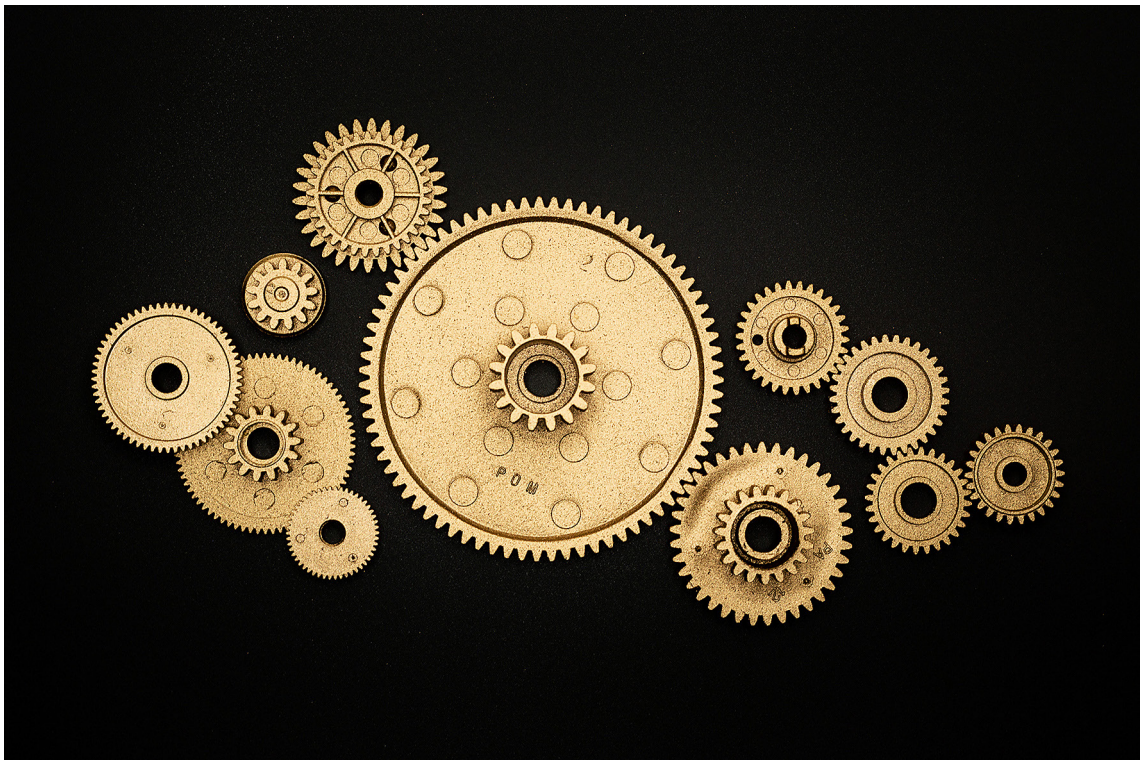
JYU DISSERTATIONS 388

Timo Salminen

Promoting student argumentation by computer-supported instructional methods



UNIVERSITY OF JYVÄSKYLÄ
FACULTY OF EDUCATION AND PSYCHOLOGY

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ABSTRACT

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This study examined how general upper secondary school students engage in argumentation in computer-supported learning environments. The study also examined how well different instructional methods, supported by network tools, promote students' argumentation skills. Further, the study sought to clarify what factors are associated with students' argumentation. Two teaching experiments were included in the curriculum. In the first experiment, students (n = 17) engaged in dyadic argumentation by combining structured and ordinary chat discussions with argument visualisation. In the second experiment, students (n = 27) engaged in face-to-face dyadic argumentation and ordinary computer chat in a role play design in which they defended either their personal standpoint or a standpoint assigned to them. In Teaching experiment 1, the data comprised 16 dyadic chat discussions, 16 argument diagrams, and 16 feedback questionnaires on the use of various computer tools. In Teaching experiment 2, the data comprised 12 dyadic face-to-face discussions and 12 chat discussions. Data were analysed using both qualitative and quantitative methods.

The results showed that students were able to engage in constructive and critical argumentation in both computer-based and face-to-face environments. The students constructed arguments and counterarguments in about one third of their speech turns, dealt with disagreements constructively during their discussions and were able to analyse the salient argumentative content of their chat discussion and capture its argumentative structure in diagrams. The environmental topics (vivisection, nuclear power, genetically modified organisms) set for discussion generated critical argumentation, and the use of network tools made for greater equality in argumentative communication between females and males. The results also showed that female students, more than male students, preferred to defend a standpoint in line with their personal opinion on the topic. Finally, the study showed that argument visualisation, structuring a discussion by argumentation templates, and role play are viable instructional methods to support student argumentation.

Keywords: argumentation, argument visualisation, counterargumentation, chat, computer support, instructional methods, role play, upper secondary school

TIIVISTELMÄ (ABSTRACT IN FINNISH)

Salminen, Timo
Opiskelijoiden argumentoinnin edistäminen verkko-oppimisympäristössä
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Tutkimuksen tavoitteena oli selvittää, miten lukiolaiset argumentoivat, kun heidän työskentelyään tuetaan 1) yhdistelemällä chattia ja argumentoinnin visualisointia, 2) käyttämällä täydennettäviin ja valmiisiin puheenvuorovaihtoehtoihin perustuvaa chattia ja 3) soveltamalla roolipelimenetelmää, jossa opiskelijat puolustivat joko henkilökohtaista tai heille annettua kantaa keskusteluaiheesta. Lisäksi tutkimuksessa tarkasteltiin, ovatko keskustelun aihe, sukupuoli ja keskustelun toteutustapa (tavanomainen chatti, strukturoitu chatti, kasvokkaiskeskustelu) yhteydessä opiskelijoiden argumentointiin. Tutkimuksessa järjestettiin kaksi opetuskokeilua. Ensimmäisessä opetuskokeilussa 17 lukiolaista väitteli pareittain eläinkokeista ja sukupuolten välisestä tasa-arvosta verkossa käyttäen tavanomaista ja strukturoitua chattia sekä kahta erilaista argumentoinnin visualisointityökalua. Toisessa opetuskokeilussa 27 lukiolaista väitteli pareittain ydinvoimasta ja geenimuuntelusta kasvokkain ja käyttäen tavanomaista chattia. Väittelyt toteutettiin roolipelinä siten, että mahdollisimman moni opiskelija puolusti omaa henkilökohtaista kantaansa keskusteluaiheesta. Tutkimusaineisto koostui ensimmäisen opetuskokeilun 16 pariväittelystä, 16 argumentaatiokaaviosta ja 16 palautekyselystä sekä toisen opetuskokeilun pariväittelyistä, joista 12 käytiin kasvokkain ja 12 verkossa chattaillen. Aineisto analysoitiin käyttäen sekä laadullisia että määrällisiä menetelmiä. Tutkimus osoitti, että lukiolaiset kykenevät rakentavaan argumentointiin ja vasta-argumentointiin sekä verkossa että kasvokkain. Vasta-argumentointistrategioiden käyttö oli enimmäkseen dialogista ja yhteisöllistä argumentointia tukevaa. Opiskelijat kykenivät myös analysoimaan käymiensä keskustelujen keskeisen argumentatiivisen rakenteen ja esittämään sen argumentointikaaviona. Ympäristöteemat saivat aikaan kriittistä argumentointia, ja keskustelujen käyminen verkossa tasoitti sukupuolten välisiä eroja kommunikoinnissa. Tulosten mukaan lukiolaisilla näyttäisi olevan sellaista argumentatiivista osaamista, joka antaa heille mahdollisuuden osallistua kriittiseen ja elaboroivaan, oppimista edistävään argumentoivaan keskusteluun. Opiskelijoiden keskustelujen visualisoiminen, chattailyn tukeminen puheenvuorovaihtoehtojen avulla ja roolipelimenetelmän soveltaminen ovat tulosten perusteella pedagogisesti toimivia tapoja edistää opiskelijoiden argumentointitaitoja.

Asiasanat: argumentointi, argumentoinnin visualisointi, chatti, lukio, roolipeli, tietokonetuetut opetusmenetelmät, vasta-argumentointi

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Jyväskylä, May Day 2021
Timo Salminen

LIST OF EMPIRICAL STUDIES

Sub-study I
Salminen, T., Marttunen, M., & Laurinen, L. 2010. Visualising knowledge from chat debates in argument diagrams. Journal of Computer Assisted Learning, 26(5), 379–391. DOI: 10.1111/j.1365-2729.2010.00354.x

Sub-study II
Salminen, T., Marttunen, M., & Laurinen, L. 2012. Argumentation in secondary school students' structured and unstructured chat discussions. Journal of Educational Computing Research, 47(2), 175–208. DOI: 10.2190/EC.47.2.d

Sub-study III
Salminen, T., & Marttunen, M. 2018. Defending either a personal or an assigned standpoint: Role play in supporting secondary school students' argumentation face to face and through chat. Journal of Argumentation in Context, 7(1), 72–100. DOI: 10.1075/jaic.17015.sal

The author of this thesis was the lead researcher in all three sub-studies. He prepared the manuscripts for the individual articles by taking into consideration feedback, comments, and suggestions from his co-authors. He was also responsible for collecting and analysing the data. In all sub-studies, the co-authors had advisory roles in interpreting the results.

FIGURES

TABLES

CONTENTS

1 INTRODUCTION

Argument is the soul of an education. (Neil Postman)

Argumentation in educational contexts does not usually just happen without planning. This dissertation study[1] examined activities in which general upper secondary school students were expected to engage constructively in argumentation in computer-supported learning environments.

This study has to do with the requirements, goals, and values of educators and the skills and competencies that students need to succeed in their studies and lives in a digital world both now and in the future. More specifically, the digital networked world of the 21st century presents educators with the challenges of identifying students' learning needs and finding ways of realising these (Voogt, Erstad, Dede, & Mishra, 2013). It is widely agreed that the so-called 21st-century competencies needed for living and acting in present-day and future societies include collaboration, communication, digital skills, problem-solving, critical thinking, creativity, productivity, and citizenship (e.g., Binkley et al., 2012). Among other things, many of these competencies require argumentation skills. Argumentation, in turn, is one of the most common forms of human interaction and an essential part of our daily lives. It is often related to individuals' beliefs and actions (e.g., Facione, 2000; Hornikx & Hahn, 2012; Mercier & Sperber, 2011; Voss & Van Dyke, 2001). We engage in argumentation, for example, when seeking probable or potential truth in situations of uncertainty, justifying our thoughts, or resolving communicative or cognitive conflicts in order to make sense of the world (e.g., Baker, 1999). We also use argumentation as a pragmatic

[1] This dissertation study has its origins in the SCALE (Internet-based intelligent tool to Support Collaborative Argumentation-based Learning in secondary schools) project funded by the European Community. The primary goal of the project was to develop a learning environment with network tools that could support collaborative argumentation-based learning at the secondary school level. I had an opportunity to work in this eight-partner project (London University, UK; Université Lumière Lyon 2, FR; Utrecht University, NL; University of Jyväskylä, FI; Ecole Nationale Supérieure des Mines - St Etienne, FR; Armines - SIMMO, FR; Számalk Systemhouse Ltd, HU) participated in. The data used in the present three sub-studies were collected during, and mainly served, the SCALE project. I was permitted to draw on these data for this dissertation.

and rhetorical means to achieve our goals, for example, to convince our interlocutors to accept our point of view. The importance of teaching students to solve problems, think critically, and become active citizens is also included in the Finnish school curricula (e.g., Finnish National Agency for Education, 2020; see also Litosseliti, Marttunen, Laurinen, & Salminen, 2005; Marttunen, Laurinen, Litosseliti, & Lund, 2005). To achieve these ends, we seek to develop students' argumentation skills and competence. The ability to engage in constructive argumentation, for example, by discussion either face to face or digitally, is an important skill in various workplaces and community contexts (e.g., Coffin & O'Halloran, 2009).

However, research results, such as those reported by Kuhn, Wang, and Li (2011), show that many students do not see argumentative interaction as having the potential to enhance their individual or collective understanding. For this reason, Kuhn et al. (2011) suggest that educators should pay attention to engaging students in argumentation with the aim of increasing their understanding of the value and potential of argumentation for learning. Several studies have shown that students' argumentation skills at different school levels are inadequate (e.g., Chan, 2001; Felton, 2004; Kuhn, Shaw, & Felton, 1997; Kuhn & Udell, 2003, 2007; Larson, Britt, & Larson, 2004; Marttunen et al., 2005; Mikkonen, 2010; Osborne, Erduran, & Simon, 2004; Reznitskya et al., 2001; Stein & Bernas, 1999; Zeitler, 1997; see also Utriainen, Marttunen, Kallio, & Tynjälä, 2017). Researchers and educators have, however, invested considerable effort in responding to these challenges. Developing university students' face-to-face and online argumentation skills (Marttunen, 1997; Salminen, Laurinen, & Marttunen, 2002), exploring how diagrams support argumentation-based learning (van Amelsvoort, 2006), discussing argumentation in the context of online reading at the upper secondary level (Kiili, 2012; Marttunen, Salminen, & Utriainen, in press) and elementary level (Hämäläinen et al., 2020; Kiili et al., 2018), solving open-ended problems in education programmes for students in social services (Vapalahti, 2017; Vapalahti & Marttunen, 2020), and developing university students' collaborative argumentation-based writing skills (Nykopp, Marttunen, & Erkens, 2019) are all examples of efforts designed to enhance students' argumentation.

This dissertation study is a continuation of these endeavours to increase our understanding of the feasibility of different instructional methods in promoting students' argumentation in the educational context. Specifically, it addresses the question of *how students engage in argumentative discussions and activities in computer-supported learning environments*. The focus is on how three different instructional methods – chat discussion combined with argument visualisation, structured discussion, and a role play design – enhance students' engagement in argumentation. In addition, the study examines whether discussion topic, student gender, and the variance in personal opinion on the topic are associated with students' argumentation.

2 AIMS OF THE STUDY

The purpose of the present study was to examine how general upper secondary school students' engage in argumentation in computer-supported learning environments. The study also aimed at developing instructional settings, supported by network tools, to enhance students' argumentative discussions. Specifically, the aims of the study were the following:

1) to examine how students engage in argumentation in various learning environments;
2) to increase understanding of different instructional methods designed to enhance students' argumentation;
3) to find out what factors are associated with students' argumentation.

This research project comprises three sub-studies. *Sub-study I* examined whether combining chat discussion and construction of an argument diagram stimulates students to deepen and broaden their argumentation. The study also examined differences in quality between argumentation incorporated in freely constructed versus modified argument diagrams. In addition, the study investigated the students' opinions on the usefulness of the different chat and argument diagrams tools when practising argumentation. *Sub-study II* investigated whether structured interaction supports students' critical and elaborative argumentation in dyadic discussions implemented through online chat facilities. The quality of students' critical and elaborative argumentation was examined by clarifying how they constructed arguments, dealt with disagreements by deploying particular counterargumentation strategies, and directed and managed their interaction during structured and ordinary (unstructured) chat discussions. The study also aimed to ascertain whether the mode of chat, discussion topic, or gender were associated with students' argumentation. *Sub-study III* examined whether a role play design in which the students defended either their personal standpoint or a standpoint assigned to them supported their face-to-face and chat argumentation conditions. The study also aimed to find out to what extent discussion topic, study mode, or gender were associated with students' argumentation.

3 ARGUMENTATION IN EDUCATIONAL SETTINGS

He, who knows only his side of the case, knows little of that. (John Stuart Mill)

This dissertation research focuses on argumentation in educational settings. The study was designed to better understand how students engage in argumentation with the help of technology. This chapter starts by defining argumentation and then proceeds to a closer discussion on the role of counterargumentation in argumentation and learning. Next, the relationship between argumentation and learning is deepened by introducing the concept of collaborative argumentation and the literature on argumentation for learning. Finally, computer-support for argumentation (although the aspect of technology to some extent runs though the former sections as well) and certain pedagogical and instructional methods to foster and support argumentation-based learning are discussed.

3.1 Defining argumentation

Argumentation as an interdisciplinary field of study has mainly been studied from the viewpoints of logic, rhetoric, and dialectic (e.g., van Eemeren et al., 1996). In (formal) logic, argumentation has been studied for normative purposes, i.e., whether the reasoning set out is valid and sound (e.g., through judging the use of logical rules) in order to establish the truth of propositions and conclusions, often through the use of symbolic language. Rhetoric, in turn, focuses on argumentation techniques (e.g., ethos, pathos, and logos as forms of rhetorical appeal) used to persuade and convince others. Dialectics involves the study of opposing viewpoints in a discourse (e.g., a debate, a critical discussion) with the aim of reaching a truth or an agreement via reasoned arguments. Dialectics also emphasises the importance in educational argumentation and knowledge construction of counterargumentation and the handling of counterarguments (e.g., Andriessen, Baker, & Suthers, 2003; Nussbaum & Schraw, 2007).

These three approaches to argumentation are also involved in informal logic (e.g., Blair & Johnson, 1987; Johnson & Blair, 2000) and pragma-dialectics (van Eemeren & Grootendorst, 1984, 1992, 2004) both of which underline the role of natural language-based argumentation in different contexts and the use of argumentation *in practice*, including in pedagogical situations. The informal logic approach, for example, has influenced the way students are taught to reason and think critically, such as by putting forward logical arguments, analysing and evaluating arguments, or displaying the structure of an argument (for an overview, see Johnson, 2006). The pragma-dialectical approach in turn (in addition to its pragmatic and dialectical dimensions) focuses, in particular, on the social and dialogical nature of argumentation, as essentially it is a theory of argumentation in dialogue (see Baker, 2015; Vapalahti, 2017). Pragma-dialectics can be used, for example, in analysing the structure of students' argumentative discussion (e.g., argument chains) and the content of students' elaboration of argumentative knowledge during a discussion.

