, and procedures) for consideration together with the domains presented by other parties (e. g. the above-mentioned studies). From this stage, the next move should be made towards deliberation. In fact, this research, as well as the other studies mentioned already, also contribute to the deliberation phase of curriculum development. It seems that only very few academics are at the moment interested in the present state of technology education in Finnish schools. There is no real debate going on, nor are there any signs from the National Board of Education of concern about technology education and especially about how girls would be involved in technology studies.

The step to follow deliberation is the design phase. Marsh (1997b, pp.145 – 155) presents a centrally based, as well as decentralized and school-based curriculum development process. When the national curriculum framework has been designed the school-based model of Marsh (1997b, p.148) can be found very useful when carrying out municipal and school level planning. Since the aim of this study was to find curriculum materials for technology education for Finnish schools, a few examples to this effect are presented in the following.

8.4.5 Examples of potential curriculum materials

The study at hand has also dealt with the concept of building materials for technology education. Therefore, following the metaphor, it is justified to present examples which refer to buildings. In the analysis of the six countries the curricula were discussed from society's, school's, and individual's point of view. Here the national and municipal curricula refer to society, the school curriculum to schools, and learning finally takes place individually in that each student has her or his own concept about learning, and the learning outcomes are specific to the individual.

The national level curriculum can be rather general. First the visions and general attainment targets could be expressed, for instance in the manner they are expressed at the moment in the Foundations of the Comprehensive School Curriculum (1994). The objectives can be considered as the foundation for learning, while the contents are studied to achieve the objectives. The contents are built on the foundation (or the contents are the functions of the building). Various methods are applied to learn the contents and to achieve the objectives. Objectives, methods and contents are derived from Chapter 6 where the findings of this study were presented in a condensed form.

Definition of technology education:
In technology, particularly hand work (handicraft), applied science, and information technology are combined. Technology education is connected with studies of interaction between technology and society, balance of technology and the environment, basic technical know-how, practical skills, and entrepreneurship by applying versatile learning methods.

The general objective is broad technology education for all regardless of sex.

In a 'technology education house' the foundation is formed of the objectives of learning. In the house itself the learning of technological study contents takes place. These studies are directed by using various learning methods. (Figure 17).

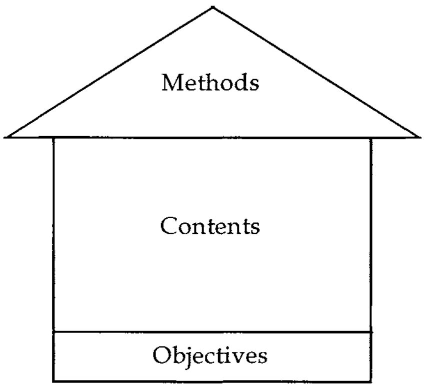

FIGURE 17 National curriculum

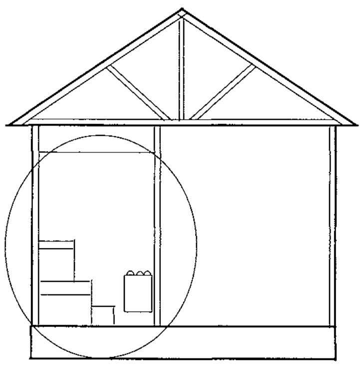

FIGURE 18 Municipal/school curriculum

Learning methods
- independent studies
- teamwork and co-operative learning
- co-operation between school and industry
- self-reflection and self-evaluation

Learning contents
- technological systems and structures
- planning, solving problems, making, evaluating
- technology and the environment
- safety precautions and ergonomics

Learning objectives
- basic technological know-how and practical skills
- hands-on activities and applications of science and technology
- interaction between technology and society
- interaction between technology and the environment
- various study methods
- entrepreneurship

At municipal or school level planning the special features of the school, locality, or expertise (or any other relevant feature) can be applied to the curriculum. However, the curriculum is more detailed and gives more exact information on how 'the technology education house' is constructed (Figure 18). The construction materials for local curriculum building can be derived from Chapter 5. In this type of curriculum the general objectives, methods and contents are expressed in an accurate manner.

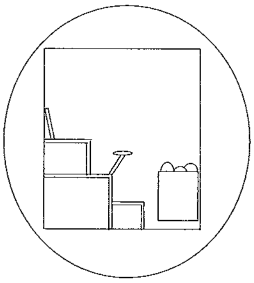

FIGURE 19 Schemes of work

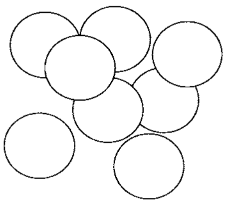

FIGURE 20 Different ideas/products

At school level 'the technology education house' is studied even closer (Figure 19). Here possibilities of integration are studied and themes planned and agreed upon. A theme could for example be energy. During science lessons students could study energy resources, various forms of energy and transfer of energy. They could observe and find out how sauna is heated, how steam is created, how fog and rain originate. During technology lessons the students' task would be to plan, produce and test a modern device for adding steam (löyly) in the sauna. At grade five level this could be a mechanical device. If this project were undertaken in grade nine, mecathronics could be applied during technology studies. The result would be a selection of different ideas and products (Figure 20) to organize the steaming of the sauna (individual level).

The above are examples of what can be brought to the platform at different levels when the curriculum planning starts. During platform phase the various parties present their views, these are argued, and be there consensus or not, the planning process gradually proceeds to a commonly accepted curriculum.

8.4.6 Time for action

The Framework Curriculum for the Comprehensive School (1994) and the Framework Curriculum for the Upper Secondary School (1994) do not give information on how technology should be studied in schools. In Finland the role of the teacher has developed from instructions implementer towards a curriculum planner. The national curriculum gives general instructions and how to go about it remains for the municipalities, schools, and teachers to decide. Marsh (1997b, p. 141) presents many advantages and disadvantages of centrally based curriculum development. One of obvious advantages in case of technology education in Finland is that this system concentrates on expertise. In the planning process teams of experts are used. For the Finnish national technology education curriculum this approach could be used at this phase of development, where only a few experts are to be found in the country.

At present notes about technology in the Foundations of the Upper Secondary Curriculum (1994) are to be found mainly in connection with languages (pp. 47 – 64), and in a very modest way in mathematics (p. 70), physics (pp. 78 – 79), and chemistry (p. 81). It is justified to ask whether technology studies can really be conducted in a comprehensive manner during language lessons.

The policy of curriculum design in Finland does not refer to a centralized system but to a decentralized system. Marsh (1997b, p.146) also points out many advantages and disadvantages of this approach. One of disadvantages in Finland at the moment might be the non-awareness of teachers of what technology education should be in schools. This obstacle could be overcome by organizing an in-service training program which would enable municipalities and schools to develop their own technology education curricula. Parallel to this in-service program, or even before it, the content of teacher education programs should be revised. Pilot programs, experiments, and development of learning materials should take place. The Confederation of Finnish Industry and Employers (Teollisuus ja Työnantajat) has also expressed its concern on the development of technology education in a memorandum to the Ministry of Education (Teknologiakasvatus; Selvitys teknologiakasvatuksesta muissa maissa sekä toimenpide-ehdotukset 2000). The experiences gained in the national science and mathematics (LUMA) project could be used and something similar organized in the field of technology education. The report at hand provides some ideas for the curriculum planners on how to go about their work. There are, however, many areas of research - as was described in the beginning of this study - which have not yet been addressed at all in the Finnish context, but which are very important for the sake of developing technology education.

In countries which have chosen a technological way of life, research and development of technology education is an on-going activity. If Finland is to maintain her position as a developed technological country with an ability to successfully compete in a modern international world, technology education should be seen as an important part of studies for both today and tomorrow. Therefore, the development of the instructions on how to organize technology studies has to start immediately. The different options have to be studied and a clear decision on how to organize technology education in our schools should be made as soon as possible.

YHTEENVETO

Nykyajan ihminen on päivittäin tekemisissä teknologian kanssa. Monien maiden yleissivistävissä kouluissa on viime vuosina aloitettu teknologiakasvatus. Peruskoulun opetussuunnitelman perusteet 1994 ja lukion opetussuunnitelman perusteet 1994 - asiakirjojen mukaan teknologia on osa yleissivistystä. Asiakirjat eivät kuitenkaan määrittele mitä teknologinen yleissivistys on, eivätkä anna operationaalisia ohjeita sen järjestämiseksi peruskouluissa ja lukioissa.

Tämän tutkimuksen tarkoituksena oli: 1) selvittää teknologian ja teknologiakasvatuksen käsitteitä, 2) etsiä rakennusaineksia Suomen yleissivistävien koulujen teknologiakasvatuksen opetussuunnitelmien laadintaa varten. Käsitteitä määriteltiin ensin aiemmin julkaistun kirjallisuuden pohjalta, ja tutkimuksen lopuksi tutkimuksen empiirisen osan tulosten pohjalta. Rakennusaineksia maamme koulujen teknologiakasvatuksen opetussuunnitelmiksi etsittiin yhtäältä analysoimalla Alankomaiden, Australian, Englannin, Ranskan, Ruotsin ja Yhdysvaltojen teknologiakasvatuksen opetussuunnitelmia, opetussuunnitelman perusteita tai opetussuunnitelmaohjeita ja toisaalta strukturoidulla ja avoimella teknologian alueen koulutuslaitoksille ja teknologian alan yrityksille suunnatulla kyselyllä.

Tutkimuksen kvalitatiivisen osan muodosti eri maiden opetussuunnitelmien systemaattinen analyysi. Kvantitatiivisessa osassa teknillisiltä korkeakouluilta ja teknologian alueen ammattikorkeakouluilta sekä teknologian alan yrityksiltä saatuja vastauksia käsiteltiin perinteisen empiirisen analyysin (keskiarvojen, keskihajontojen ja faktorianalyysin) metodein.