These different approaches to argumentation are also reflected in the various definitions of argument and argumentation. Some definitions refer to the logical nature of argumentation or the process of reasoning while others highlight the dialectic nature of argumentation, i.e., the importance of taking a critical stance towards a discussion topic and inspecting rival and divergent arguments. In addition to these definitions, other definitions of argumentation emphasise the rhetorical nature of an activity, or include all these aspects.

An argument has been briefly defined as a concluding statement justified by at least one reason (Angell, 1964), or as a set of one or more reasons for doing something, such as accepting a proposition (Blair, 2012) or seeking to persuade or convince someone to accept a claim (Johnson, 2000). For Toulmin (1958), an argument consists of at least three fundamental components, i.e., claim, grounds, and warrant, where a claim is supported by grounds and the warrant explains how the grounds support the claim.

Argumentation, in turn, has been briefly defined as a process of making and presenting arguments, i.e. giving reasons for or against something (Golanics & Nussbaum, 2008; cf. Toulmin, 1958; Voss, 2005; Wolfe & Britt, 2008), as a generation and evaluation of arguments (Voss & Means, 1991), or as a critical discussion of divergent claims (Isohätälä, Näykki, Järvelä, & Baker, 2018). Argumentation has also been defined as "a verbal, social and rational activity aimed at convincing a reasonable critic of the acceptability of a standpoint by advancing a constellation of propositions justifying or refuting the proposition expressed in the standpoint" (van Eemeren, 2001, p. 11; van Eemeren et al., 1996). Moreover, from the point of view of learning, good educational argumentation, according to Kruger (1993), consists of the collaborative use of transactive reasoning including criticism, explanation, justification, clarification, and elaboration of ideas in order to investigate and evaluate arguments, evidence, and alternative perspectives. The last two of these definitions stress that argumentation is a social and interactive process, not only an individual act.

In this dissertation study, founded on a pragma-dialectic approach, argumentation is defined as a social process in which students construct and critique arguments together (cf. Nussbaum, 2008, p. 348), that is, put forward reasons for and against claims to gain a better understanding of the issue of interest. Here, students' argumentation is examined by analysing the structure of their argumentative discussions, argument elaboration, and counterarguments.

3.2 Counterargumentation

The importance of counterargumentation has been widely emphasised in argumentation theories, research on argumentation, and in learning. In Toulmin's structural model of argumentation (1958), a key part of the process of building a sound argument is dealing with counterarguments and objections. However, several scholars (e.g., Andriessen, 2006; Jonassen & Kim, 2010; Leitão, 2001; van Eemeren, Grootendorst, & Kruiger, 1987) criticise Toulmin's model by stating that it mainly focuses on the proponent's side, minimises the opponent's side, and does not take into account the discursive and dialogic nature of argumentation. Walton's dialogue theory (1989) for critical thinking answers this criticism. According to Walton, skilled argumentation requires that the arguer pays attention to the opponent's position and seeks to challenge it both by trying to secure commitments from the opponent that can be used to support one's own argument and by identifying and challenging weaknesses in the opponent's argument. Both Toulmin's and Walton's argumentation frameworks highlight that "every argument has two sides to be considered, the pro and con of argument" (Walton, 1989, p. 169). In fact, argumentation can be seen as a dialogue between proponents of alternative claims during a discussion, also known as a dialectical argumentation (Barth & Krabbe, 1982; van Eemeren & Grootendorst, 1992). Similarly, Baker (1999, p. 182) defines argumentation as "a verbal communicative interaction in which the dialectical dimension is present".

Many researchers (e.g., van Eemeren & Grootendorst, 1984; Stein & Miller, 1993) point out that the existence of a recognised disagreement about an issue is a prerequisite for argumentation to be developed (Coirier, Andriessen, & Chanquoy, 1999). A disagreement is an expression of doubt; questioning expresses a neutral point of view – a claim can be either true or false (Walton, 2006). Effective argumentation involves not only producing arguments to support one's position but also considering counterarguments, and evaluating and combining arguments and counterarguments, and so arrive at a final position (Nussbaum & Schraw, 2007).

However, in the learning context, learners may ignore views that are incompatible with their own view on the issue (Jonassen & Kim, 2010), avoid generating counterarguments in writing (e.g., Leitão, 2003) as well as in face-to-face and computer-mediated discussions (e.g., Koschmann, 2003), and seek to avoid conflict, confrontation, and tension in general (e.g., Andriessen, Pardijs, & Baker, 2013). Several studies (Chan, 2001; Dawson & Carson, 2017; Felton & Kuhn, 2001;

Kuhn, 1991; Kuhn & Udell, 2003; Leitão, 2003; Perkins, Farady, & Bushey, 1991; Stapleton, 2001; Wolfe & Britt, 2008; Wolfe, Britt, Petrovic, Albrecht, & Kopp, 2009) have shown that people – adults, adolescents, and children – experience difficulties, particularly in counterarguing; it is difficult for people to think about alternative theories, counterarguments that support their theories, and to think of and give rebuttals to them. Instead, people tend to focus their efforts on their own position neglecting counterclaims and other perspectives, a behaviour known as myside bias (Perkins, 1985, 1989; Perkins et al., 1991). It seems that some people have not realised the benefits of counterargumentation in communication and learning. For example, previous studies have shown that in an online environment, the practice of counterargumentation is related to better quality of discussion (Andriessen et al., 2003). Further, the willingness of participants to disagree has been found to be related to better performance in collaborative problem-solving (Erkens, Andriessen, & Peters, 2003). In addition, the integration of arguments and counterarguments in order to reach a conclusion involves evaluating, refuting, and synthesising arguments, processes which have been observed to be important for learning (Shehab & Nussbaum, 2015).

Many instructional methods have been developed and investigated by scholars and teachers to overcome the above-mentioned obstacles to the use counterargumentation as a constructive strategy in communication and learning. Over the past 15-20 years, in particular, numerous online environments and computer-based tools have been developed and studied for the purposes of teaching and supporting argumentation, and learning through argumentation (see e.g., Hirsch, Saeedi, Cornillon, & Litosseliti, 2004; McAlister, 2004; Noroozi et al., 2012; Scheuer, Loll, Pinkwart, & McLaren, 2010; Wolfe et al., 2009). Such instructional support has focused on knowledge representation tools and various means to guide and structure, or has even stipulated, students' learning activities and interaction, such as the use of collaboration scripts, prompts, and sentence openers (Noroozi et al., 2012). Previous studies (e.g., Veerman, 2000) have, however, shown that if such support focuses solely on direct forms of argumentation, such as claiming, backing, challenging, or counterarguing, the outcome for student learning is weaker than if students' are also stimulated to engage in indirect forms of argumentation, such as information checking, explaining, evaluating, summarising, and transformation. For these reasons, when planning effective argumentative activities for learning, the objectives, tasks, and pedagogical methods to be used are crucial.

3.3 Argumentation for learning

Jointly engaging, critically but constructively, with each other's ideas through argumentative discussion has been seen as a prerequisite for collaborative learning (e.g., Mason, 1998; Mercer, 1996). In collaborative learning, students not only construct and transform their own knowledge (Bereiter & Scardamalia, 1989) but

also co-construct and create new knowledge structures together (Dillenbourg, 1999).

Engaging in collaborative argumentation may be productive for learning because participants have to react to what others say. As a method, collaborative argumentation can be used to promote learning that is based on striving towards a common goal as a result of acquiring a better understanding of the issues in question through putting forward different points of view, claims and arguments and exploring these in depth and critically (Andriessen et al., 2003; Baker, 2003; Litosseliti et al., 2005; Marttunen & Laurinen, 2002; Marttunen et al., 2005; Vapalahti, 2017; cf. van Eemeren & Grootendorst, 2004). Collaborative argumentation is the exchange of justified ideas, evaluating and judging reasons, and elaborating and (re)constructing knowledge together with another, or others, in dialogue with the aim of broadening and deepening understanding of the issue at stake. In other words, collaborative argumentation can be seen as knowledge transformation that takes place together with one or more other persons to gain a better understanding of the space of the debate on the issue in question, that is, through arguing to learn argumentative knowledge (van Amelsvoort, Andriessen, & Kanselaar, 2007). In collaborative knowledge transformation and construction during the process of argumentative activity, students explore different subtopics, viewpoints, and perspectives on the discussion topic, arguments associated with these by relating these previously unrelated viewpoints and arguments to each other and elaborating already stated arguments. Such elaboration can happen, for example, by giving an example to justify an argument or by challenging an argument with counterarguments. Thus, transformations broaden and deepen argument chains on the levels of topic, perspective, and argumentation (van Amelsvoort et al., 2007).

Constructive argumentation in educational contexts occurs in most cases through dialogue. Arguing together with another person is a dialogical collaborative process in which the interlocutors build a consensus by testing the validity of each other's ideas and viewpoints by, in particular, the use of counterargumentation (Coffin & O'Halloran, 2009; Muller Mirza & Perret-Clermont, 2009). To enter fully into such a process of argumentation requires both intrapersonal and interpersonal skills (Muller Mirza, Perret-Clermont, Tartas, & Iannaccone, 2009) such as the ability to hear and consider others' points of view as well as just one's own, relate one's point of view to the views of others, and provide justification and evidence for one's arguments.

Research on educational argumentation has focused on students' ability to generate and evaluate arguments (e.g., Kuhn, 1991), how students' ability to argue emerges (e.g., Stein & Albro, 2001), students' argumentative discourse (e.g., Baker, Andriessen, Lund, van Amelsvoort, & Quignard, 2007; Clark, Sampson, Weinberger, & Erkens, 2007), how engaging in argumentation benefits content learning (see e.g., Schwarz, 2009), and how different instructional methods may promote argumentation and learning through argumentation (e.g., Clark et al., 2010; Marttunen, 1997; Nussbaum & Schraw, 2007; van Amelsvoort, 2006; Veer-

man, 2000) (Chinn & Clark, 2013). These research areas highlight the twofold relationship between learning and argumentation, namely, the learning-to-argue approach (e.g., Kuhn et al., 1997; Voss & Means, 1991; Zohar & Nemet, 2002) and the arguing-to-learn approach (e.g., Andriessen, 2006; Andriessen et al., 2003; Andriessen & Coirier, 1999; Munneke-de Vries, 2008; van Amelsvoort, 2006). Both of these approaches are relevant when studying educational argumentation such as students' argumentative discourse.

Learning to argue refers both to the acquisition of general skills, such as justifying, reasoning, challenging, counterchallenging, or conceding (Andriessen et al., 2003; Schwarz, 2009), and to other educational benefits of argumentation such as developing critical thinking skills (see Nussbaum & Schraw, 2007; Shehab & Nussbaum, 2015) and argumentative literacy skills (see Kiili, Mäkinen, & Coiro, 2013; Newell, Beach, Smith, & VanDerHeide, 2011). Engaging in argumentation can improve learners' ability to argue, but without instruction the benefits are likely to remain small (Kuhn et al., 1997). Practising argumentation may also increase learners' intrinsic motivation especially among students who find controversy inherently interesting (Johnson & Johnson, 1979). However, argumentation can also foster aggressive verbal interaction and promote a confrontational style of discourse that could hinder learning (Chinn, 2006). A style of that kind seems to be more characteristic of boys, while girls may find it uncomfortable (Anders & Commeyras, 1998; Carr, Cox, Eden, & Hanslo, 2004; Prinsen, Volman, & Terwel, 2007).

Arguing to learn, in turn, refers to achieving a specific goal, such as conceptual understanding, the construction of knowledge, or clarifying misconceptions through argumentation, i.e., learning as an outcome of argumentative activity (Andriessen et al., 2003; Rapanta, Garcia-Mila, & Gilabert, 2013; Schwarz, 2009). Such learning may occur through four mechanisms: making knowledge explicit, conceptual change, co-elaboration of new knowledge, and increased articulation (see Andriessen, 2006; Baker, 2004). Argumentation often contains explanations to make reasoning more explicit and understandable; argumentative "talk" or defence (when counterclaims exist) of this kind induces and fosters reflection that may lead to learning, for example, through conceptual change and understanding other points of view. Argumentation may also lead students to generate links between ideas, including the different viewpoints and arguments associated with these, and their prior knowledge (Wittrock, 1992). Thus, argument elaboration may also lead to learning. Argumentation increases the ability to articulate because students need to express and explain their ideas, formulate questions, and organise their own knowledge and argument chains during argumentative activities.

This doctoral research study draws on both the learning to argue and arguing to learn approaches, as both serve the aim of clarifying the structure of general upper secondary school students' argumentative discussions, that is, how students argue, counterargue, and manage their interaction during arguing in pairs. Drawing on the learning to argue approach, the study evaluates the educational benefits of different methods of teaching argumentation through two

teaching experiments. In turn, drawing on the arguing to learn approach, the study clarifies how students develop and elaborate their argumentation while performing set tasks.

3.4 Computer-supported argumentation

This chapter discusses, first, computer-supported learning and argumentation. This is followed by a discussion on the challenges presented by designing this kind of learning activity. Finally, the methods of structuring and visualising argumentation used to enhance student argumentation in this study are discussed.

Information technology has been developed and used over many years to support students' engagement in learning activities. For example, Scardamalia and Bereiter designed and implemented a networked system, Computer Supported Intentional Learning Environment (CSILE, later known as Knowledge Forum), for knowledge building as early as the 1980s (see e.g., Scardamalia & Bereiter, 1994; Scardamalia, Bereiter, McLean, Swallow, & Woodruff, 1989). Jonassen (1996) later proposed the use of computers and computer applications as cognitive mind tools to enhance learner engagement in critical thinking and meaningful learning. Consequently, learning together with others using support from computers, widely known as computer-supported collaborative learning (CSCL), has been a growing research area since the 1990s (e.g., Dillenbourg, Järvelä, & Fischer, 2009). The increasing interest in this specific research area is justified by the recent shift in the concept of learning that emphasise the importance of learners' joint activities above that of their work as individuals, the changes in work-life that highlight the role of networked expertise, and the rapid development of digital technology and applications for educational purposes (e.g., Clark et al., 2010; Koschmann, 1996; Lipponen, 2001; Stahl, Koschmann, & Suthers, 2006; Strijbos, Kirschner, & Martens, 2004). The positive effects of CSCL have been demonstrated in numerous studies. In their meta-analysis, Chen, Wang, Kirschner, and Tsai (2018) synthesise the research findings on the effects of CSCL of 425 empirical studies published between 2000 and 2016. The results show that collaboration per se, the use of computers, the incorporation of extra learning environments or tools, and various supporting strategies (e.g., role assignment, peer feedback, facilitation by the teacher) had positive effects on individual knowledge gains, individual skill acquisition, individual perceptions, group task performance, and social interaction.

Collaborative learning and interaction, however, do not usually happen in the absence of carefully design. Learners' willingness to engage in social interaction and argumentation cannot be taken for granted, and social interaction cannot be confined to cognitive processes to the neglect of socio-emotional and social processes (Kreijns, Kirschner, & Jochems, 2003). Furthermore, argumentation in itself may impose an additional cognitive burden on learners since it is a demanding activity requiring high-level interaction and collaboration in which participants need, e.g., to formulate their own arguments, examine and criticise other

people's arguments as well as consider how to respond to counterarguments presented by other people (e.g., Dillenbourg & Bétrancourt, 2006; Kuhn & Udell, 2003). Designing learning activities based on argumentation is, thus, a difficult task. In spite of the importance of having a debatable topic (Golder & Pouit, 1999), the productivity of argumentation ultimately depends on the level of the participants' engagement in interaction (Andriessen & Schwarz, 2009). This means that educational argumentation is highly sensitive to context, i.e., to what kind of social interaction emerges, what kinds of tools are available, and what kinds of goals and argumentation skills the participants possess (Schwarz, Neuman, Gil, & Ilya, 2003). To help to take these notions into account when designing computer-supported collaborative learning methods, Strijbos, Martens, and Jochems (2004) presented a model of the critical elements that affect the quality of interaction. This model can also be utilised when designing productive argumentative activities for educational purposes.

The critical elements included in the design model by Strijbos, Martens, and Jochems (2004) are, first, that we need to determine the learning objectives and the expected nature of the interaction (or changes expected in the interaction), since in the case of argumentation these are intertwined; argumentation as an open and complex skill depends on the nature of the students' reciprocal interaction, i.e., how students react and build on each other's contributions in order to learn about a given topic. Next, a suitable task type needs to be selected. Many argumentative tasks are so-called ill-structured tasks (Jonassen, 1997) without a clear-cut solution but requiring a lot of argumentation, negotiation, and discussion of multiple points of view. Finally, in order to ensure appropriate collaboration and interaction, we need to determine whether and how much interaction needs to be pre-structured. In addition, the optimal group size and appropriate computer support with respect to the design elements mentioned above need to be determined. The importance of taking care when designing learning activities based on computer-supported collaborative argumentation is also mentioned in numerous empirical studies in the review by Scheuer et al. (2010).

Computer applications can be used to generate learning by, for example, scaffolding and structuring socio-cognitive processes for knowledge sharing and argumentative knowledge building (Lipponen, 2002; Scardamalia & Bereiter, 1994), structuring argumentative interaction (e.g., Jeong & Lee, 2008), promoting in-depth argumentative discussions (Andriessen et al., 2003), and deepening and broadening students' argumentative knowledge about an issue (Andriessen et al., 2003) or the space of debate (van Amelsvoort, 2006). More specifically, computer support in argumentation-based learning environments has mainly focused on scaffolding learners' interaction, for example, with sentence openers, prompts, or scripts, and the visualisation of argumentative interaction and knowledge (see e.g., Kirschner, Buckingham Shum, & Carr, 2003; the review by Noroozi et al., 2012).