Teknologiakasvatusta tutkittiin opiskelutavoitteiden, opiskelumenetelmien ja opiskelusisältöjen kannalta. Ensin tehtiin yhteenveto eri maiden opetussuunnitelmien analyysissä esiin tulleista tavoitteista, menetelmistä ja sisällöistä. Sitten tehtiin yhteenveto suomalaisten asiantuntijoiden esittämiksi teknologiakasvatuksen tavoitteiksi, menetelmiksi ja sisällöiksi. Lopuksi ulkomaisten opetussuunnitelmien analyysin tuloksia ja kotimaisten asiantuntijoiden kyselytutkimuksen tuloksia vertailtiin ja yhteiset elementit yhdistettiin tiivistetyn taulukon muotoon.

Eri analyysien pohjalta muodostettiin teknologiakasvatuksen määritelmä, jonka mukaan teknologiassa yhdistyvät erityisesti käden työ, soveltavat luonnontieteet ja tietotekniikka. Teknologiakasvatus nähdään kuitenkin itsenäisenä opiskelualana. Teknologiakasvatukseen liittyy teknologian ja yhteiskunnan vuorovaikutuksen, teknologian ja ympäristön tasapainon, teknisten perustietotaitojen, käytännön taitojen ja yrittäjyyden opiskelua. Kaikkia näitä tulisi opiskella monipuolisia opiskelumenetelmiä soveltamalla.

Taulukko 1 Teknologiakasvatuksen tavoitteet, menetelmät ja sisällöt tiivistettynä

Tavoitteet	Menetelmät	Sisällöt
• käden työn, luonnontieteiden, tietotekniikan ja teknologian sovellusten opiskelu • teknologian ja yhteiskunnan vuorovaikutuksen opiskelu • teknologian ja ympäristön tasapainon opiskelu • erilaisten opiskelumenetelmien opiskelu • teknisten perustietotaitojen ja käytännön taitojen opiskelu • yrittäjyyden opiskelu	• sosiaalisien menetelmien opiskelu • itsenäisten ja omavastuisten menetelmien opiskelu • arvioinnin ja itsearvioinnin menetelmien opiskelu • koulun ja tuotantoelämän yhteistyön menetelmien opiskelu	• teknisen työn sisältöjen opiskelu • high tech'in sisältöjen opiskelu • kodin ja vapaa-ajan varusteiden huolto- ja korjaustöiden opiskelu

Tutkimuksen tiivistetyistä taulukoista ja niihin liittyvästä tekstistä voidaan etsiä elementtejä, kun vuoden 2003 valtakunnallista opetussuunnitelmaa ryhdytään suunnittelemaan. Laajemmista taulukoista ja niihin liittyvästä tekstistä voidaan etsiä rakennusaineksia kunta- ja koulutason opetussuunnitelmiin. Käsitteenmäärittelyyn löytyy tietoa esimerkiksi aikaisempien tutkimusten analyysistä. Tutkimuksen pohdintaosassa esitetään esimerkkejä siitä, miten opetussuunnitelmatyötä voitaisiin eri tasoilla tehdä tulevia ohjeita laadittaessa.

Tämän tutkimuksen tulokset tukevat selvästi näkemystä siitä, että mikäli Suomi haluaa säilyttää asemansa johtavien teknologisesti kehittyneiden maiden joukossa, teknologiakasvatus tulisi kiireesti aloittaa maassamme. Sen tulisi olla kaikille oppilaille, niin tytöille kuin pojille, yleissivistävään koulutukseen kuuluva oppiaine kaikilla luokkatasoilla esikoulusta lukioon ja vielä tästäkin eteenpäin.

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APPENDIX 1

FIGURES AND TABLES

APPENDIX 2

QUESTIONNAIRE

TEKNOLOGIAKASVATUSTUTKIMUS
(A study of technology education)

Kyselyyn vastataan rengastamalla sopiva vaihtoehto tai sopivat vaihtoehdot taikka kirjoittamalla vastaus sille valittuun tilaan. Jos jokin kohta vaatii mielestänne tarkennusta, voitte kirjoittaa sen sitä varten varattuun tilaan tai vastauspaperin kääntöpuolelle. Pyrkikää nostamaan joitakin tärkeimpinä pitämiänne asioita selvästi esiin.
(Please answer by circling the appropriate alternative, or alternatives, or by writing your answer in the space reserved for it. If you want to add some comments, you can use the space reserved for it or the back side of the paper. Please try to raise the issuess you consider the most important clearly.)

I TAUSTATIEDOT
(Background information)
Nimi ....
(Name)
Toimipaikka ....
(Workplace)
Koulutus tai tehtävä työorganisaatiossa ....
(Positieon or duties in the organization)
Toiminta teknologian (tai vastaavan) alalla .... vuotta
(How many years have you worked in the field of technology (or equivalent)?.......years.)

Hyväksyn, että näkemyksiäni esitellään nimelläni kyllä ei
(I accept that my views are presented in my name yes no)

II OPISKELUTAVOITTEIDEN ARVIOINTI
(Evaluation of learning objectives)

Arvioikaa seuraavassa esitettävien tavoitteiden hyödyllisyyttä tai tarpeellisuutta peruskoulun ja lukion opetuksessa lähitulevaisuuden teknologian kannalta. Vastatkaa kysymyksiin rengastamalla mielestänne sopivin vaihtoehto. Esittäkää lisäksi alariveillä muita, mielestänne tärkeitä opiskelutavoitteita.
(Please evaluate the usefulness and importance of the following learning objectives from the point of view of the technology studies of comprehensive schools and upper secondary schools in the near future. Please circle the alternative closest to your opinion. Present on the lines provided also other learning objectives which you regard as important.)

Opiskelutavoitteiden, -menetelmien ja -sisältöjen arviointiin käytetään seuraavaa asteikkoa:
(Please use the following scale when evaluating learning objectives, methods, and contents)

1 = ei lainkaan tarpeellinen tai hyödyllinen
(not useful or important)
2 = vain vähän tarpeellinen tai hyödyllinen
(only a little useful or important)
3 = jonkin verran tarpeellinen tai hyödyllinen
(useful or important)
4 = hyvin tarpeellinen tai hyödyllinen
(very useful or important)
5 = erittäin tarpeellinen tai hyödyllinen
(most useful or important)

Opitaan suunnitelmallisen työnteon taitoa eli sitä, miten esimerkiksi ammattitaitoinen työntekijä taikka korjaaja työskentelee (Students learn systematic working skills, e.g. how a professional worker or repairer works)	1 2 3 4 5
Opitaan teknisiä perustaitoja ja työturvallisuuden perusteita (Students learn basic technical know-how and basics of safety precautions)	1 2 3 4 5
Harjoitellaan teknistä ajattelua ja keksimistaitoja (ideoista tuotteiksi) (Students practice technical thinking and innovation skills (from idea to product))	1 2 3 4 5
Tutkitaan luonnonilmiöitä ja luonnontieteitä sekä niiden teknologisia sovelluksia, esimerkiksi vivun käytännön sovelluksia (Students explore natural phenomena and science and their applications, e.g. the applications of a lever)	1 2 3 4 5
Tutustutaan käytännön teknologisiin järjestelmiin, esimerkiksi kodin lämpö-, vesi- ja viemäröinti- sekä ilmastointijärjestelmien toimintaan (Students familiarize themselves with practical technological systems, e.g. the functioning of heating, water, sewage, and air-conditioning systems)	1 2 3 4 5
Opitaan teknologista käsitteistöä ja teknistä piirtämistä (Students learn technological concepts and technical drawing)	1 2 3 4 5
Tutustutaan kestävän kehityksen aikaansaamiseksi eri materiaalien ominaisuuksiin, niiden kierrätykseen ja uudelleenkäyttöön (Students familiarize themselves for the sake of sustainable development with the properties of materials, their circulation and recycling)	1 2 3 4 5
Tutustutaan teknologian historiaan ja kulttuurisiin vaikutuksiin (Students familiarize themselves with the history of technology and its effects on culture)	1 2 3 4 5
Arvioidaan teknologisen maailman kehittymistä (mikä on oikein, mikä väärin) ja otetaan kantaa sen yhteiskunnallisiin seurauksiin (Students evaluate the development of the technological world (what is right, what is wrong) and express their opinion on its societal consequences)	1 2 3 4 5
Opetellaan käyttämään tietokoneita monenlaisissa töissä (Students learn to use computers in many types of tasks)	1 2 3 4 5
Tutustutaan yrittäjyyteen, tuotantoelämään ja teollisuuden toimintatapoihin (Students familiarize themselves with entrepreneurship, production life, and industrial ways of action)	1 2 3 4 5
Opitaan käsityötaitoja eli opitaan tekemään erilaisia tuotteita käsityövälineillä (Students learn handicraft skills, students learn how to make various articles with hand tools)	1 2 3 4 5
Opetellaan kodin sallittuja sähkötöitä (Students practice doing non-regulated electrical work of home)	1 2 3 4 5
Opetellaan kunnostamaan kodin laitteita ja välineistöä (Students study how to service and repair home utensils)	1 2 3 4 5
Opetellaan tekemään kodin pieniä remonttitöitä (esimerkiksi seinien maalaus ja tapetointi) (Students study how to do small repairs of home (e.g. painting and papering the walls))	1 2 3 4 5
Opetellaan huoltamaan suksia, polkupyörää, mopoa yms. (Students study how to service skis, bicycle, motorbike etc.)	1 2 3 4 5
Tutustutaan erilaisiin teknisiin harrastuksiin, esimerkiksi lennokkirakenteluun (Students familiarize themselves with various technical hobbies e.g. constructing model airplanes)	1 2 3 4 5
Opetellaan asettamaan omia oppimistavoitteita ja arvioimaan omaa oppimistyöskentelyä (Students study how to set their own learning objectives and how to evaluate their own study progress)	1 2 3 4 5
	1 2 3 4 5
	1 2 3 4 5

Muita näkökohtia (Any other views)

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III OPISKELUMENETELMIEN ARVIOINTI
(Evaluation of learning methods)

Arvioikaa seuraavien opiskelumenetelmien hyödyllisyyttä tai tarpeellisuutta edellä olevan asteikon 1 - 5 mukaan. Esittäkää lisäksi alariveillä muita, mielestänne tärkeitä koulutyöskentelyn tapoja.
(Please evaluate the usefulness and importance of the following learning methods by means of the 1 to 5 scale described above. Please present on the lines under also other methods which you regard as important)