In this study (Sub-study I), student engagement in argumentation in pairs was supported by combining two synchronous chat tools with an argument visualisation tool. One of the chat tools was an ordinary synchronous textual chat

tool and the other, a structured chat tool, was based on sentence openers that support students' engagement in argumentation both socially and cognitively. The students also used diagrams as a means to analyse, elaborate, and visualise their argumentation. In Sub-study II, students' structured and unstructured synchronous dyadic chat discussions were compared in order to ascertain whether structuring an interaction is beneficial for productive argumentation. In Sub-study III, student engagement in the argumentative discussion in pairs was supported by the synchronous chat tool using a role play design to contrast the variation in stands on the topic.

3.4.1 Structuring argumentation

When working collaboratively with the help of computers, structuring interaction seems to be an effective means of supporting learning activities. Vogel, Wecker, Kollar, and Fischer (2017) have reviewed several studies (articles published 2005-2012) on students' collaborative activities guided by computer technology. They concluded that, compared to unstructured CSCL, learning through structured CSCL leads to a small positive effect on domain-specific skills and to a large effect on collaboration skills.

Structuring argumentative discussions has been found to be an appropriate means to both support and ease the problems of synchronous computer-based interaction, such as lack of focus, incoherence of contributions, insufficient feedback, dispersion of discussion, and the weak elaboration of arguments (e.g., Baker & Lund, 1997; Burnett, 2003; Hron, Hesse, Cress, & Giovis, 2000; Oehl & Pfister, 2010; Pimentel, Fuks, & de Lucena, 2003; Weger & Aakhus, 2003). In particular, structuring students' communication has been found to encourage counterargumentation, for example, by using note starters or sentence openers in the context of online discussion (McAlister, 2004; Nussbaum et al., 2004) or by using Web-based counterargumentation tutor during argumentative reading and writing (Wolfe et al., 2009).

In practice, structuring an online discussion or other interactive activity from the point of view of argumentation has been actualised by focusing mainly on argument construction and managing an ongoing activity. The quality of argumentative activities can be said to rely on these cognitive skills and processes (cf., Felton, 2004). For example, Ravenscroft (2007) reviewed some of the dialogue environments that structure and promote argumentative practices for learning. These environments include, for example, a task sequence with argumentative activities such as questioning and challenging designed to promote inquiring, reasoning, and knowledge construction. Yeh and She (2010) found that students' online synchronous argumentation was supported by the Toulmin templates (Toulmin, 1958) for the components of argumentation (data, claim, warrant, backing, and rebuttal) and by writing templates for each component (e.g., for rebuttal, "I do not agree with …, because…"). In the present study, the students' synchronous chat discussions were structured by the templates designed for argument construction, exploration, and elaboration, expressing an opinion, and managing and maintaining dialogue (see Hirsch et al., 2004; Sub-study I).

Another means to structure and trigger students' argumentative discussion is role play. Role play can be defined as an arranged learning situation in which participants engage by assuming a viewpoint or character identity that they do not normally adopt (Yardley-Matwiejczuk, 1997). Role play provides a clear socio-cognitive structure and atmosphere for students to engage both cognitively and emotionally in considering multiple perspectives on the issue (Lim et al., 2011; Marttunen & Laurinen, 2001; Vapalahti, 2017). Through role play, students may also become more aware of their own assigned roles and understand more clearly other students' roles and points of view (van Ments, 1989; Vapalahti, 2017). In addition, role play gives students an opportunity to develop their interpersonal skills, such as active listening and collaboration (e.g., Feinstein, Mann, & Corsun, 2002; Holsbrink-Engels, 2001; Russell & Shepherd, 2010) that are needed when engaging in a constructive dialogical argumentative discussion (e.g., Coffin & O'Halloran, 2009; Mercer, 1996).

Previous studies have shown that discussions implemented through role play (vs. without role play) generate more argumentation, stimulate more developed arguments, and reduce cognitive load (Holsbrink-Engels, 2001; Marttunen & Laurinen, 2001, 2002; Simonneaux, 2001; Vapalahti, 2017). Role play has also been found to support students' problem-solving skills and understanding of different viewpoints by increasing consideration of others' perspectives and justifications for the standpoints presented (Vapalahti, 2017). In addition, acting in different argumentative roles in synchronous online discussions, such as challenging others to provide evidence or counterarguments, and asking for explanations, seems to improve the overall coherence, focus and depth of discussions (Pilkington & Walker, 2003). However, for role play to be successful, students need to be motivated and to take their roles seriously (Agboola Sogunro, 2004). For example, when role play is organised around students' own interests (e.g., a familiar topic or a stand), it may promote their engagement in fruitful discussions.

3.4.2 Visualising argumentation

Argument visualisation is based on the idea that we are much better at visualising complexity, such as the complex argumentative structures of debates on societal issues, than cognising it by words alone (van Gelder, 2003). Moreover, combining different ways of representing the same content (e.g., textual and graphical representations) can enable different reasoning processes (Larkin & Simon, 1987), prevent cognitive overload (Sweller, van Merriënboer, & Paas, 1998), and lead to better retention of information than the use of one form of representation alone (Mayer, 2001). These theoretical approaches are described in more detail in Sub-study I.

Argument diagrams have been used as a pedagogical means to visualise argumentation and support students' collaborative argumentation. In argument diagrams, the main components and functions of arguments and their interrelations can be illustrated, for example, by putting claims, arguments, and counterarguments in boxes and connecting these elements with lines or arrows (van Amelsvoort & Schilperoord, 2018). Previous studies have shown that the use of

argument diagrams have several benefits for student learning. Diagrams can help students gain a grip on argumentation as a whole and direct and shape their reasoning (Jermann, 2004), understand how the different elements of an argument are linked to each other and how different argument chains are interlinked (van Amelsvoort, Andriessen, & Kanselaar, 2008), improve their ability to analyse (Harrell, 2011), and evaluate (Schwarz et al., 2003) arguments and related claims, and provoke and guide their interaction and reasoning (Marttunen & Laurinen, 2007; van Amelsvoort et al., 2007). Suthers (2003) concluded that graphical representational tools may influence learners' use of epistemological concepts (e.g., the different components of an argument), evoke more elaboration of salient knowledge units, and guide learners to pay attention to missing knowledge units. The above-mentioned benefits highlight the knowledge-generating function of argument visualisation. In collaborative settings, the use of representations may also help learners to maintain the focus and coherence of argumentative discussions by making the argumentation structure visible (see Schwarz et al., 2003). Diagrams provide learners with an instant overview of the argumentation process (Carr, 2003) and the possible differences in opinions between learners.

Although argument visualisation has many obvious learning-related benefits and several visualisation tools have been developed to support argumentation-based learning, more well-designed empirical research is needed to demonstrate the effectiveness of these tools (van den Braak, van Oostendorp, Prakken, & Vreeswijk, 2006). Bresciani and Eppler (2018), for example, propose a socio-visual approach to evaluate the quality and effects of argument visualisation tools. Their approach underlines the importance of social interaction and collaboration of people involved in complex argumentation processes. The effectiveness of visualisation also depends on the nature of the task at hand and the knowledge level of the learners (Goldman, 2003; van Amelsvoort, 2006). For many students, argument visualisation may be a new activity for which they need training.

4 RESEARCH QUESTIONS

The present study addressed the following research questions:

1) How did students engage in argumentation in computer-based and face-to-face environments?
    a) How did students construct and elaborate their arguments by using various computer-based tools (Sub-studies I, II, and III) and face-to-face (Sub-study III)?
    b) How did students direct and manage their argumentative discussions in different chat environments? (Sub-study II)
    c) How counterargumentative were students' discussions? (Sub-studies II and III)

2) How did counterargumentation appear in students' chat and face-to-face discussions, and argument diagrams?
    a) What kind of counterargumentation strategies did students use in different chat environments (Sub-study II)
    b) What level of counterargumentation was incorporated in the argument diagrams based on chat discussions? (Sub-study I)

3) Were the discussion topic (Sub-studies I, II, and III), gender (Sub-studies II and III), and the variance in stands (one's own vs. assigned) on the topic (Sub-study III) associated with the students' argumentation?

4) How did the use of various instructional methods, i.e., a combination of chat discussion and argument diagrams (Sub-study I), structured discussion (Sub-study II), and the use of a role play design (Sub-study III), support students' argumentation?

The above-mentioned overarching research questions were formed on the basis of the three sub-studies. This dissertation research, aimed at promoting general upper secondary school students' engagement in argumentation, and especially

counterargumentation, is grounded in previous studies on argumentation in educational settings. First, students' argumentation skills have been shown to be inadequate and upper secondary school students have been shown to need more practice especially in their analytical argumentation skills (e.g., Marttunen et al., 2005). Second, although previous studies (e.g., Andriessen et al., 2003; Baker, 1999; Walton, 1989) have emphasised the importance of counterargumentation in communication and learning, people continue to experience difficulties in counterarguing (e.g., Chan, 2001; Kuhn, 1991; Leitão, 2003; Perkins, Farady, & Bushey, 1991). Third, constructive argumentation often occurs through discussions involving several factors. Issues considered of central importance for generating constructive argumentation with peers that have been raised in previous studies include the discussion topic (e.g., Golder & Pouit, 1999; Zohar & Nemet, 2002), gender (e.g., Asterhan, 2018; Harskamp, Ding, & Suhre, 2008; Kreijns, Kirschner, & Jochems, 2003; Sladek, Bond, & Phillips, 2010), and the stands taken by debaters on the topic (e.g., Perkins, 1985). To further investigate and contribute to knowledge on these issues, three computer-supported instructional methods (chat discussion combined with argument visualisation, structured chat discussion, and a role play design) were applied and examined in this dissertation research.

5 METHODS

5.1 Research participants and teaching experiments

Two teaching experiments on student argumentation with computer support were conducted in two Finnish general upper secondary schools (Table 1). In Teaching experiment 1, carried out in one school, data were collected for Sub-studies I and II, and in Teaching experiment 2, carried out in another school, data were collected for Sub-study III. Both teaching experiments were implemented as a part of the general upper secondary school curriculum. Experiment 1 was integrated into a course on mother tongue, i.e., Finnish language and Literature, and Experiment 2 was conducted as a part of a cross-curricular course that combined content drawn from two school subjects, i.e., Finnish language and Religious education.

TABLE 1 Teaching experiments and participants

Teaching experiment	Participants	Instructional method	Working mode	Discussion topic
Experiment 1 (Sub-studies I and II)	17 upper secondary school students; (n = 16 in Sub-study I; n = 17 in Sub-study II)	Combining chat discussion and argument visualisation, Structured chat discussion	Working in pairs using two different chat and two different argument visualisation tools	Vivisection Gender equality
Experiment 2 (Sub-study III)	27 upper secondary school students	Role play	Working in pairs face to face and through chat	Nuclear power Genetically modified organisms

Teaching experiment 1 aimed at exploring student argumentation in the condition of a combination of (ordinary and structured) chat discussion and argument visualisation. Participants were 17 students (10 females, 7 males; age 16–17 years). These 17 students participated in Sub-studies I and II. One student was excluded from the analysis in Sub-study I.

Teaching experiment 2 aimed at examining student argumentation when using a role play design both face to face and through ordinary computer chat. Participants were 27 students (18 females and 9 males; age 16–17 years).

In both teaching experiments, the argumentative discussions were on debatable societal topics (Golder & Pouit, 1999). Debatable topics do not offer objective truths but leave space for negotiations on the multiple perspectives from which the issues in question can be approached. The discussion topics were Vivisection and Gender equality in Teaching experiment 1 and Nuclear power and Genetically modified organisms (henceforth GMO) in Teaching experiment 2. The flow of the teaching experiments are described below in sections 5.1.1 and 5.1.2.

5.1.1 Teaching experiment 1

Since, for practical reasons, the random assignment of participants into experimental and control groups was not possible, a quasi-experimental counterbalanced design (Borg & Gall, 1989; Campbell & Stanley, 1963) was implemented. The teaching experiment was carried out in an authentic school setting following the fixed teaching schedule of the school including the time allocated for the experiment. The experiment and related learning tasks were planned in collaboration between teachers and researchers. Nevertheless, experimental control was achieved by offering the same treatment to all participants (Campbell & Stanley, 1963).

The students were divided into two groups and their discussions carried out in two sessions on two different days with two different chat tools (ordinary and structured chat), two different argument diagram tools, and two topics, Vivisection and Gender equality (Table 2). An equal gender distribution between the groups was set as a grouping criterion.

On both days, the experiment proceeded in five phases (Table 2). On Day 1 the discussion topic was Vivisection and on Day 2 Gender equality. In the *introduction* phase on Day 1, the students practised with the chat tools and were introduced to the discussion topic by completing a cloze test on vivisection. On Day 2, the students were introduced to the topic through a general discussion on gender equality. On both days, in the *preparation* phase, the students prepared themselves for their discussions on the day's topic by reading and analysing three articles containing arguments for and against the topic. While reading the texts, the students were asked to think about the different viewpoints on the topic presented in the texts and the arguments expressed in support of these viewpoints. Preparation for a discussion is important because "one does not argue with anyone, about anything, in any situation" (Golder, 1996), that is, the students must have something to argue about and they should be willing to argue.

TABLE 2 Phases of Teaching experiment 1

Phase	Day 1: Vivisection			Day 2: Gender equality		
	Group 1 (n = 8)	Group 2 (n = 8)	Time allocated (min)	Group 1 (n = 8)	Group 2 (n = 8)	Time allocated (min)
Introduction	Training in use of the chat tools		25	General discussion on Gender equality		20
	Cloze test on Vivisection		10			
Preparation	Reading 3 articles on Vivisection		20	Reading 3 articles on Gender equality		20
Chat discussion	Ordinary chat tool	Structured chat tool	15	Structured chat tool	Ordinary chat tool	15
Diagram construction	Free construction of diagram	Modifying the computer-made diagram	20	Modifying the computer-made diagram	Free construction of diagram	20
Feedback	-	-	-	Answering questionnaire		15

During the *chat discussion* phase, the students engaged either in ordinary or structured chat discussions in pairs on both Day 1 (Vivisection) and Day 2 (Gender equality). The students were tasked with discussing the following claims: "Vivisection should be allowed" / "There is gender equality in Finland" on the basis of the articles they had read previously. The students were paired to maximise the number of mixed gender pairs.

The *diagram construction* phase was carried out in two different ways on both days. After the ordinary chat discussions, the students continued their argumentation by constructing an argument diagram together with their partner on the basis of their chat discussions. They were asked to include in their diagram the most central arguments and counterarguments that emerged during their chat discussion, and to add to the diagram new arguments that emerged during its construction. After the structured chat discussions, the student pairs worked on a diagram automatically produced by the computer during their discussion. They were asked to check that the computer-made diagram was meaningful in content and to modify it if necessary. They were also asked to add new arguments they had not expressed during their discussion.

At the end of the teaching experiment, the students answered a short *feedback* questionnaire on the usefulness of the chat and argument visualising tools.

5.1.2 Teaching experiment 2

In Teaching experiment 2, by the same token as in Teaching experiment 1, a quasi-experimental counterbalanced design (Borg & Gall, 1989; Campbell & Stanley, 1963) was applied. The students were divided into two groups. Grouping criteria were an equal gender distribution between groups and a similar level of skills in argumentation, as tested before the experiment. The students discussed two topics on two different days: Nuclear power on Day 1 and Genetically modified organisms on Day 2. The discussions were carried out face to face and through ordinary chat (Table 3).

TABLE 3 Phases of Teaching experiment 2

Phase	Day 1: Nuclear power			Day 2: Genetically modified organisms (GMO)		
	Group 1 (n = 12)	Group 2 (n = 12)	Time allocated (min)	Group 1 (n = 12)	Group 2 (n = 12)	Time allocated (min)
Preparation	Reading and analysing 5 articles on Nuclear power in five small groups		60	Reading and analysing 5 articles on GMO in pairs		60
Presenting one's individual opinion	Short essay on Nuclear power		30	An argument diagram on GMO		30
Discussion	Face to face	Ordinarychat	20 (F2F) 30 (chat)	Ordinary chat	Face to face	20 (F2F)) 30 (chat)

Experiment 2 proceeded in three phases during both days (Table 3). In the *preparation* phase, the students read and analysed five source articles on the topic. On the topic of Nuclear power (Day 1), the students worked with the articles in small groups (5-6 students/group), and on the topic of GMO (Day 2), they worked in pairs. In the case of the articles on Nuclear power, the students were asked to identify the different stakeholders and their arguments on the topic, and in the case of the articles on GMO, they were asked to find arguments for and against GMO. After working on the articles on both days, the students presented their group analyses to the other groups of students.

In the second phase, *Presenting one's individual opinion*, the students presented their personal opinion on the topic, with justifications, in the form of either a short essay (Nuclear power) or an argument diagram (GMO). Finally, in the *discussion* phase, the students engaged in dyadic discussions so that as many students as possible had the opportunity to defend their personal standpoint. However, the students in each pair had to represent opposite standpoints. As a result

of this principle, in the case of each topic 58% of the students defended their personal standpoint and 42% defended an assigned standpoint during the discussions. The question for discussion on the topic of Nuclear power was "Does Finland need a new nuclear power station?", and the question on GMO was "Should we allow genetically modified organisms or not?" Because of the differences in time demands between face-to-face and written communication, 20 minutes was allocated for the face-to-face discussions and 30 minutes for computer chat discussions.

5.2 Data sources and analyses

In Teaching experiment 1 (Sub-studies I and II), the data consisted of 16 dyadic chat discussions and 16 argument diagrams saved automatically to a file. The data also included 16 feedback questionnaires on the students' experiences of the use of the different chat and argument diagram tools. In Teaching experiment 2 (Sub-study III), the data consisted of 12 dyadic tape-recorded and transcribed face-to-face discussions, and 12 chat discussions saved automatically to a file. The chat and argument diagram tools used in the experiments were components of the digital learning environment developed in connection with an EU-funded research project titled "Internet-based intelligent tool to Support Collaborative Argumentation-based Learning in secondary schools" (see http://scale.emse.fr/).