Ryhmänä työskentely, sosiaalisuus eli yhteisvastuulliset menetelmät, esimerkiksi projekti- ja tiimityöskentely (Working as a group, social or co-operative methods, e.g. project- and team work)	1 2 3 4 5
Asioiden itsenäinen selvilleotto ja asioiden merkityksen arviointi, esimerkiksi kirjaston ja internetin käyttö (Looking for information independently, and evaluating the significance of issues, e.g. use of libraries and the internet)	1 2 3 4 5
Omavastuinen etätyöskentely, esimerkiksi oppimistehtävien tekeminen, tietojen hankinta haastattelulla, tietokoneavusteinen suunnittelu (Taking own responsibility for distance work, e.g. doing learning tasks, getting information by interviews, computer aided design)	1 2 3 4 5
Käyttöohjeiden ja ohjekirjojen avulla työskentely (Working with operating instructions and manuals)	1 2 3 4 5
Vieraalla kielellä opiskelu eli kielen oppiminen toiminnallisissa yhteyksissä (Studying through a foreign language, learning foreign language in active and functional contexts)	1 2 3 4 5
Tutkiminen ja kokeilu, esimerkiksi lujuus- tai liimauskokeiden tekeminen (Studying and exploring, e.g. experiments with strength or glues)	1 2 3 4 5
Toiminnalliset opintokäynnit yrityksiin (opintokäynnin aikana oppilaat tekevät tutustumiskohteessa jotakin konkreettista eivätkä vain kulje esittelijän mukana) (Active study tours to enterprises (during the study-tour students work on something concrete instead of mere walking with the guide))	1 2 3 4 5
Kummiyritystoiminta (yhteistyö paikkakunnan jonkin yrityksen kanssa) (Partnership between school and enterprises)	1 2 3 4 5
Oman työskentelyn ja oppimistoimintojen arviointi sekä esitysten tekeminen oppimisjärjestelyjen parantamiseksi (Evaluation of own work and learning activities, and proposals for improvement of learning organizations)	1 2 3 4 5
Mallin mukaiseen toimintaan harjaantuminen, jäljentäminen (Training oneself to copy models)	1 2 3 4 5
Sarjatyönomainen työskentely (liukuhihnatyöskentely) (Training for serial work (line production))	1 2 3 4 5
Alan kilpailu- ja näyttelytoiminta (osallistuminen oman koulun, kansallisella ja kansainvälisellä tasolla) (Taking part in competitions and shows (at international, national, regional, and school level))	1 2 3 4 5
	1 2 3 4 5
	1 2 3 4 5

Muita näkökohtia (Other comments)

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IV OPISKELUSISÄLTÖJEN ARVIOINTI
(Evaluation of learning contents)

Arvioikaa seuraavien teknologiakasvatuksen oppisisältöjen hyödyllisyyttä tai tarpeellisuutta arkielämän kannalta käyttäen edellä olevaa asteikkoa. Yliviivatkaa ensin ne esimerkkeinä luetellut asiat, jotka näyttävät tulevaisuudessa olevan tarpeettomia. Ottakaa sen jälkeen kantaa jäljelle jääneiden tarpeellisuuteen tai hyödyllisyyteen.
(Please evaluate the usefulness and importance of the following learning contents of technology education from the perspective of everyday life, by using the above scale. Strike out those examples which you regard as unnecessary in the future. After this, please respond on the usefulness and importance of those remaining.)

Puuteknologia, esimerkiksi mittaaminen ja merkitseminen, sahaus, poraus, höyläys, talttaus ja vuolu, sorvaus, liitosten tekeminen, pintakäsittely, materiaalituntemus (**Wood technology**, e.g. measuring and marking, sawing, drilling, planing, chiseling, carving, turning wood, making joints, surface treatment, knowledge of materials)	1 2 3 4 5
Metalliteknologia, esimerkiksi sahaus, viilaus, poraus, pehmytjuotto (esim. tinaliitos), kovajuotto (esim. hopeajuotos), kaasu- ja sähköhitsaus, pakotus (esim. kuparilevyn muotoilu pakotusvasaralla), niittaus, pintakäsittely, materiaalituntemus (**Metal technology**, e.g. sawing, filing, drilling, soft soldering (e.g. with tin soldering), hard soldering (e.g. silver soldering), gas, arch and mig welding, embossing (e.g. forming a copper sheet with an embossing hammer), riveting, surface treatment, knowledge of materials)	1 2 3 4 5
Muoviteknologia, esimerkiksi taivutus, liimaus, pintakäsittely, muovilajit ja materiaalituntemus (**Plastic technology**, e.g. bending, gluing, surface treatment, different types of plastics, knowledge of materials)	1 2 3 4 5
Askartelu, esimerkiksi pienoismallien rakentelu, lennokit, leijat, kuumailmapallot, materiaalituntemus (**Hobby crafts**, e.g. building miniature models, model planes, kites, hot-air balloons, knowledge of materials)	1 2 3 4 5
Sähköoppi ja elektroniikka, esimerkiksi sähköilmiöiden perusteet, paristot, akut, aurinkokennot, elektroniikan komponentit, laiterakentelu (esim. vilkkuvalo) (**Electricity and electronics**, e.g. basics of electrical phenomena, batteries, solar elements, electronic components, building electronic device (e.g. blinking light))	1 2 3 4 5
Tietotekniikka, esimerkiksi piirto-ohjelmien käyttö, taulukko-ohjelmien käyttö, tekninen piirtäminen (CAD), CNC-teknologia = tietokoneella ohjattujen työstökoneiden käyttö, ohjaus ja säätötekniikka, mekatroniikka (**Information technology**, e.g. use of drawing programs, use of spreadsheet programs, computer-aided design (CAD), CNC-technology (using machines which are controlled by computer), control technology, mechatronics)	1 2 3 4 5
Mekaniikka, esimerkiksi kalteva taso, vipu, akselit ja laakerointi, voimansiirto ja vaihteistot, laiterakentelu (esim. rakentelusarjoista rakennukset, sillat, nosturit, kulkuvälineet yms.) (**Mechanics**, e.g. inclined plane, lever, axles and bearings, transmission of power and gears, building constructions (e.g. using assembly kits to construct buildings, bridges, cranes, vehicles etc.))	1 2 3 4 5
Sähköalan sallitut työt, esimerkiksi lampun vaihto, sulakkeen vaihto, valaisimen vaihto, pistorasian korjaus, jatkojohdon teko, tv- ja radioantennin asennus, sähköturvallisuus (**Non-regulated electronical work,** e.g. changing a bulb, changing a fuse, changing a lamp, fixing a socket, making an extension cord, mounting a TV or radio aerial, electrical safety)	1 2 3 4 5

Huonekalujen ja kodin korjaus, esimerkiksi puuliimaukset, entisöintimaalaus, huonekalujen verhoilu, tapetointi ja maalaus, tarveaineiden hankinta, töiden esivalmistelu (esim. pintojen puhdistus ja suojaus, pölyn vaikutusten torjunta, liuotinaineiden vaarat, varotoimenpiteet ja suojautuminen) (**Repairs of furniture and home**, e.g. gluing wood, renovating, upholstering, painting and papering walls, procurement of materials, preparatory work (e.g. cleaning and protecting the surfaces, preventing the effects of dust, dangers of dissolvents, precautions and protection))	1 2 3 4 5
Muut kodin työt, esimerkiksi lukkojen, saranoiden ym. huolto, tiivisteiden vaihto esim. vesihanaan tai pesukoneeseen, WC-laitteiston huolto ja säätö, koukut ja proput eri materiaaleihin, jätteiden lajittelu ja hyötykeräys, työvälineiden, esim. saksien, veitsien, kirveiden ja sahan teroitus (**Other work at home**, e.g. service of locks and hinges, changing gaskets to a tap or washing machine, service and adjustment of toilet equipment, hooks and plugs for different materials, sorting waste and recycling, sharpening of tools e.g. scissors, knives, axes and saws)	1 2 3 4 5
Vapaa-ajan varusteiden korjaus ja huolto, esimerkiksi polkupyörän vaijerien säätö ja vaihto, kumin paikkaus, suksien kunnostus ja siteiden kiinnitys, kalastusvälineiden huolto ja korjaaminen (**Repairs and service of hobby equipment**, e.g. adjusting and changing the cables of a bicycle, mending a tube, servicing skis and fixing bindings, repairs and service of fishing equipment)	1 2 3 4 5
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Muita näkökohtia (Other comments)

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V YLEISIÄ TEKNOLOGIAN TULEVAISUUDEN KEHITYSNÄKYMIÄ
(General views of the development of technology)

1. Minkälaiselta **teknologian kehitys** näyttää lähivuosikymmeninä? (Esim. mahdolliset trendit, painoalueiden muuttuminen, suunnittelun ja tuotannon sijoittuminen globaalisti.)
(How do you see the **development of technology** in the decades to come? (e.g. possible trends, change in emphasis, how design and production are placed globally.))

2. Miten peruskoulua ja lukiota pitäisi kehittää **teknologiakasvatuksen edistämiseksi**? (Esim. näkemykset yhteistyöstä ympäröivään tuotantoelämään, tiimi- ja projektityöstä, yrittäjyydestä, kansainvälisyydestä.)
(How should the comprehensive school and upper secondary school be developed **to promote technology education**? (e.g. co-operation between schools and the trade and industry around, team work, project work, entrepreneurship, internationality.))

3. Miten **teknologiakasvatusta tulisi opettaa** peruskoulussa ja lukiossa? (Esim. näkemykset aineiden välisestä yhteistyöstä erityisesti matemaattis-luonnontieteellisen alueen ja käsityökasvatuksen kanssa, erillisten oppiaineiden lisäämisestä/vähentämisestä.)
(How should **technology education be taught** in comprehensive schools and upper secondary schools? (e.g. integration between different subject areas, especially science, mathematics and handicrafts, increasing/reducing subject areas.))