The data sources and data analyses of the present study are summarised in Table 4. Both qualitative and quantitative methods of analysis were applied in the study.

In the qualitative analysis of verbal utterances, the unit of analysis was a text written in an argument box in the diagram (Sub-study I). The argument boxes were analysed by first differentiating the claims, arguments, counterarguments, refutations of counterarguments, and their interrelations (Björk & Räisänen, 1996), then by clarifying the breadth, balance, and depth of argumentation (Lund, Molinari, Séjourné, & Baker, 2007), and finally, by calculating a numerical estimate of the counter-argumentativeness of the argument diagram. Furthermore, the origin, transfer, and elaboration of ideas presented in the argument boxes in the diagrams were analysed in order to clarify how the students further elaborated their argumentation after the chat discussions (see Marttunen & Laurinen, 2007). In Sub-study I, the students' feedback questionnaires on the usefulness of the different chat and argument diagram tools were also analysed.

TABLE 4 Summary of the data analyses

	Teaching experiment 1		Teaching experiment 2
	Sub-study I	Sub-study II	Sub-study III
Aim	To examine how students recapitulate the argumentative content of chat discussions and further develop their argumentation in diagrams	To examine the quality of argumentative discussions through argument construction, discourse management, and the use of counterargumentation strategies	To study the quality of argumentation in students' role play discussions through argumentativeness and argument elaboration
Data sources	8 dyadic ordinary chat discussions (420 speech turns in total), 8 dyadic structured chat discussions (189 speech turns in total), 8 freely constructed argument diagrams (108 argument boxes in total), 8 modified diagrams (97 boxes in total), 16 feedback questionnaires	8 dyadic ordinary chat discussions (420 speech turns in total) 8 dyadic structured chat discussions (189 speech turns in total)	12 dyadic face-to-face discussions (1 044 speech turns in total) 12 ordinary chat discussions (1 373 speech turns in total)
Design of the study	Quasi-experimental counterbalanced design	Quasi-experimental counterbalanced design	Quasi-experimental counterbalanced design
Unit of analysis	Argument box in a diagram, Response of feedback questionnaire	Speech turn	Speech turn
Qualitative analysis	Differentiating argumentative structure of diagrams (claims, arguments, counterarguments, and their interrelations), Content analysis of feedback questionnaires	Classifying speech turns into categories of argument construction and discourse management, Categorising counterarguments by counterargumentation strategies	Classifying speech turns into categories of argumentativeness and argument elaboration
Statistical methods	Kruskal-Wallis test, Mann-Whitney test	Logit analysis	Logit analysis

In Sub-study II, in order to analyse the quality of the students' argumentative discussions, the speech turns presented during chat discussions were classified into the two categories of argument construction and discourse management (see Felton, 2004). Furthermore, to examine the quality of their counterargumentation, the students' speech turns indicating justified disagreement were sub-categorised into three counter-argumentation strategies (Leitão, 2000).

In Sub-study III, the speech turns presented during the face-to-face and chat discussions were analysed for argumentativeness and argument elaboration (see Baker et al., 2002, 2007). For argumentativeness, the categories were *Argumentative*, *Counterargumentative*, and *Non-argumentative*, and for argument elaboration the categories were *Poor*, *Good*, and *No elaboration.*

In the quantitative data analyses for Sub-study I, Kruskal-Wallis and Mann-Whitney tests were used to explore differences between the different argument diagrams. Further, Logit analysis was used to study whether the independent variables *Mode of chat, Topic*, and *Gender* in Sub-study II, and *Standpoint*, *Topic, Study mode*, and *Gender* in Sub-study III were associated with the dependent variables of the argumentative quality of the discussions.

6 SUMMARIES AND RESULTS OF THE SUB-STUDIES

This dissertation research examined how general upper secondary school students engage in argumentation and argumentative activities for learning through computer-supported instructional methods. This chapter summarises the three sub-studies and their main results. Sub-studies I and II report the results of Teaching experiment 1, and Sub-study III the results of Teaching experiment 2.

6.1 Visualising knowledge from chat debates in argument diagrams (Sub-study I)

The aim of Sub-study I was *to examine whether combining chat discussion and the construction of an argument diagram stimulates students to develop the quality of their argumentation*. General upper secondary school students (n = 16) were asked to recapitulate the argumentative content of their previous dyadic chat debate and to further develop their argumentation on the topic by freely constructing an argument diagram or by modifying an argument diagram made automatically by a computer.

The students' freely constructed (n = 8) and modified diagrams (n = 8) were analysed for their argumentative structure and the origin, transfer and elaboration of the ideas presented in them. The *argumentative structure* of the diagrams was defined by the breadth, balance, and depth of the argumentation given, and the level of counterargumentativeness of the diagrams was assessed. The *origin of the ideas* presented in the diagrams was determined and classified into three categories: 1) the chat debate, 2) the previously read texts on the topic, and 3) prior knowledge. The *transfer and elaboration of* ideas were classified into four categories: 1) copied, 2) slightly modified, 3) revised, and 4) added as a new argument. Statistical analyses were used to test the differences between the four types of argument diagrams, i.e., the free and modified diagrams on each of the two

discussion topics, Vivisection and Gender equality, were tested using various statistical methods.

The results for *the structure of argumentation* of the diagrams showed that on average the student pairs either directly supported or criticised the main thesis with 3.6 arguments (Breadth). The means for the different types of diagrams varied from 2.3 for the modified diagrams on vivisection to 5.0 for the free diagrams on gender equality. The results also showed that the diagrams were, to some extent, unbalanced in the number of arguments for and against the main claim: the mean for the balance of argumentation varied from 0.8 to 2.0 where the value 0 indicates complete balance, i.e., the number of arguments for and against the main claim is equal. The argument chains (Depth) ranged from 2.2 to 4.4 in length (M = 2.9). However, the different types of diagrams did not differ in the breadth, depth, and balance of argumentation. The differences in counterargumentativeness between the diagrams were statistically significant. The modified diagrams on vivisection were, on average, more counterargumentative than the modified diagrams on gender equality ($U = 0.00$; $p < .05$).

The results for *the origin of the ideas presented in the diagrams* showed that in the free diagrams, 59% of the content originated from the students' preceding chat debates, 30% from the set texts, and 11% from the students' prior knowledge. In turn, in the modified diagrams, 90% of the content originated from the debates, 3% from the texts, and 7% from prior knowledge. These results suggest that free construction of argument diagrams seems to activate students to integrate previously read content into their co-constructed diagrams.

Examination of how the students *transferred and elaborated* their arguments in the diagrams revealed that the students' most common way of constructing arguments was to revise the contents of the arguments presented in their previous chat debates (40%). The second most common way was to add a new argument (29%), and the third most common way was to copy content directly from the related chat debates (26%). In the free diagrams, revising arguments presented in the debates (44%) and adding a new argument to a diagram (44%) were equally common ways to elaborate arguments. In the modified diagrams, in turn, the corresponding proportions were 34% and 13%. The students most often left intact the arguments automatically copied by the computer (51%). Moreover, the proportion of content directly copied from the debates to the free diagrams was only 5%.

The students also mostly presented their arguments in the diagrams in the same order as they presented them in their debates. This finding suggests that students usually construct argument diagrams in a narrative way (van Amelsvoort et al, 2007). Further, when constructing or modifying their diagrams, the students focused mainly on the content of the arguments and less often on the links between the arguments in the different argument chains. This suggests that students should be encouraged to pay more attention to the visual organisation of arguments in argument diagrams. They could also be assigned a more

specific purpose for formulating argument diagrams, such as utilising them in a writing task.

The results of the students' feedback questionnaires on the usefulness of the different chat and argument diagrams tools showed that most of the students (13 of 16) did not like the structured chat tool in which they had to choose their speech turns from ready-made options. They found it difficult to find a suitable response option (12 of 16), and almost all students (14 of 16) wanted more response options. However, many students (10 of 16) mentioned that they often chose the same response options. In the case of the argument diagram tools, the students found it easy both to freely construct diagrams (12 of 16) and to modify the ready-made computer-based diagrams (11 of 16). Many students (10 of 16) reported that constructing argument diagrams helped them to understand the discussion topic from more diverse viewpoints and to better discern the argumentative structure of their debate (14 of 16). Overall, the students found that constructing diagrams was useful when learning argumentation skills (11 of 16).

To conclude, the results of this study suggest that students are able to analyse the salient argumentative content of a debate in which they are participants, capture its argumentative structure, and visualise it in a diagram. These activities foster students' co-elaboration of knowledge. However, revising automatically constructed diagrams seems to be an inadequate way of evoking knowledge work and higher-order thinking in students. From the point of view of learning, it is important that technical tools are not allowed to do the requisite cognitive work on behalf of students.

6.2 Argumentation in students' structured and ordinary chat discussions (Sub-study II)

The aim of Sub-study II was *to examine whether dyadic discussions through structured and unstructured (ordinary) online chat affect the quality of students' argumentation*. The quality of students' argumentation was examined by clarifying how students constructed arguments, how they used various counterargumentation strategies, and how they directed and managed their interaction. In addition, the study aimed to clarify whether the mode of chat, discussion topic, or gender affected argumentation quality.

For the analyses, the students' speech turns (n = 609) were classified into two argument construction categories (*Argument*, *Justified disagreement*) and five discourse management categories (*Request, Opinion, Agreement or unjustified disagreement, Comment, Off-task*). To examine how the students presented counterargumentation, their speech turns indicating justified disagreement were sub-categorised into three categories showing different kinds of counterargumentation strategies: *Supporting the opposite position*, *Questioning the truth of a claim or a statement*, and *Questioning a reason-position link*. Logit analyses were used to clarify whether Mode of chat, Topic, and Gender were associated

with the students' argument construction, discourse management, and counter-argumentation strategies.

The results showed that the students constructed arguments in 17% and presented justified disagreements in 20% of their speech turns. In 63% of their speech turns they managed and stimulated their interaction by presenting comments (29%), opinions (12%), requests (10%), agreements or unjustified disagreements (7%), and off-task speech turns (5%).

The logit analyses of the students' argument construction showed that the students produced more arguments in the discussions on gender equality than on vivisection (21% vs. 14%) and that girls produced more arguments than boys (21% vs. 13%). In addition, during the structured chat, the students expressed justified disagreements nearly as often on both topics (22% vs. 21%). During the ordinary (unstructured) chat, in turn, justified disagreements were more common on vivisection than gender equality (28% vs. 12%).

The logit analyses of the students' discourse management showed that when engaging in structured chat, the students presented both requests (17% vs. 7%) and agreements or unjustified disagreements (15% vs. 3%) more often than in ordinary chat. In contrast, opinions were more common during ordinary than structured chat (16% vs. 3%).

The students most often used "Questioning a reason-position link" (46%) as their counterargumentation strategy. The second most often-used strategy was "Supporting the opposite position" (32%), and the least used strategy was "Questioning the truth of a claim or a statement" (22%). The logit analyses showed that the students used the strategy "Supporting the opposite position" more often in the discussions on vivisection than those on gender equality (9% vs. 4%) and that boys used this strategy more often than girls (9% vs. 5%). The logit analyses also showed that during the ordinary chat, boys questioned the truth of a claim or a statement more often than girls (5% vs. 3%). In contrast, girls used this strategy more often than boys during the structured chat (9% vs. 1%). In addition, the counterargumentation strategy "Questioning a reason-position link" was more common in the discussions on vivisection than on gender equality (12% vs. 7%).

The results indicated that secondary school students are able to construct and manage their argumentative chat discussions as argumentation was incorporated in almost half (47%) of their speech turns: the students presented arguments in 17%, justified disagreements in 20%, and stimulated their argumentative discussion by requests in 10% of their speech turns. The proportion of off-task talk was also low (5%). Furthermore, when the students presented justified disagreements, they also used constructive and dialogic counterargumentation strategies, i.e., "Questioning a reason-position link" and "Questioning the truth of a claim or a statement" more often than the unconstructive strategy "Supporting the opposite position" (68% vs. 32%). The two first-mentioned strategies enable collaborative knowledge construction in a dialogue, as they are focused on the other person's arguments and position. The third strategy focuses on one's own position and does not bring the merits of the interlocutor's arguments into

question; it cannot, therefore, be regarded as a constructive and dialogic means of argumentative knowledge construction.

The results also indicated that the mode of chat, topic, and gender were all associated with the quality of the argumentative discussions. A structured chat environment also seemed to evoke counterargumentation on topics that do not spontaneously provoke conflicting viewpoints, like gender equality. Further, structuring a discussion seems to level out gender differences in communication, in particular by allowing girls to employ a more adversarial communication style than they would normally use.

6.3 Defending either a personal or an assigned standpoint: Role play in supporting students' argumentation face to face and through chat (Sub-study III)

In Sub-study III, general upper secondary school students (n = 27) engaged in dyadic debates on environmental issues both face to face and through ordinary computer chat. The aim of the study was *to examine whether a role play design in which the students defended either their personal standpoint or a standpoint assigned to them supported their argumentation*. The study also aimed to examine whether discussion topic, study mode, or gender affected students' argumentation quality.

The quality of the students' argumentation was examined by analysing their speech turns (n = 2417) for argumentativeness and argument elaboration. The analysis categories for argumentativeness were *Argumentative*, *Counterargumentative*, and *Non-argumentative*, and for argument elaboration *Poor elaboration*, *Good elaboration*, and *No elaboration*. Logit analyses were used to study whether the standpoint (either one's own or assigned), topic, study mode, and gender were associated with students' argumentativeness and argument elaboration.

The results showed that about a third (33%) of the students' speech turns included argumentation: 25% of these were categorised as counterargumentative and 8% as argumentative. However, the majority (67%) of their speech turns were non-argumentative in nature. These non-argumentative speech turns consisted of descriptive topic-related (36%), interaction management (15%), task management (3%), social relations (3%), and off-task (10%) talk. Further, 83% of the students' speech turns contained no elaboration of arguments and 17% either good or poor elaboration of arguments. Of the elaborative speech turns, nearly three quarters (74%) were coded as good elaboration and one quarter (26%) as poor elaboration.

The logit analyses on the associations of role play with argumentation quality showed that when the students defended an assigned standpoint (a standpoint contrary to their personal opinion on the topic), the female students produced counterargumentative speech turns less frequently (22% vs. 42%) and non-argumentative speech turns more frequently (72% vs. 50%) than the male students. However, when defending their personal standpoints, the female and

male students produced both counterargumentative (26% vs. 27%) and non-argumentative (65% vs. 65%) speech turns equally often. The logit analyses also showed that when the students defended their personal standpoints, they produced poorly elaborated arguments more often than when their standpoint was assigned to them (5% vs. 3%).

On the quality of the students' argumentation, the logit analyses showed that the students presented more argumentative speech turns on the issue of GMO than on that of nuclear power (10% vs. 6%). Furthermore, the male students produced more counterargumentative speech turns when discussing GMO than females (22% vs. 16%), whereas when discussing nuclear power, the situation was the reverse, favouring females (40% vs. 34%). In addition, males produced counterargumentative speech turns more often during the face-to-face discussions than females (31% vs. 21%). During the chat discussions, however, males and females produced counterargumentative speech turns almost equally often (26% vs. 28%). Further, the students produced non-argumentative speech turns more often during the face-to-face than chat discussions (69% vs. 64%). The logit analyses also showed that when discussing the GMO topic, females produced more non-argumentative speech turns than males (75% vs. 67%), whereas when discussing the nuclear power topic, the situation was the reverse (55% vs. 59%).

On the elaboration of arguments, the logit analyses showed, first, that the students' argument elaboration was more frequently poor on the nuclear power than GMO topic (7% vs. 5%). Second, when the topic was nuclear power, males put forward non-elaborative speech turns more often than females (84% vs. 79%, whereas the reverse (80% vs. 85%) was observed for GMO.

The results suggest that students tend to elaborate their arguments more when they defend a standpoint assigned to them than when defending a standpoint in line with their personal opinion. Thus, assigning students roles in an argumentative discussion that do not represent their personal opinions seems to be a viable means of enhancing students' understanding of the topic. The results also suggest that for female students, it seems to be important to be able to defend one's personal opinion on the topic when engaging in argumentative discussions, while for males this is not such an important issue. Thus, to promote learning, it seems to be fruitful to use mixed gender pairs and to select topics that encourage females, in particular, to argue. In addition, the study suggests that gender differences in argumentative communication may be levelled out using a network environment.

7 DISCUSSION

This dissertation research examined how general upper secondary school students engaged in argumentation and counterargumentation (RQ1&2) and what factors were associated with their argumentation in computer-supported learning environments (RQ3). The study also examined specific instructional methods (RQ4) for enhancing students' argumentation ability as a learning tool.

7.1 Student engagement in argumentation and counterargumentation

The results of this study indicate that general upper secondary school students were able to engage in constructive argumentation in both computer-based and face-to-face environments. First, it was found that the students constructed arguments and counterarguments in about a third of their speech turns, 37% in Sub-study II and 33% in Sub-study III. Second, during the discussions, 17% of the students' speech turns contained requests, for example, for arguments, counterarguments, and justifications (Sub-study II) and elaboration of arguments (Sub-study III). It was also found that students were able to analyse the salient argumentative content of their discussion and capture its argumentative structure in diagrams (Sub-study I).

The results also indicated that students were especially able to engage in counterargumentation as they produced justified disagreements in 20% of all their speech turns in Sub-study II, and even more (25%) in their speech turns in Sub-study III. Further, they rebutted a large proportion of all the claims and arguments presented in the diagrams by presenting a counterargument (Sub-study I). In addition, students presented justified disagreements in a constructive way during their debates: they more often questioned the reason-position links and the truth of claims or statements (68%) than merely supported positions opposed (32%) to those presented in their interlocutors' speech turns (Sub-study II). These

two afore-mentioned counterargumentation strategies – *Questioning a reason-position link* and *Questioning the truth of a claim or a statement* – are dialogical and productive ways of constructing knowledge collaboratively, as they bring the merits of the interlocutor's arguments into question, whereas the counterargumentation strategy of *Supporting the opposite position* cannot be considered a dialogical way to think critically as it focusses solely on the position of one person.

These results suggest that upper secondary school students are capable of arguing together in a way that produces relevant and elaborated arguments and deals with questioning through counterargumentation regardless of whether these argumentative activities take place face to face or in computer-supported environment. Thus, students have the potential to acquire effective educational argumentation skills (Kruger, 1993; Nussbaum & Schraw, 2007; van Amelsvoort et al., 2007), leading to possible learning gains through both the "arguing to learn" and "learning to argue" approaches (Andriessen et al., 2003).

Although several of the studies cited in Chapter 3.2 suggest that learners often struggle with counterargumentation regardless of whether they are discussing a topic verbally or in writing, the present results show the opposite: general upper secondary school students may already possess a level of argumentative competence (Kuhn, 1991; Perkins, 1989; Perkins et al., 1991) that enables them to sustain constructive argumentation and reasoning through counterargumentation. This result may be due to the instructional methods and task designs used in this study to generate productive and dialogical argumentation, i.e., argument visualisation, argument/counterargument templates to structure a chat discussion, a debate as a form of discussion, and role play.

7.2 Associations of the discussion topic, gender, and variance in stands with students' argumentation

In this study, students' conducted argumentative discussions on four *topics*: Vivisection, Nuclear power, Genetically modified organisms (GMO), and Gender equality. The first three of these topics are polarised environmental topics, offering debaters clear positions for or against the proposition. Gender equality, however, did not offer students clear conflicting viewpoints and for or against positions.

The results showed that environmental issues were viable debatable topics (Golder & Pouit, 1999) for generating productive argumentation and counterargumentation. This result is supported by the fact that the students' discussions were more counterargumentative on vivisection than on gender equality, as shown by their argument diagrams (Sub-study I) and ordinary chat discussions (Sub-study II). This was the case even though the students put forward fewer arguments on vivisection than gender equality in the chat discussions. However, during the structured chat, the students expressed counterarguments nearly as

often on both topics. Thus, structuring a chat discussion also seems to generate counterargumentation on topics that do not spontaneously provoke conflicting viewpoints, such as gender equality in this study. Students also need to practise argumentation on topics that do not offer clear for or against positions, because many current societal questions, such as climate change, deal with complex problems that require multifaceted examination and the construction of arguments from multiple points of view. For example, Christenson (2015) investigated upper secondary students' argumentation on socioscientific topics, such as gene technology and environmental issues, and concluded that students are able to draw on multiple subject areas in their argumentation. In addition, using authentic problems that resonate with learners' daily lives has been noticed as a motivational means to enhance students' argumentation (Zohar & Nemet, 2002) and critical literacy skills (Coiro, 2017).

The *gender*-relatedness of specific discussion topics should be taken into account when seeking to induce educational argumentation. The present results suggest that, compared to GMO, the topic of nuclear power stimulated female more than male students to engage in counterargumentative and elaborative argumentation (Sub-study III). The topics set in Sub-study II, Vivisection and Gender equality, also seemed to prompt more argumentation from female than male students. Several studies have reported that, in general, females exhibit stronger attitudes and behaviour towards environmental issues than males (e.g., Milfont & Sibley, 2016; Uitto et al., 2011; Xiao & McCright, 2015; Zelezny, Chua & Aldrich, 2000). However, to generate good argumentation it is also important that students have adequate knowledge on the topic to be discussed (e.g., Mason & Scirica, 2006) and that they are confident about that knowledge (see e.g., Noroozi, Hatami, Mulder, & Biemans, 2017).

The results also suggest that gender differences in argumentative communication may be levelled out using online chat discussion (Sub-study II and III). That is, female students may use a more adversarial communication style when discussing a topic online than they would normally use, a behaviour resulting in more equal communication between females and males. Equal and mutual argumentation between females and males may also, owing to its nature, be more exploratory, and hence through, e.g., counterargumentation, lead to joint knowledge construction (see Mercer, 1996). These results are in line with those of previous studies. For example, Erkens and Janssen (2008) found that female students used more argumentative dialogue acts (reasons and conclusions) than males when communicating synchronously online. Similarly, Sullivan, Kapur, Madden and Shipe (2015) found that secondary school students, neither females nor males, used a gender-stereotypical communication style when engaging in the discussions online.

Gender differences may, however, also facilitate constructive argumentative communication. Previous studies (e.g., Prinsen et al., 2007) found that males display a more adversarial, assertive, and competitive communication style compared to females, who are often more task-focused and willing to collaborate. In

an argumentative discussion situation these gender-related differences in communication styles may mean that males provoke female participants to debate and to present arguments both for and against the issue, while females, in turn, may maintain the argumentative discussion with male participants and promote argument elaboration through their tendency to be collaborative (see Robertson, Hewitt, & Scardamalia, 2003; Sub-study II and III). Previous studies have also shown that both female (Ding, Bosker, & Harskamp, 2011) and male students (Zhan, Fong, Mei, & Liang, 2015) benefit from mixed-gender study groups when participating in knowledge elaboration processes in CSCL settings. In the present study, mixed-gender pairs were used as a grouping criterion in Sub-studies I and II.

In Sub-study III, students defended either their personal *standpoint* or a standpoint assigned to them when they engaged in argumentative debates on the set topics. The study revealed that when the aim is to achieve productive argumentation on an issue, variance in personal opinion on the topic matters. This was especially important for the female students, who preferred to defend a standpoint in accordance with their personal opinion. The results showed that females presented more non-argumentative and fewer counterargumentative speech turns than males when defending a standpoint which was not their own. For the male students, it did not seem to be important whether or not they were obliged defend their personal opinion on a topic. In general, males prefer rational reasoning, and females experiential reasoning, which refers to, for example, experiences of affects, positive emotions, and avoidance of negative emotions (e.g., Sladek, Bond, & Phillips, 2010). In the present study, when defending a stand counter to their personal opinion, the female students may have sought to avoid the negative emotions that can arise in a situation that disturbs their beliefs (Ben-Ze'ev, 1995). In addition, people often tend to focus on their own position, avoiding other perspectives and counterclaims, a phenomenon known as myside bias (e.g., Perkins, 1985). Myside bias may also be one reason that prevents female students from defending a stand assigned to them. Previous studies have also shown that students' argumentative abilities may be fostered when using authentic problems that relate to their lives (e.g., Zeitler, Sadler, Applebaum, & Callahan, 2009) or when discussing topics of personal relevance to them (e.g., Udell, 2007).

As Kreijns, Kirschner and Jochems (2003) point out, gender differences in students' interaction should not confined solely to cognitive processes, thereby neglecting socio-emotional and social processes. In fact, the high-level cognitive processes, such as justifying, elaborating, and reasoning, needed in constructive argumentation, have been shown to depend on socio-emotional processes that support collaboration between learners (e.g., Baker, Andriessen, & Järvelä, 2013; Rogat & Adams-Wiggins, 2015). This means, for example, knowing how to express disagreement in a constructive way during collaborative argumentation and how to sustain a critical discussion instead of avoiding confrontation and tension (Isohätälä et al., 2018). In the present study, the structured chat templates were based on regular patterns of argumentative strategies (see Sub-study I) and

consisted of, for example, critical questions and explorations in relation to arguments presented during discussion.

7.3 Supporting students' argumentation

In this study, students' argumentation was supported by various instructional methods: argument visualisation by diagrams, structuring chat discussions by argumentation templates, and role play.

Argument visualisation. When the students' task was to co-construct an argument diagram on the basis of their preceding chat debates, they were able to analyse, capture and modify the salient argumentative content and structure of their discussions for inclusion in their diagrams. Students also seemed to benefit from argument visualisation in terms of knowledge activation and integration, since the student pairs also integrated previously read information, and to some extent also their prior knowledge, into the diagrams. These results are in line with the notion that a combination of text and graphics supports learning (Mayer, 2001) and text comprehension (King, 2007), as students have to process text propositions (such as arguments) with visual elements.

The student pairs also revised automatically constructed computer-based argument diagrams, although this task did not help them activate their previous knowledge and develop their ideas further. One explanation for this result may be that learners need to be motivated to act productively with each other in a collaborative situation (e.g., Häkkinen & Mäkitalo-Siegl, 2007). In this study, the specific purpose for reformulating and utilising automatically constructed diagrams remained unclear, and thus some students may have experienced the task as non-motivating. One way to motivate students to utilise argument diagrams is via a writing task (e.g., a joint essay) in which they can use their own previously constructed diagrams (see e.g., Kiili, 2013). Similarly, Howell, Butler and Reinking (2017) report an instructional intervention in which high school students used digital tools to construct multimodal arguments as a part of their argumentative writing. The students found the intervention to motivate and help them formulate better arguments.

Another explanation for the students' failure to activate their previous knowledge or develop their ideas when revising the computer-made diagrams may be that although computer tools may support students' productive argumentation, the automatic diagram tool did a large part of the requisite cognitive work on the students' behalf, a factor which does not promote learning. For this reason, when aiming at enhancing students' skills to argue and argue to learn through argumentative discussions, an argumentative design (Andriessen & Schwarz, 2009) and an educational rationale (Salomon, 2016) are necessary. This means designing learning situations in which students participate actively and collaboratively in producing and elaborating arguments on topics that motivate them to continue their argumentation, and in which appropriate computer tools

can be incorporated into suitable tasks (see Chapter 3.4; Strijbos, Martens, & Jochems, 2004).

Despite the above-mentioned disadvantages of the automatic diagram tool, the students, according to their feedback, felt that the argument diagrams helped them to more deeply understand the discussion topic and the different viewpoints associated with it. The diagrams also helped them to figure out the structure of their argumentative discussions. Thus, argument visualisation and representational tools can be regarded as promising means to support argumentation-based learning. Nowadays, many students also increasingly use online sources when studying and learning. However, the use of online sources requires students to evaluate critically, compare, and integrate ideas from multiple sources and perspectives (Leu, Kinzer, Coiro, Castek, & Henry, 2013). To support students' skills to synthesise arguments from various sources when exploring controversial issues on the Internet, a representational tool (An Online Inquiry Tool) has recently been developed (Kiili, Coiro, & Hämäläinen, 2016) and successfully implemented both in upper secondary (Kiili, Coiro, & Räikkönen, 2019; Murphy, Coiro, & Kiili, 2019) and university education (Pirttimaa, Kiili, & Marttunen, 2016). In addition, to further understanding of the pedagogical benefits of argument diagrams, recent research has focused on the extent to which students are able to use perceptual cues, i.e., the spatial, graphical, and textual elements of argument diagrams (van Amelsvoort & Maes, 2016; van Amelsvoort & Schilperoord, 2018) when they create, read, and interpret diagrams. Another increasingly popular way of employing visual argumentation artefacts as cognitive tools is to use infographics to enhance students' discipline-based argumentation skills. In science education and teaching, for example, infographics are commonly used and have been found to be suitable representations to construct and state argumentative knowledge (e.g., Gebre, 2018; Walsh & McGowan, 2017).

Finally, enhancing students' argument visualisation skills can also be seen as enhancing digital skills and competence (e.g., Ilomäki, Paavola, Lakkala, & Kantosalo, 2016). Namely, understanding how to use and apply digital technologies and tools in a meaningful way in education can be seen as one of the more important 21st –century competencies (Binkley et al., 2012; Ilomäki et al., 2016). This issue is also highlighted in the new national core curriculum for general upper secondary schools in Finland (The Ministry of Education and Culture; https://minedu.fi/en/general-upper-secondary-education).

Structuring a discussion. The students' argumentative discussions were structured by using a chat tool with argumentation templates (Sub-studies I and II) and by role play (Sub-study III). The results revealed that, irrespective of the discussion topic, the use of argumentation templates (argument construction, exploration and elaboration, expressing an opinion, managing and maintaining dialogue; Sub-study I; cf. Hirsch et al., 2004) increased students' counterargumentation, and the kind of discussion management that sustains argumentative interaction, such as making requests and expressing disagreement. As mentioned previously, the argumentation templates also seemed to equalise argumentative discussion between females and males by offering females an opportunity to

adopt a more adversarial communication style than the one they would normally use. Overall, the structured chat tool guided the learners to consider first what they wanted to say and only then to choose a suitable template for their statement. This may increase the quality of argumentation and hence also of the discussion.

When the students' discussions were structured by the role play design (personal standpoint vs. assigned standpoint), the results indicated that role play enhanced argument elaboration when students were defending an assigned standpoint counter to their personal opinion on the topic. Co-elaboration and increased articulation, i.e., the need to express and explain ideas and organise knowledge and arguments, have been proposed as mechanisms that, through argumentation, promote learning (Andriessen, 2006; Baker, 2004). The role play design used seemed to favour the male students, as they were able to engage in argumentation irrespective of whether or not they were defending their personal opinion. The female students, in contrast, were better able to engage in argumentative discussion when asked to defend their personal opinion on the discussion topic. The success of educational argumentation is known to be sensitive to context (Schwarz et al., 2003), and thus, careful attention should be paid to how argumentative activities are designed (Scheuer et al., 2010; Strijbos, Martens, & Jochems, 2004).

To sum up, structuring a discussion or other activities in CSCL settings has been shown to be an effective means to enhance learning, especially when the structuring supports learners' transactive actions, for example, their mutual elaborative and critical argumentation (see e.g., Vogel et al., 2017). Structuring has also been found a good way of supporting the development and exploration of ideas and arguments in chat-based communication (e.g., Burnett, 2003; Hron et al., 2000; Oehl & Pfister, 2010; Pimentel et al., 2003; Weger & Aakhus, 2003). In addition, structuring students' discussions via role play has been shown to generate constructive argumentation (Holsbrink-Engels, 2001; Marttunen & Laurinen, 2001, 2002; Simonneaux, 2001; Vapalahti, 2017). The results of the present study lend support to these advantages of structuring. Thus, argumentation templates and a role play design seem to be fruitful ways of enhancing students' argumentation and understanding of a topic.

To conclude, supporting students' argumentative activities by argument visualisation and structuring a discussion by templates or role play seem to be workable instructional methods for learning in CSCL environments (Vogel et al., 2017). Support in generating counterargumentation during argumentative activities is of especial importance for achieving a better understanding of the issue at stake (Nussbaum & Schraw, 2007; van Amelsvoort et al., 2007; Walton, 1989). Engaging, critically but constructively, with peers' ideas through argumentation has been seen as a prerequisite for collaborative learning (Mercer, 1996; Mason, 1998). Thus, promoting argumentation in educational settings is not only a means to the better learning of argumentation but also to the better learning of content through argumentation (Andriessen et al., 2003).

7.4 Evaluation of the study

This study contributes to our understanding of general upper secondary school students' engagement in argumentation in computer-supported learning environments and, more specifically, of how certain instructional methods can promote students' argumentation. The study was based on two teaching experiments conducted in authentic and ecologically valid settings in Finnish general upper secondary schools. The experiments were integrated into the standard curriculum in collaboration between teachers and researchers.

A counterbalanced quasi-experimental design was applied in the study to examine students' argumentation and potential factors associated with it. The design enabled adequate exploration of the target issue while also ensuring that the teaching experiments and learning tasks were pedagogically meaningful to the students. However, applying the design in an authentic school setting with a small number of participants imposed some constraints on the study. For example, the facts that the time allocated to the experiments was less than optimal and the chat and visualisation tools used were novel for the students means that their full potential enhancing students' argumentation was probably not realised. In addition, the extent to which the students' argumentative discussions and other activities observed in one ecologically valid context can be generalised to other contexts is debatable (Cohen, Manion, & Morrison, 2007, p. 157). Moreover, due to the small number of participants in the sub-studies, generalisation of the results to larger populations is not warranted.

The settings used in the design of this study can be discussed with reference to the critical elements affecting the quality of students' interaction in computer-supported learning settings proposed by Strijbos, Martens, and Jochems (2004) (see Chapter 3.4). *First*, the learning objectives and target type of student interaction need to be determined. The objective of the present sub-studies was, by the help of computer tools, to evoke and trigger productive argumentative activities for learning such as learning to argue and arguing to learn about the set issues. Achieving this goal was sought by combining chat discussion and argument diagram construction (Sub-study I), structuring a discussion with the argumentation templates (Sub-study II), and applying a role play design (Sub-study III).

Second, to achieve the desired objectives for argumentative activities, it is important that the task is both well planned and appropriate for the participants (Strijbos et al., 2004), as one does not argue with anyone, about anything, in any situation (Golder, 1996). In both the teaching experiments carried out in this study, the argumentative tasks were based on a task sequence consisting of different phases. The students prepared themselves for the subsequent argumentative discussions by training with the computer tools, activating their prior knowledge, and reading and analysing texts on the discussion topics. The environmental and societal discussion topics used can be considered as debatable topics (Golder & Pouit, 1999) that typically arouse conflicting standpoints during

discussions. However, this study showed that when selecting topics for constructive argumentative discussions, it is also important to pay attention to ensuring that the topics are connected to participants' daily lives and are of personal relevance to them (cf., Coiro, 2017; Zohar & Nemet, 2002). The study also showed that it is important to design argumentative task assignments that enable adequate use of the computer tools in seeking to evoke students' higher-order thinking (Sub-study I).