4. Miten **teknologiakasvatuksen opinnot pitäisi sijoittaa**? (Esim. järjestetäänkö teknologiakasvatuksen opintoja vuosittain ala-asteelta lukion loppuun, vain yläasteella ja lukiossa vai vain lukiossa?)
(How should **technology education lessons be placed in the curricula**? (e.g. should technology education studies be organized annually from primary school to the end of upper secondary, only during senior comprehensive and upper secondary, or only in upper secondary?))

Kiitän lämpimästi vaivannäöstänne!
I am very grateful for your time!

APPENDIX 3

FREQUENCY DISTRIBUTIONS, MEANS, AND STANDARD DEVIATIONS OF LEARNING OBJECTIVES (N=42)

Question	Frequency 5	4	3	2	1	-	Mean value	Standard deviation
1. Systematic working skills	11	20	7	2	1	1	3.93	0.93
2. Technical know-how and safety	6	15	18	1	1	1	3.59	0.87
3. Technical thinking and innovation skills	17	12	10	1	-	2	4.13	0.88
4. Technological applications of science	25	10	6	1	-	-	4.41	0.83
5. Practical technological systems	8	24	8	2	-	-	3.91	0.76
6. Technological concepts and technical drawing	4	11	16	9	1	1	3.20	0.98
7. Sustainable development and recycling	11	12	14	5	-	-	3.70	1.00
8. History and culture	5	7	19	7	3	1	3.10	1.07
9. Developments and societal consequences	3	14	17	6	1	1	3.29	0.90
10. Use of information technology	18	16	6	2	-	-	4.19	0.86
11. Entrepreneurship, production life, and industry	15	16	8	3	-	-	4.02	0.92
12. Handicraft skills	12	13	12	3	1	1	3.78	1.04
13. Permitted electric work	2	7	19	10	3	1	2.88	0.95
14. Service and repairs of utensils at home	1	10	18	9	3	1	2.93	0.93
15. Repairs at home	4	12	15	7	3	1	3.17	1.07
16. Service (of e.g. skis, bicycle, motorbike)	4	17	15	3	2	1	3.44	0.95
17. Technical hobbies	2	9	21	6	3	1	3.02	0.94
18. Own learning objectives and self-evaluation	17	15	8	1	-	1	4.17	0.83

APPENDIX 4

FREQUENCY DISTRIBUTIONS, MEANS, AND STANDARD DEVIATIONS OF LEARNING METHODS (N=42)

Question	Frequency 5	4	3	2	1	-	Mean value	Standard deviation
1. Group work	19	17	3	1	1	1	4.27	0.90
2. Looking for information independently	22	15	4	-	-	1	4.44	0.67
3. Taking own responsibility of distance work	7	22	11	1	-	1	3.85	0.72
4. Working with operating instructions and manuals	3	15	17	3	3	1	3.29	0.98
5. Studying through a foreign language	16	17	5	2	1	1	4.10	0.97
6. Studying and exploring	8	13	15	3	2	1	3.54	1.05
7. Active study tours to enterprises	11	11	13	5	-	2	3.70	1.02
8. Partnership between school and enterprise	5	14	15	5	2	1	3.37	1.02
9. Evaluating own work and learning activities	9	14	15	2	1	1	3.68	0.96
10. Copying after model	1	6	16	13	5	1	2.63	0.97
11. Serial work (line production)	-	-	11	19	11	1	2.00	0.74
12. Taking part in competitions and shows	2	14	14	9	2	1	3.12	0.98

APPENDIX 5

FREQUENCY DISTRIBUTIONS, MEANS, AND STANDARD DEVIATIONS OF LEARNING CONTENTS (N=42)

Question	Frequency 5	4	3	2	1	-	Mean value	Standard deviation
1. Wood technology	6	16	16	4	-	-	3.57	0.86
2. Metal technology	4	17	13	7	1	-	3.81	0.96
3. Plastic technology	5	11	18	8	-	-	3.31	0.92
4. Hobby crafts	3	12	16	8	2	1	3.15	0.99
5. Electricity and electronics	11	23	6	1	1	1	4.07	0.72
6. Information technology	19	16	5	2	-	-	4.24	0.85
7. Mechanics	6	17	12	6	-	1	3.56	0.92
8. Permitted electric work	7	16	12	3	4	-	3.45	1.15
9. Repairs of furniture and home	6	12	13	10	1	-	3.29	1.07
10. Other technical work at home	5	18	12	6	1	-	3.48	0.97
11. Repairs and service of hobby equipment	7	15	10	5	1	4	3.58	1.03