Third, Strijbos et al. (2004) highlight that to ensure appropriate collaboration and interaction between students, pre-structuring of the discussion is needed. First, in the present study, the argumentative discussions were structured to enhance the interlocutors' debate for and against the topic-related claims. Second, the discussions were arranged in a form of a debate and structured by using argumentation templates (Sub-studies I and II) and role play (Sub-study III). Third, in Sub-study III, the debates were arranged so that as many students as possible could defend their personal standpoint (cf., Baker, 2015). *Fourth*, a pair was determined as the most appropriate group size for argumentative discussions. It was assumed that the debates organised in pairs would produce reciprocal and elaborative argumentation and to reduce cognitive load compared, for example, to groups of three or more students.

Finally, the computer-support used needs to be in line with the other design elements (Strijbos et al., 2004). The objective of the present study was to engage students' in critical and elaborative argumentative activities. In the sub-studies, this objective was pursued by using both structured and ordinary chat facilities and by combining chat and argument visualisation tools. Both the structured chat tool and the argument visualisation tool were novel for the students, and hence may, despite being designed to assist them to engage in constructive argumentation, have negatively influenced the quality of their argumentation.

To increase the reliability and validity of the study, first, the applied quasi-experimental design was counterbalanced (Borg & Gall, 1989) in both the teaching experiments (see Table 2 in section 5.1.1 and Table 3 in section 5.1.2). Second, the inter-rater reliabilities (Cohen's kappa; Cohen, 1960) were calculated for the analytical categories of speech turns when analysing the quality of the students' argumentative discussions. In Sub-study II, inter-rater reliability was .74 for the argument construction and discourse management categories and .71 for the counterargumentation strategies. In Sub-study III, inter-rater reliability was .88 for the argumentativeness categories and .81 for the argument elaboration categories. Third, both qualitative and quantitative methods were used in the data analyses to take the richness of the different data sources (different chat and face-to-face discussions, different types of argument diagrams, and feedback questionnaires) into account. In all three sub-studies, the theorising underpinning the qualitative data analyses was drawn from the previous research on educational argumentation and reported with representative examples of the data to render the coding procedure transparent and replicable (Hiles, 2008). Despite the small number of students participating in the teaching experiments, quantifying the

qualitative analyses of the students' argumentative discussions and activities enabled the application of statistical methods and the examination of the associations of several factors with students' argumentation.

That the sub-studies did not include measures of learning outcomes is a possible limitation of the study. The studies mainly examined students' argumentative discussions and activities, i.e., how they learned instead of what they learnt, on the assumption that learning occurs once students engage in constructive argumentation (e.g., Coffin & O'Halloran, 2009; Mercer, 1996). The studies also mainly focused on students' argumentation on the structural level instead of evaluating the quality of the arguments students presented. Although the role of the quality of argumentation for learning domain-specific knowledge in CSCL settings has been shown to be an ambiguous phenomenon (Wecker & Fischer, 2014), this study showed that students were able to engage in constructive and elaborative argumentation and counter-argumentation for learning.

7.5 Ethical issues

This study was conducted following the research ethics guidelines laid down by the National Advisory Board on Research Ethics (see TENK, 2019). To respect subject autonomy, the students participated voluntarily in the study and had the right to withdraw their participation or to deny the use of data concerning them personally at any time without any negative consequences. The participants were clearly informed about the aims, purposes, and potential benefits of the study and about the activities expected of them during the study. An informed consent stating the aim of the study, use to be made of the collected data, the voluntariness of participation, and the researchers' contact information was obtained from the parent(s) or carer of under-aged students.

The study was integrated into the general upper secondary school curriculum so that, while obligatory, the tasks set resembled the kinds of tasks they normally perform during their lessons. In addition, the teaching experiments were planned and carried out together with the students' teachers. Teaching experiment 1 was integrated into a course on Finnish language and literature, and Teaching experiment 2 into a cross-curricular course on Finnish language and Religious education (the course on Ethics).

Students' privacy was ensured by guaranteeing their anonymity and by storing the research data in a secured server accessible only by the researchers. Authentic examples of the data have all been reported with pseudonyms.

Finally, the data were analysed systematically and the analyses and results reported with accuracy in all three Sub-studies. All sources of the financial support, in line with the publisher's instructions, are mentioned in the study reports.

7.6 Educational implications and future research

This study addressed general upper secondary school students' engagement in argumentation in computer-supported environments. More specifically, the study examined whether particular instructional methods, namely visualisation of argumentation and structuring discussions by argumentation templates and role play, promote students' engagement in constructive collaborative argumentation.

It has been shown that educational argumentation is a demanding activity, especially for students (e.g., Dillenbourg & Bétrancourt, 2006; Kuhn & Udell, 2003). Research has also shown that designing effective argumentative tasks that engage students in productive argumentation presents educators with many challenges (e.g., Andriessen & Schwarz, 2009). Some researchers have proposed that in seeking to increase students' argumentative competence we also need to further elaborate the definition and assessment of educational argumentation (Rapanta et al., 2013), including the establishment of norms, e.g., shared standards and values (Kuhn, Zillmer, Crowell, & Zavala, 2013). Here, argumentative competence refers to engaging in and sustaining argumentation as a social practice in which the main argument skills, i.e., construction of arguments, justifications, counterarguments, and rebuttals, are used in a strategic way (Kuhn et al., 2013; Rapanta et al., 2013). It is also evident that argumentation skills are also an important component of many competencies and skills, including the digital skills needed in the 21st century (Binkley et al., 2012; Ilomäki et al., 2016; Voogt et al., 2013). For these reasons, educators need to provide well-designed interventions and task assignments for use in computer-supported learning situations in which students are expected to engage in argumentative activities as a way of learning subject matter as well as the ability produce better arguments. This study yielded empirical knowledge of value in designing interventions in which an argumentation is supported by computer-based tools with the over-arching aim of at promoting the competencies needed in the contemporary digitally networked world.

The key elements in promoting student argumentation accentuated in this study are illustrated in Figure 1, in which student argumentation is depicted as a triangle where the three sides represent dialogue, counterargumentation, and collaborative learning, all of which can be supported by computer tools. Student argumentation occurs in most cases in dialogue conducted with peers. When argumentation with other people is dialogic and collaborative in nature, it enables one to listen genuinely and honestly to what other people are saying, challenge their ideas by appropriate counterargumentation, further elaborate arguments already presented, and synthesise opposing viewpoints to achieve a better understanding of the issue under discussion (e.g., Baker, 2003; Dillenbourg, 1999; Felton et al., 2019; Kruger, 1993; Muller Mirza & Perret-Clermont, 2009). The diagram depicted in Figure 1 can also be utilised in further promoting, designing, and researching student argumentation for learning.

This study showed that students were able to engage in constructive and critical argumentation in both computer-based and face-to-face environments. However, the students' engagement in argumentation was associated with both the discussion topics and gender. While the societal and environmental set topics generated critical and elaborative argumentation, they also seemed to stimulate argumentation more from the female than male students. Thus, further research is needed to investigate the possible gender-relatedness of different discussion topics. Furthermore, the study also showed that up to one third of the students' counterarguments during the dyadic discussions were not directly focused on their interlocutors' arguments but criticised them indirectly by simply supporting the opposite viewpoint. Counterargumentation of this kind violates the requirements for skilled argumentation that, among others, Walton (1989) characterises as dialogic and collaborative in nature. Thus, further strategies are needed to support students' advanced counterargumentation skills, such as developing chat discussion templates that focus, in particular, on promoting the use of dialogic counterargumentation strategies, such as the *Questioning a reason-position link* during argumentative discussions.

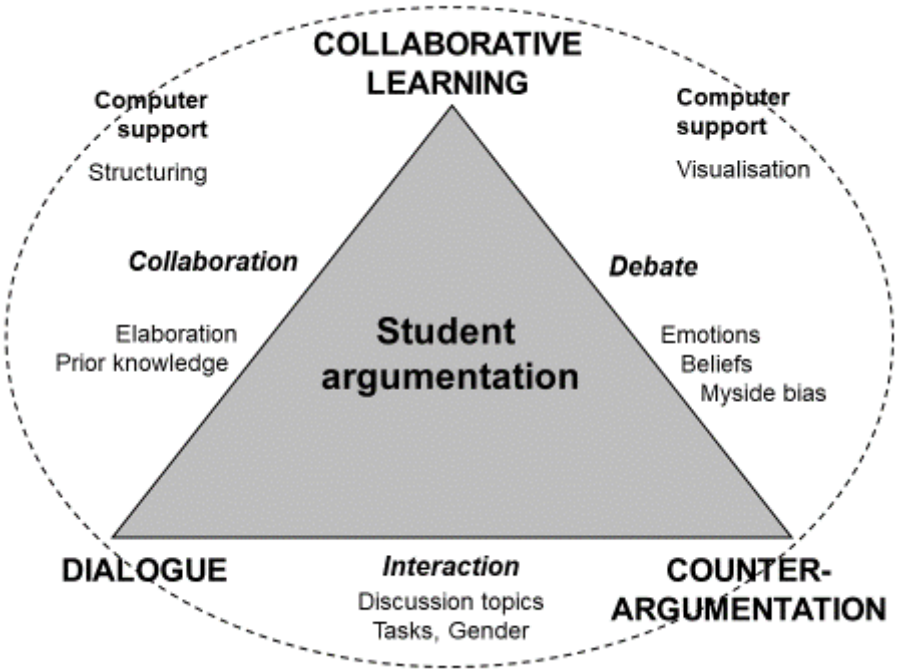

FIGURE 1 Key elements to be needed when promoting student argumentation for learning with computer support

It is also important to recognise that students' epistemic beliefs (e.g., Iordanou, Kendeou, & Zembylas, 2020; Noroozi et al., 2017), topic beliefs (e.g., McCrudden & Sparks, 2014), myside bias (e.g., Felton et al., 2015; Iordanou et al., 2020; Perkins, 1985), prior knowledge (e.g., Kuhn, 1991), and emotions (e.g., Baker et al., 2013; Iordanou et al., 2020; Sladek et al., 2010) may influence their engagement in argumentative activities. Further research is needed to clarify

how these factors are intertwined and how they can be better taken into account when designing interventions and instruction for promoting student argumentation. Attention should also be paid to devising task assignments that stimulate students to argue constructively together and that resonate with their daily lives and emotions.

Further, the study showed that computer support (e.g., argument visualisation tools and a structured chat tool) is helpful in evoking critical and elaborative argumentation for learning. However, computer support per se may not be enough to evoke higher-order thinking. As suggested in this study (Sub-study I), students need clearly defined tasks and good reasons for using visualisations along with synchronous argumentative discussion either during or after their learning activities. For this purpose, novel templates and prompts for further elaboration of argumentative contents could be designed and tested in future research.

Finally, the study revealed that student argumentation is a complex task for both students and educators. Several factors are associated with engaging in and promoting productive argumentation in computer-supported learning environments. To achieve a more comprehensive understanding of educational argumentation, the present findings should encourage future studies to examine students' joint argumentative activities more closely, for example from dialogic and contextual perspectives (e.g., Arvaja & Hämäläinen, 2021; Asterhan & Schwarz, 2016). Research on the first of these would increase our understanding on the dialogic features of collaborative argumentation, in relation to the notions of alterity, diversity of thought, multiplicity of meanings, and dialogic attitude and orientation (Arvaja & Hämäläinen, 2021). Arvaja and Hämäläinen (2021) also emphasise the importance of the contextual perspective, by which they refer to learning resources, such as past experience, prior knowledge, values, learning materials, and aspects of a learning situation, that are relevant in, for example, argumentative discussions with peers. Asterhan and Schwarz (2016), in turn, emphasise the non-cognitive dimensions of argumentation (social, motivational, and interpersonal), topics on which more research is needed to ascertain the conditions and characteristics that enable or inhibit student engagement in argumentation.

In conclusion, by paying more attention to context and different ways of supporting student argumentation, we will better understand its value for learning. Argument competence can be seen as fundamental to being educated (Graff, 2003). As Neil Postman (1997) puts it, *argument is the soul of an education*.

YHTEENVETO

Tutkimuksen tavoitteet

Tämän tutkimuksen tavoitteena oli selvittää, miten lukiolaiset argumentoivat verkko-oppimisympäristössä ja kasvokkain sekä millaisin tietokonetuetuin pedagogisin keinoin opiskelijoiden argumentointia voidaan edistää. Tutkimuksessa tarkasteltiin, miten opiskelijat argumentoivat, kun heidän työskentelyään tuetaan 1) yhdistelemällä verkkokeskustelua (chatti) ja argumentoinnin visualisointia, 2) käyttämällä täydennettäviin ja valmiisiin puheenvuorovaihtoehtoihin perustuvaa chattia ja 3) soveltamalla roolipelimenetelmää, jossa opiskelijat puolustivat joko henkilökohtaista tai heille annettua kantaa keskusteluaiheesta. Lisäksi tutkimuksessa tarkasteltiin, ovatko keskustelun aihe, sukupuoli ja keskustelun toteutustapa (tavanomainen chatti, strukturoitu chatti ja kasvokkaiskeskustelu) yhteydessä opiskelijoiden argumentointiin.

Tutkimuksen toteutus

Tutkimuksessa järjestettiin kaksi opetuskokeilua. Ensimmäiseen opetuskokeiluun osallistui 17 lukiolaista ja se toteutettiin osana lukion äidinkielen opetusta. Opetuskokeilu koostui kahdesta 90 minuutin oppitunnista, jotka pidettiin kahtena eri päivänä. Opiskelijat jaettiin kahteen samansuuruiseen ryhmään siten, että molemmissa ryhmissä oli yhtä paljon tyttöjä ja poikia. Molemmissa ryhmissä opiskelijat keskustelivat pareittain verkossa sekä tavanomaista että strukturoitua chattia käyttäen. Keskusteluaiheina olivat eläinkokeet ja sukupuolten välinen tasa-arvo. Molemmat ryhmät työskentelivät verkossa käyttäen myös kahta erilaista argumentoinnin visualisointityökalua. Toisella visualisointityökalulla opiskelijat laativat verkkokeskustelujensa pohjalta argumentointikaavion itsenäisesti ja toisen työkalun avulla he muokkasivat argumentointikaaviota, jonka tietokone oli tehnyt automaattisesti strukturoidun chatin pohjalta. Ensimmäisen oppitunnin alussa opiskelijat harjoittelivat chatti-työkalujen käyttöä 25 minuutin ajan. Opiskelijoita motivoitiin keskusteluaiheisiin siten, että ensimmäisellä oppitunnilla he täyttivät eläinkoeaiheisen aukkotäydennystehtävän (10 minuuttia) ja toisella oppitunnilla he keskustelivat luokassa yhdessä sukupuolten välisestä tasa-arvosta 20 minuutin ajan. Opiskelijat valmistautuivat molempia aiheita koskeviin verkkokeskusteluihin lukemalla 20 minuutin aikana kolme tekstiä, jotka sisälsivät sekä aihetta puoltavia että kritisoivia argumentteja. Tämän jälkeen opiskelijat chattailivat pareittain 15 minuutin ajan keskusteluaiheesta. Keskustelujen tehtävänannot olivat seuraavat: Keskustele pareittain väitteestä ”Eläinkokeet tulee sallia” / ”Naisten ja miesten välinen tasa-arvo toteutuu Suomessa”.

Opiskelijaparit muodostettiin siten, että mahdollisimman moni pari oli tyttö–poikapareja. Keskustelujen jälkeen tavanomaista chattia käyttäneillä opiskelijapareilla oli 20 minuuttia aikaa laatia argumentointikaavio keskustelujensa pohjalta. Heidän tuli esittää kaaviossaan keskustelunsa keskeisimmät argumentit ja vastaargumentit sekä lisätä kaavioon uusia argumentteja, jos niitä tuli esille kaavion laatimisen aikana. Strukturoitua chattia käyttäneiden opiskelijaparien tehtävänä oli muokata heidän keskustelunsa pohjalta tietokoneen automaattisesti rakentamaa argumentointikaaviota siten, että se havainnollisti käydyn keskustelun argumentaatiota mahdollisimman selkeästi. Aikaa kaavion muokkaamiseen oli varattu 20 minuuttia. Opiskelijoilla oli myös mahdollisuus lisätä kaavioon uusia argumentteja. Opetuskokeilun lopuksi opiskelijat vastasivat palautekyselyyn.

Toinen opetuskokeilu toteutettiin osana lukion äidinkielen ja etiikan kursseja ja siihen osallistui 27 lukiolaista. Opiskelijat jaettiin kahteen ryhmään, siten, että molemmissa ryhmissä oli yhtä paljon tyttöjä ja poikia sekä ryhmät olivat argumentointitaidoiltaan mahdollisimman samanlaiset. Opiskelijoiden argumentointitaidot oli testattu ennen opetuskokeilua. Molemmissa ryhmissä opiskelijat keskustelivat pareittain sekä verkossa chattaillen että kasvokkain. Keskusteluaiheina olivat ydinvoima ja geenimuuntelu (GMO) ja keskustelua ohjaavia kysymyksiä olivat ”Tuleeko Suomeen rakentaa uusi ydinvoimala vai ei?” sekä ”Tuleeko geenimuuntelu sallia vai ei?”. Opiskelijoiden työskentely eteni kolmessa vaiheessa. Aluksi opiskelijat valmistautuivat keskusteluihin lukemalla ja analysoimalla joko pienryhmissä (ydinvoima) tai pareittain (GMO) viisi keskusteluaihetta käsittelevää artikkelia. Työskentelyaikaa oli varattu 60 minuuttia. Seuraavaksi opiskelijoita pyydettiin esittämään oma perusteltu kantansa keskusteluaiheesta joko laatimalla aiheesta lyhyt essee (ydinvoima) tai argumentointikaavio (GMO); aikaa perustellun kannan esittämiseen oli varattu 30 minuuttia. Tämän jälkeen opiskelijat väittelivät pareittain aiheesta siten, että mahdollisimman moni opiskelija puolusti väittelyssä omaa henkilökohtaista kantaansa aiheesta. Jokaisessa väittelyparissa opiskelijoiden tuli kuitenkin edustaa vastakkaisia kantoja. Tästä johtuen joillekin opiskelijoille annettiin puolustettavaksi kanta, joka ei edustanut heidän henkilökohtaista kantaansa keskusteluaiheesta. Suullisen ja kirjoitetun kommunikoinnin eroista johtuen kasvokkain toteutettuihin keskusteluihin oli varattu aikaa 20 minuuttia ja verkkokeskusteluihin 30 minuuttia.

Tutkimusaineisto koostuu ensimmäisen opetuskokeilun 16 verkkokeskustelusta, 16 argumentaatiokaaviosta ja 16 kokeilun jälkeen kerätystä palautekyselystä sekä toisen opetuskokeilun aikana käydyistä parikeskusteluista, joista 12 toteutettiin kasvokkain ja 12 verkossa chattaillen. Aineiston analysoinnissa käytettiin sekä laadullisia että määrällisiä menetelmiä.

Ensimmäisen opetuskokeilun verkkokeskustelut analysoitiin luokittelemalla keskustelupuheenvuorot argumentatiivisiin sekä keskustelua ylläpitäviin ja ohjaaviin puheenvuoroihin. Argumentatiivisia puheenvuoroja olivat esitetyt argumentit ja perusteltua erimielisyyttä ilmaisevat puheenvuorot. Keskustelua ylläpitäviä ja ohjaavia puheenvuoroja olivat pyynnöt, mielipiteet, kommentit sekä perustelematonta samanmielisyyttä tai erimielisyyttä ilmaisevat puheenvuorot. Perusteltua erimielisyyttä ilmentävät puheenvuorot luokiteltiin edelleen

kolmeen erilaisia vasta-argumentointistrategioita kuvaavaan luokkaan, jotka olivat ”Vastakkaisen kannan tukeminen”, ”Väitteen totuudenmukaisuuden kyseenalaistaminen” sekä ”Perusteen ja väitteen välisen yhteyden kyseenalaistaminen”. Toisessa opetuskokeilussa analysoitiin opiskelijoiden kasvokkain ja verkossa chattaillen käymien keskustelujen argumentoivuutta ja argumentoinnin elaboroinnin tasoa. Keskustelujen aikana esitetyt puheenvuorot luokiteltiin joko argumentatiivisiksi, vasta-argumentatiivisiksi tai ei-argumentatiivisiksi puheenvuoroiksi. Puheenvuorot luokiteltiin myös tasoltaan kolmeen eri luokkaan sen perusteella, miten opiskelijat olivat elaboroineet niiden sisältämää argumentointia. Luokat olivat ”Hyvä”, ”Heikko” ja ”Ei-elaborointia”. Argumentointikaaviot analysoitiin erittelemällä niistä väitteet, argumentit, vasta-argumentit ja niiden kiistämiset sekä näiden keskinäiset suhteet. Analyysin perusteella selvitettiin opiskelijoiden argumentoinnin laajuutta, tasapainoisuutta ja syvyyttä sekä vasta-argumentoivuutta.

Ensimmäisessä opetuskokeilussa analysoitiin määrällisin menetelmin (mm. Kruskal-Wallis testi, logit-analyysi) sitä, eroavatko erilaiset argumentointikaaviot argumentoinnin laadultaan toisistaan ja ovatko verkkokeskustelujen toteutustapa (tavanomainen chatti ja strukturoitu chatti), keskusteluaihe ja sukupuoli yhteydessä keskustelujen argumentatiiviseen laatuun. Toisessa opetuskokeilussa analysoitiin määrällisin menetelmin (logit-analyysi) keskusteluaiheen, keskustelun toteutustavan (kasvokkain ja verkossa chattaillen), keskustelussa puolustettavan kannan (henkilökohtainen kanta, annettu kanta) ja sukupuolen yhteyttä keskustelujen argumentatiiviseen laatuun.

Tulokset ja johtopäätökset

Tämä tutkimus osoitti, että lukiolaiset kykenevät rakentavaan argumentointiin ja vasta-argumentointiin niin verkossa kuin kasvokkain. Noin kolmannes opiskelijoiden puheenvuoroista liittyi argumenttien ja vasta-argumenttien esittämiseen kummassakin opetuskokeilussa. Ensimmäisessä opetuskokeilussa viidennes ja toisessa opetuskokeilussa neljännes puheenvuoroista ilmensi perusteltua erimielisyyttä. Tämän lisäksi ensimmäisessä opetuskokeilussa 17 % puheenvuoroista sisälsi argumentointia stimuloivia pyyntöjä (perustelun, vasta-argumentin, selvennyksen tai esimerkin pyytäminen) ja toisessa opetuskokeilussa 17 % puheenvuoroista sisälsi argumenttien elaborointia. Opiskelijat kykenivät myös analysoimaan käymiensä keskustelujen keskeisen argumentatiivisen rakenteen ja esittämään sen argumentointikaaviona. Myös vasta-argumentointistrategioiden käyttö oli enimmäkseen dialogista ja yhteisöllistä argumentointia tukevaa: 68 % opiskelijoiden keskustelujen aikana esittämistä vasta-argumenteista kohdistui suoraan keskustelukumppanin esittämän väitteen tai väitteen ja sitä tukevan perusteen välisen yhteyden kyseenalaistamiseen; 32 % vasta-argumenteista oli kuitenkin muotoiltu niin, että niissä tuettiin keskustelukumppanin esittämälle kannalle vastakkaista kantaa ja siten kritisoitiin epäsuorasti keskustelukumppanin esittämiä näkemyksiä. Tulosten perusteella lukiolaisilla näyttäisi olevan sellaista

argumentatiivista osaamista, joka antaa heille mahdollisuuden osallistua kriittiseen ja elaboroivaan, oppimista edistävään argumentatiiviseen keskusteluun (Kruger, 1993; Nussbaum & Schraw, 2007; van Amelsvoort ym., 2007;). Tällaisen osaamisen kehittymistä edesauttoi tässä tutkimuksessa se, että opetuskokeiluissa kiinnitettiin huomiota erityisesti vasta-argumentointiin ja sen tukemiseen keskusteluja visualisoimalla, käyttämällä tiettyjä strukturoidun chatin puheenvuorovaihtoehtoja, varioimalla erilaisia väittelytilanteita ja soveltamalla keskusteluissa roolipelimenetelmää.

Tutkimus osoitti myös, että keskustelun aiheella on merkitystä, kun opiskelijoiden odotetaan käyvän kriittistä ja rakentavaa argumentoivaa keskustelua. Ympäristöteemat (eläinkokeet, ydinvoima ja geenimuuntelu) saivat aikaan argumentoivaa keskustelua, kun taas sukupuolten välinen tasa-arvo ei ollut niin hyvin väittelyä aikaan saava aihe. Argumentointikaavioiden (osatutkimus I) ja tavanomaisen chatin avulla käytyjen keskustelujen (osatutkimus II) analyysien perusteella opiskelijoiden keskustelut eläinkokeista olivat vasta-argumentoivampia kuin keskustelut sukupuolten tasa-arvosta. Kun opiskelijat keskustelivat käyttäen strukturoitua chattia, he esittivät kuitenkin yhtä paljon vasta-argumentteja molemmista aiheista. Tutkimuksen perusteella näyttäisi siltä, että chatin strukturointi lisää vasta-argumentointia myös silloin, kun keskusteluaihe ei tarjoa osallistujille keskustelua polarisoivia, vastakkaisia puolesta–vastaan-näkökulmia, kuten sukupuolten välinen tasa-arvo -teema tässä tutkimuksessa. Opiskelijoiden on hyvä harjoitella argumentointia myös tällaisista ei-polarisoivista aiheista, sillä monet yhteiskunnalliset ongelmat, kuten esimerkiksi ilmastonmuutos, edellyttävät moninäkökulmaista tarkastelua, eri näkökulmiin liittyvien argumenttien ja vasta-argumenttien muodostamista, punnitsemista ja yhdistelemistä. Argumentoidessaan tällaisista aiheista opiskelijat pystyvät myös hyödyntämään eri oppiaineiden sisältöjä (ks. Christenson, 2015). Kun aiheet ja ongelmat koskettavat opiskelijoiden arkea, niiden on todettu myös lisäävän opiskelijoiden motivaatiota käydä argumentoivaa keskustelua (Zohar & Nemet, 2002) ja myös edistävän heidän kriittisiä tekstitaitojaan (Coiro, 2017).

Keskustelun aiheita valittaessa tulee kiinnittää huomiota myös siihen, että eri aiheet saattavat motivoida eri sukupuolia keskusteluun eri tavalla. Tutkimus osoitti, että ydinvoima-aihe verrattuna geenimuuntelu-aiheeseen stimuloi erityisesti tyttöjä käymään vasta-argumentoivaa ja elaboroivaa keskustelua (osatutkimus III); myös eläinkokeet ja sukupuolten välinen tasa-arvo keskusteluaiheina saivat tytöt argumentoimaan poikia enemmän (osatutkimus II). Tutkimus osoitti myös, että sukupuolten välisiä eroja argumentatiivisessa kommunikoinnissa voidaan tasoittaa käymällä keskustelut verkossa chattaillen (osatutkimukset II ja III). Verkkoympäristö näyttäisi tarjoavan tytöille mahdollisuuden käydä hyökkäävämpää keskustelua kuin silloin, jos keskustelu käydään kasvokkain, joten verkkoympäristön voidaan sanoa tasa-arvoistavan sukupuolten välistä kommunikointia. Tämä puolestaan mahdollistaa paremmin tutkivan puheen (Mercer, 1996) ja yhteisen tiedonrakentamisen esimerkiksi vasta-argumentoinnin avulla. Toisaalta sukupuolten väliset erot kommunikointitavoissa voivat myös edistää rakentavaa argumentointia. Miesten vastakkainasettelua korostava keskustelutyyli

voi jopa yllyttää naisia vasta-argumentoimaan, kun taas naiset omalla yhteisöllisemmällä ja rakentavammalla keskustelutyylillään voivat ylläpitää keskustelua ja kollaboraatiota ja näin edistää argumenttien kehittelyä yhdessä (ks. Robertson ym., 2003; osatutkimukset II ja III). Aiemmat tiedonrakentamista verkko-oppimisympäristöissä käsitelleet tutkimukset (esim. Ding ym., 2011; Zhan ym., 2015) ovat osoittaneet, että sekä mies- että naisopiskelijat hyötyvät opiskeluryhmistä, joissa molemmat sukupuolet ovat edustettuina. Hyvään argumentointiin vaikuttaa myös opiskelijoiden aiempi tietämys keskusteluaiheesta (esim. Mason & Scirica, 2006) sekä se, miten varmoja he ovat aiemmista tiedoistaan (ks. Noroozi ym., 2017).

Osatutkimuksessa III toteutetuissa pariväittelyissä lukiolaiset puolustivat joko henkilökohtaista kantaansa tai heille annettua kantaa aiheesta. Tytöille näyttäisi olevan poikia haasteellisempaa argumentoida henkilökohtaisen kannan vastaisesti, sillä tulosten mukaan he esittivät enemmän ei-argumentatiivisia ja vähemmän vasta-argumentatiivisia puheenvuoroja silloin, kun he puolustivat keskustelussa henkilökohtaiselle kannalle vastakkaista kantaa. Tulosta voi selittää se, että tytöt pyrkivät välttämään negatiivisia emootioita keskustellessaan (Ben-Ze'ev, 1995; Sladek ym., 2010). Kykyä argumentoida oman kannan vastaisesti saattaa myös haitata taipumus huomata ja vastaanottaa vain sellaista tietoa, joka tukee omaa käsitystä aiheesta; tämä taipumus tunnetaan vahvistusharhana (esim. Perkins, 1985). Oppimistilanne ei ehkä ollut tytöille myöskään riittävän autenttinen ja henkilökohtaisesti merkittävä (Stein & Albro, 2001; Udell, 2007; Zeitler ym., 2009).

Rakentava argumentointi edellyttää vaativia kognitiivisia prosesseja kuten päättelyä ja tiedon elaborointia, jotka ovat myös yhteydessä opiskelijoiden kollaboraatiota tukeviin sosio-emotionaalisiin prosesseihin (esim. Baker ym., 2013; Rogat & Adams-Wiggins, 2015). Tällöin kyse voi olla esimerkiksi siitä, miten yhdessä argumentoidessa ilmaistaan erimielisyyttä rakentavalla tavalla ja ylläpidetään kriittistä keskustelua pyrkimättä välttämään vastakkainasettelua ja jännitteiden syntymistä keskustelijoiden välille (ks. Isohätälä ym., 2018).

Tutkimus osoitti, että argumentoinnin visualisointi edisti aiemman tiedon aktivointia ja tiedon integrointia silloin, kun lukiolaiset laativat argumentointikaavioita verkkokeskustelujensa ja niitä varten ennakkoon luetun materiaalin pohjalta. Palautekyselyssä opiskelijat kertoivat, että argumentointikaavioiden laatiminen auttoi heitä ymmärtämään paremmin käymiensä keskustelujen argumentatiivista rakennetta ja aiheeseen liittyviä eri näkökulmia. Toisaalta silloin, kun opiskelijoiden tehtävänä oli muokata tietokoneen automaattisesti rakentamaa, strukturoituun chattiin perustuvaa argumentointikaaviota, tehtävä ei aktivoinut opiskelijoiden aiempaa tietoa aiheesta eikä motivoinut heitä kehittelemään kaavion sisältämiä argumentteja edelleen. Tehtävän tulisikin olla riittävän selkeä ja työskentelyllä tulisi aina olla motivoiva tarkoitus. Argumentointikaavioita voisikin jatkossa hyödyntää esimerkiksi esseen kirjoittamisen tukena (ks. esim. Kiili, 2013), sillä kaaviot auttavat jäsentämään muun muassa argumenttien

välisiä suhteita. Argumentoinnin visualisointi edistää myös opiskelijoiden monilukutaitojen ja digitaalisten valmiuksien kehittymistä (ks. esim. Ilomäki ym., 2016).

Verkossa chattaillen toteutettavan keskustelun osittainen strukturointi tai kokonaan valmiiden puheenvuorovaihtoehtojen käyttäminen edisti lukiolaisten, erityisesti tyttöjen vasta-argumentointia. Keskustelun strukturointi tarjoaa opiskelijoille myös mahdollisuuden harkita ensin huolella sitä, mitä haluaa sanoa ja valita sen jälkeen sopiva puheenvuorovaihtoehto. Opiskelijoiden keskustelun toteuttaminen roolipelinä edisti myös yhteisöllistä argumentointia ja tiedon elaborointia. Keskustelun strukturointi, valmiiden puheenvuorovaihtoehtojen käyttäminen ja roolipelin soveltaminen erityisesti verkkoympäristössä on myös aiemmissa tutkimuksissa todettu hyviksi tavoiksi tukea yhteisöllistä, kriittistä ja elaboroivaa argumentointia (ks. esim. Oehl & Pfister, 2010; Vapalahti, 2017; Vogel ym., 2017).

Tutkimus osoitti, että opiskelijoiden argumentoinnin edistäminen verkko-oppimisympäristössä edellyttää useiden eri tekijöiden huomioon ottamista. Näiden tekijöiden tarkempi selvittäminen jatkotutkimuksissa auttaa kehittämään edelleen yhteisölliseen, oppimista edistävään argumentointiin perustuvaa pedagogiikkaa.

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ORIGINAL PAPERS

I

VISUALISING KNOWLEDGE FROM CHAT DEBATES IN ARGUMENT DIAGRAMS

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Visualising knowledge from chat debates in argument diagrams

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Abstract This study investigates whether combining chat discussion and construction of an argument diagram stimulates students to formulate new ideas in practising argumentation. In this study, 16 secondary school students discussed vivisection and gender equality in pairs using both free and structured chat tools. In structured chat, the students selected and completed partial sentences provided by the computer. After the discussion, they jointly constructed either argument diagrams freely based on the previous discussions with an Internet tool or modified a diagram the computer had constructed automatically during the structured chat. The freely constructed diagrams contained more of the students' prior knowledge than the modified diagrams. However, the different types of diagrams did not differ significantly in breadth, depth, or balance of argumentation. Thus, free construction of argument diagrams seems to activate students to incorporate their prior knowledge into those diagrams.

Keywords argument diagram, collaborative argumentation, computer chat, secondary education, visualisation of argumentation.

Introduction

Skills in evaluating, constructing, and transforming knowledge not only by ourselves alone but also together with others are highly valued in today's network society. These skills are essential not only for learning across the lifespan and in many careers involving non-routine interactive work, but also for participating in general debates on many societal questions. Participation in debates entails the ability to express thoughts and ideas in a clear and convincing way, as well as constructively to consider and judge others' views and arguments. However, it has been shown that both adolescents (e.g. Chan 2001; Marttunen *et al*. 2005) and university students (Marttunen 1997) have difficulties in acquiring argumentation skills. These skills can be practised through face-to-face interaction or in computer-assisted learning environments by using graphical or other non-verbal techniques for visualizing argumentation (van Gelder 2003). When argumentation is visualized, chains of reasoning, conclusions, and logical relationships between arguments are made explicit. It is assumed that such explicitness helps students to deepen their argumentation and better understand the subject matter.

In this study, secondary school students constructed argument diagrams in pairs on the basis of chat debates. The aim was to clarify whether combining these two modes of representations (chat and diagram) in practising argumentation enables students to deepen and broaden their arguments.

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Collaborative argumentation

Argumentation through dialogue has been seen as one prerequisite for successful collaborative learning (e.g.

Mercer 1996). The term collaborative argumentation has been used to refer to a method of collaborative learning in which the participants strive towards the common goal of attaining a better understanding of the issues in question by putting forward different points of view, claims, and arguments, and by exploring them in a deep and critical way (Litosseliti *et al*. 2005).