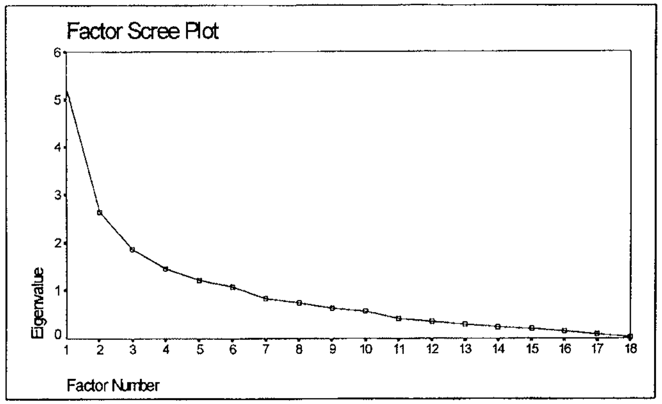
APPENDIX 6

CORRELATION MATRIX OF THE OBJECTIVES DOMAIN

	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18
1	1.00																	
2	.08	1.00																
3	.32	.27	1.00															
4	.07	.29	.04	1.00														
5	.32	.21	.14	.27	1.00													
6	.15	.51	.51	.07	.16	1.00												
7	.05	.18	.08	.13	.09	.14	1.00											
8	.41	.18	.34	.30	.33	.42	.27	1.00										
9	.23	.22	.31	-.00	.12	.55	.36	.76	1.00									
10	.08	-.05	.13	-.07	.03	.37	.02	.22	.38	1.00								
11	.36	-.15	.47	-.11	.12	.25	.18	.41	.55	.34	1.00							
12	.19	.40	.17	.45	.23	.29	.29	.27	.23	.24	.09	1.00						
13	.24	.45	.11	.17	.56	.39	.05	.26	.20	.01	.27	.25	1.00					
14	.23	.26	.05	-.02	.43	.36	.13	.32	.34	.12	.33	.21	.77	1.00				
15	.24	.12	.06	-.09	.47	.14	.05	.25	.22	.21	.36	.28	.60	.71	1.00			
16	-.02	.22	-.13	.18	.46	.16	.19	-.02	-.02	.14	-.01	.48	.55	.48	.68	1.00		
17	.32	.09	.03	.00	.26	.36	.08	.36	.30	.40	.36	.42	.41	.47	.43	.46	1.00	
18	.21	.02	.36	.21	.07	.09	-.03	.24	.15	.03	.23	-.19	-.04	-.18	-.31	-.34	-.03	1.00

Kaiser-Meyer-Olkin Measure of Sampling Adequacy =.54317

Bartlett Test of Sphericity = 363.01297. Significance =.00000



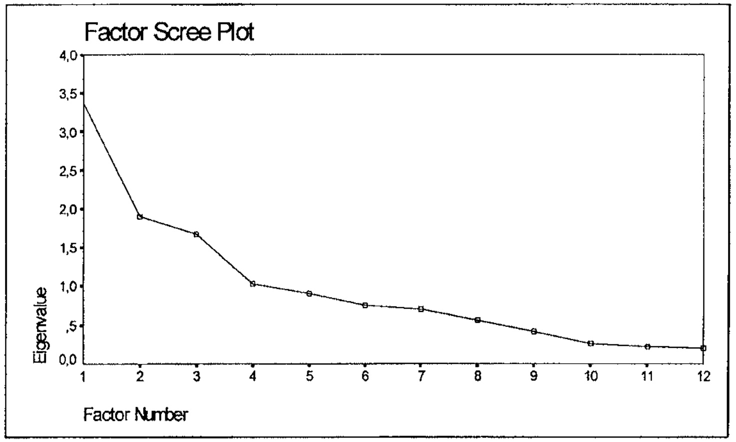
APPENDIX 7

CORRELATION MATRIX OF THE METHODS DOMAIN

	1	2	3	4	5	6	7	8	9	10	11	12
1	1.00											
2	.19	1.00										
3	.03	.49	1.00									
4	.03	.26	.51	1.00								
5	.04	.18	.43	.46	1.00							
6	.24	.34	.12	.31	.16	1.00						
7	.31	.01	-.00	.17	.18	.17	1.00					
8	.20	-.03	-.01	.21	-.11	.28	.55	1.00				
9	.47	.25	.17	.20	.08	.42	.21	.37	1.00			
10	.30	.13	.20	.59	.25	.21	.30	.39	.18	1.00		
11	.13	-.08	-.01	.33	.11	-.21	.16	.22	-.01	.61	1.00	
12	.20	.08	.06	.07	.21	.19	.34	.34	.07	.24	.22	1.00

Kaiser-Meyer-Olkin Measure of Sampling Adequacy = .60451

Bartlett Test of Sphericity = 143.96767. Significance = .00000



APPENDIX 8

CORRELATION MATRIX OF THE CONTENT DOMAIN

	1	2	3	4	5	6	7	8	9	10	11
1	1.00										
2	.49	1.00									
3	.47	.75	1.00								
4	.54	.50	.60	1.00							
5	.55	.62	.63	.51	1.00						
6	-.05	.49	.20	.05	.28	1.00					
7	.23	.51	.32	.22	.26	.34	1.00				
8	-.02	.12	.23	.20	-.07	-.15	.35	1.00			
9	.22	-.03	.04	.14	-.07	-.19	.09	.60	1.00		
10	.18	.02	.08	.17	-.08	-.22	.06	.70	.77	1.00	
11	.39	.11	.06	.34	.04	-.27	-.12	.43	.54	.67	1.00

Kaiser-Meyer-Olkin Measure of Sampling Adequacy = .66772

Bartlett Test of Sphericity = 209.45835. Significance = .00000