Earlier empirical studies have shown collaborative argumentation to have positive learning effects in terms of improving reasoning about a topic (Kuhn *et al*. 1997), solving problems (Erkens 1997) and writing argumentative and persuasive essays (Reznitskaya *et al*. 2001). However, such effects are not usually achieved without scaffolding. It is possible to scaffold argumentative co-elaboration of knowledge (Baker 2003) by structuring learning tasks and student interaction in computer-supported collaborative learning environments. In this study, synchronous computer-based communication and visualization tools were used to support students' joint construction of argumentative knowledge.

Argumentation through free and structured chat

Synchronous chat interaction has many advantages in enhancing learning and argumentation skills. Condon and Cech (1996) have stated that the need for brevity during chat interaction may cause students to articulate their opinions and arguments more precisely, thereby clarifying their thinking. Morgan and Beaumont (2003), in turn, found that chat interaction helped students to express more substantial, sound, and logical arguments, and to offer examples and justifications more sharply to the point. Furthermore, in the experimental studies by Veerman (2000) synchronous computer-mediated communication contained more counter-argumentative speech acts than asynchronous communication.

One problem of synchronous chat interaction is that it suffers from a lack of focus and coherence due to the lack of non-verbal communication (Burnett 2003). On the other hand, the lack of non-verbal communication can also benefit learning due to the need, when communication is based on written text only, for the participants to communicate in a clear and explicit way, and check whether they understand each other (Erkens 2004). Another problem with chat is that participants can compose and send messages or reply to previous messages in parallel, resulting in multi-stranded and dispersed discussions. Dispersion of discussion together with the pressure to reply quickly to others' opinions makes it difficult to explore ideas in any depth or to explain the argumentative relations between claims, reasons and justifications (Burnett 2003). Weger and Aakhus (2003), for example, found that in chat interaction arguments tended to be underdeveloped or unresponsive to those raised by other participants.

The problems of lack of focus and coherence, as well as dispersed discussion, may be eased through structuring a discussion by using prompts, such as questions or rules for discussion. Hron *et al*. (2000) state that the use of prompts can help to maintain focus on the subject matter, decrease off-task talk, and lead to a more coherent discussion on the topic. In addition, Baker and Lund (1997) found that students' structured interaction was more reflective than their unstructured communication. Furthermore, McAlister (2004) used the AcademicTalk tool with sentence openers (such as 'Can you give an example . . .?', 'I disagree because . . .', or 'Let me elaborate . . .') and found that students addressed previous arguments more clearly, and both examined and challenged more arguments compared with students using free chat. However, students do not always use such sentence openers in the intended way (Robertson *et al*. 1998). Instead, students tend to use the most generic sentence openers like 'I think . . .' (McManus & Aiken 1996) or they feel that sentence openers excessively restrict their communication (Lazonder *et al*. 2003). For these reasons, more attention should be paid to framing appropriate conditions and suitable tasks in using chat for effective argumentation.

In the present study, the sentence openers used were based on regular argumentative strategies. Their purpose was to structure interaction and to stimulate argumentative discussion between students.

Theoretical approaches to the visualization of information

Keller *et al*. (2006) have justified the benefits of visualization with reference to three cognitive theories: the theory of computational efficiency (Larkin & Simon 1987), the cognitive theory of multimedia learning (Mayer 2001), and the cognitive load theory (Sweller *et al*. 1998). The *computational efficiency theory* (Larkin & Simon 1987) includes the idea that different representations with the same content (e.g. textual and

diagrammatic representations) can enable different reasoning processes. Textual representations, i.e. successive words, are sequential, whereas diagrammatic representations are indexed by their location in a plane. This allows learners to see possible links between relevant units of information at adjacent locations.

According to the *cognitive theory of multimedia learning* (Mayer 2001), a combination of text and graphics leads to better retention of information than the use of only one representational form. This is possible because when utilizing the capacity of two information processing systems (verbal and visual) the cognitive resources needed for information processing are distributed between both systems. This also allows more information to be processed than if only one system is used. In addition, information visualizations can prevent *cognitive overload* (cognitive load theory; Sweller *et al*. 1998) because they enable an individual to focus on information that is directly relevant to the given topic. Combining a visualizing task with an argumentation task may, by contrast, also evoke cognitive load, since argumentation is a demanding activity requiring high-level interaction (e.g. Kuhn & Udell 2003).

Visualization of argumentation by diagrams

Diagrams have often been used as a means to visualize argumentation. Argument diagrams have been shown to improve university students' critical thinking (Twardy 2004) and their understanding of argumentative relations (Suthers 2003). In the study conducted by Schwarz *et al*. (2000), fifth grade students expressed better arguments when they jointly constructed an argument diagram on vivisection compared to students who just jointly listed arguments for and against it. Furthermore, argument diagrams have been found to help both university students (van Boxtel & Veerman 2001) and secondary school students (van Drie *et al*. 2005) to express arguments for and against in a balanced way.

When argument diagrams are constructed on the basis of a preceding chat debate, students encounter two forms of knowledge representation (chat and a diagram). Chat debate is a written text that proceeds linearly and vertically. When the argumentative structure of a linear chat debate is visualized in a diagram, knowledge takes a form of horizontal and spatial representation. In this way, visualization reveals the non-linear nature of the argumentation of a chat debate (see van Amelsvoort *et al*. 2008).

Argument diagrams can also be thought to give affordances (see, e.g. Jermann 2004) to students in the learning situation. First, a diagram can help students not only to gain a grip on argumentation as a whole but can also direct and shape their reasoning. Students can then see links between different arguments, deepen their argumentation within a particular line of argument or add new arguments to the diagram from other viewpoints. In addition, not only the links within one chain of argument but also the interlinks between different chains of arguments are valuable for learning (van Amelsvoort *et al*. 2008).

The between-structure (interlinks) of argumentation should help students to weigh up the relations between different viewpoints and the arguments expressing them. However, although this kind of elaboration of arguments is important for learning, it seems to be difficult for students to master. Van Amelsvoort *et al*. (2007, 2008) found that interlinks which indicate the between-structure of argumentation were rare in students' diagrams; the latter tended simply to resemble linear narrative text.

In this study, the students' task was to recapitulate the argumentative content of their previous chat debate and to further develop their argumentation on the topic by constructing or modifying an argument diagram. The research questions posed in this study were as follows:

- How much breadth, balance, and depth of argumentation, and what level of counter-argumentation were incorporated in the free and modified argument diagrams, respectively, constructed by students on the basis of their previous chat debates?
- How did the students develop their argumentation from their preceding debates in their free and modified diagrams?
- What were the students' opinions on the usefulness of the different chat (free and structured) and argument diagram tools (freely constructed and modified)?

Method

Teaching experiment

The study was carried out in a Finnish secondary school as a part of a course in mother tongue. Sixteen students

(aged between 16 and 17 years) participated in the course. Before the teaching experiment, the students had been taught the main principles of argumentation and the main features of the computer software they would be using.

The students were divided into two groups. The experiment was carried out in two sessions on different days using two conditions and two topics (Table 1). In the first session (90 min), the discussion topic was vivisection and in the second session (90 min), it was gender equality. During the first session, group 1 worked under condition A (free chat) and group 2 under condition B (structured chat). During the second session, the order was reversed.

The teaching experiment consisted of five phases (Table 2). During the *introduction phase* (35/20 min), the students were taught how to use the free and structured chat tools. In order to trigger students' motivation for the subsequent chat discussions, the students' prior knowledge of vivisection was activated by a cloze task and their knowledge of gender equality through a discussion.

During the *preparation phase* (20 min), the students read three articles containing arguments both for and against the topic. While reading, the students were asked to think about the different viewpoints on the topic presented in the texts and arguments to support them.

During the *debate phase* (15 min), the students engaged in chat discussions in pairs in both conditions. The teacher formed the student pairs to maximize the number of mixed gender pairs. She also paired students whom she knew would work well together. The students were asked to discuss the following topic-related claims: 'Vivisection should be allowed/There is gender equality in Finland'. Under condition A, the students used free chat and under condition B, they used structured chat.

After the debates, the students in both conditions were asked to *construct an argument diagram* (20 min) together with their partner on the basis of their debate. In condition A, the students constructed a joint diagram freely using the diagram tool. They were asked in their diagram to include the most central claims, arguments, and counter-arguments that emerged during their debate. They were also asked to add new arguments and counter-arguments to the diagram. In condition B, the students modified a diagram the computer had already made during the debate. Their task was to check that the argument diagram was meaningful in content and to modify it if necessary. The pairs were able to reduce and complete arguments, remove redundant boxes and check whether the links between arguments ('+' signs for supported and '−' signs for refuted arguments) were correct. They were also asked to add new arguments that they had not expressed during their debate. In both

Table 1. Design of the study.

Group	First session, day 1 (90 min)	Second session, day 2 (90 min)
Group 1	Vivisection (condition A)	Gender equality (condition B)
Group 2	Vivisection (condition B)	Gender equality (condition A)

Table 2. Phases of the teaching experiment.

Phase		Condition	
		Both conditions (A & B)	
Introduction	First session (35 min)	Training with the chat tools (25 min), and a cloze test on vivisection (10 min).	
	Second session (20 min)	General discussion on gender equality.	
Preparation (20 min)		Reading three articles on the topic in each session.	
		Condition A	Condition B
Debate (15 min)		Free chat.	Structured chat.
Diagram construction (20 min)		Free construction of an argument diagram.	Modifying a diagram constructed by the computer.
Feedback questionnaire (15 min)		Feedback questionnaire on the experiment at the end of the 2nd session.	

conditions the students were also encouraged to elaborate their arguments by adding commentary boxes behind argument boxes and writing comments in them.

At the end of the second session the students answered a short *feedback questionnaire* on the teaching experiment concerning the usefulness of the chat and argument diagram tools. The questionnaire contained six Likert-scale items, five on argument diagrams, and one open-ended question asking the students for opinions on pros and cons of constructing argument diagrams.

Technological tools used during the experiment

The chat debates were carried out using both free and structured chat tools. The free chat tool was an ordinary synchronous textual chat integrated into an Internet-based learning environment (Dialogical Reasoning Educational Webtool; see Corbel *et al*. 2002). The structured chat tool (Argumentative Learning Experience; Hirsch *et al*. 2004) consisted of four categorized sets of either full or partial sentences. The sets were: 1) Argument, 2) Explore, 3) Opinion, and 4) Comment (see Table 3). Each set consisted of templates that students could either select or complete. The partial sentences inside the argument and explore sets are based on regular patterns of argumentative strategies, and contain a reference to one or more previous sentences (Hirsch *et al*. 2004).

The argument diagrams were constructed by both a free and an automatic diagram tool. The free diagram tool enabled students to write arguments in boxes, to draw links between the boxes, and to label the links as either supportive (+) or critical (−) (see Clark *et al*. 2010). The automatic tool built a diagram in parallel with the structured chat discussion on the basis of the

Table 3. Templates of the structured chat.

Categorised sets of templates		Templates	
Argumentative categories	Argument	(1) Can you give an argument for statement X?	
		(2) I support statement X *because several Finnish women have gone a long way in our country*.	
		(3) Can you give an argument against statement X?	
		(4) I attack statement X because *men are not yet equally making their way into 'female domains'*.	
	Explore	(5) Can you clarify statement X?	
		(6) I would like to clarify statement X by saying that *in general gender equality is a fact*.	
		(7) There is a problem between statement X and statement Y because *men have full freedom enter to 'female domains'*.	
		(8) I retract statement X because *the attitudes of society and of my friends greatly affect in the situation*.	
		(9) Can you give an example to justify statement X?	
		(10) I would like to justify statement X by saying that *in our school there is a nameless male teacher of maths who cannot understand that girls can be good in maths as well*.	
Non-argumentative categories	Opinion	(11) I don't agree with statement X.	
		(12) I agree with statement X.	
		(13) I changed my opinion about statement X.	
		(14) What is your opinion about statement X?	
	Comment	(15) Hello!	(19) Hurry up!
		(16) Bye!	(20) Slow down!
		(17) My turn.	(21) I would like to talk about statement X.
		(18) Your turn.	(22) I see what you mean.

Note: X, number of speech turn; examples of how the students used the templates in debating the topic 'gender equality' are given in *italics*.

templates in the argument and explore sets. The free argument diagram tool was interconnected with the free chat tool, and the automatic diagram construction tool with the structured chat tool.

Data

The data consist of 16 dyadic chat debates (609 speech turns in total) and 16 argument diagrams (205 argument boxes in total; Table 4). Eight debates were carried out by free chat, and eight by structured chat. Eight collaborative diagrams were constructed freely, while the other eight diagrams were modified after the automatic tool had constructed them. The data also include 16 feedback questionnaires.

Data analyses

Argumentative structure in the diagrams

The diagrams were analysed, first, by differentiating the claims, arguments, counter-arguments and refutations of counter-arguments, and their interrelations (see Björk & Räisänen 1996). Second, the breadth, balance and depth of argumentation (Lund *et al*. 2007), and counter-argumentativeness of the diagrams were defined. *Breadth* of argumentation was measured by counting the number of arguments and counter-arguments directly linked to the main thesis. For example, a score of 5 was given for Breadth in the diagram in Fig 1. *Balance* of argumentation was assessed by counting the difference (|x|) between the

Table 4. Data of the study.

Mode of chat	Topic	Chat debates	Speech turns	Diagrams	Argument boxes
		f	*f*	*f*	*f*
Free	Vivisection	4	188	4	53
	Gender equality	4	232	4	55
Structured	Vivisection	4	94	4	38
	Gender equality	4	95	4	59
Total		16	609	16	205

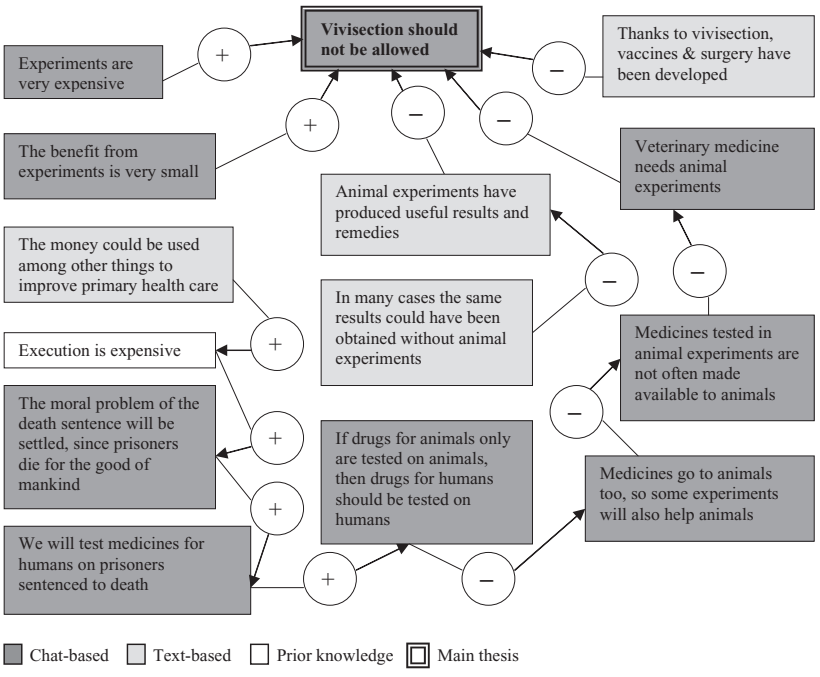

Fig 1 An argument diagram on vivisection based on free chat debate.

number of arguments for and against the main thesis: The higher the value, the lower the balance (0 indicates full balance). For example, in Fig 1, Balance is scored 1.0. *Depth* of argumentation was defined by counting the mean length of the argument chains included in the diagram. The length of a chain of arguments was based on the number of arguments and counter-arguments successively linked to each other. For example, depth of argumentation in the diagram in Fig 1 is 2.6 (mean length of the five argument chains). The *Counter-argumentativeness* of the diagrams was calculated by dividing the total number of counter-arguments and refutations of counter-arguments by the total number of claims and arguments: the higher the value, the higher the counter-argumentativeness. If the number of arguments and counter-arguments is the same, the score for counter-argumentativeness is one, as is the case in Fig 1.

Origin, transfer, and elaboration of ideas

The origin and transfer and elaboration of the ideas presented in the constructed and modified argument diagrams were analysed in order to examine how the students further developed their argumentation following the chat debate (Marttunen & Laurinen 2007). The *origin of the ideas* was classified into three categories: 1) the students' preceding dyadic chat debate; 2) the texts the students had read before their debate; and 3) students' general prior knowledge. The *transfer and elaboration of ideas* was classified into four categories (the unit of analysis was an argument box):

- Copied, i.e. arguments which students copied directly from the related chat debates to their diagrams.
- Slightly modified, so that modifications retained the meaning of the original arguments. The students, for example, removed extra words, such as 'for example' from their previous arguments, or corrected spelling mistakes.
- Revised. Modifications in which students revised a previous argument by recapitulating, rewording, or replacing part of it, or elaborating it in some way. For example, one dyad recapitulated the argument '*Animals do have a sense of feeling, don't they? Well then, they feel pain like humans*' expressed in the chat debate to the words '*Animals have a sense of feeling*'.
- Added a new argument, i.e. new argument boxes added to the diagram. These arguments were not presented during the chat debates. By means of these modifications the students enlarged the range of their argumentation on the topic.

Furthermore, in the case of modified diagrams: 1) the visual modifications in the layout of arguments were noted; and 2) the number of deletions in the existing argument boxes was counted.

Statistical analyses

The diagrams were classified into four groups according to their form (free, modified) and the discussion topic (vivisection, gender equality). Nonparametric Kruskal-Wallis variance analysis (X^2) was used to test for differences between the different groups of diagrams. The two-by-two comparisons of the diagrams were performed by the Mann-Whitney test (*U*).

Results

Structure of argumentation in the diagrams

When the extent to which the topic was explored in the diagrams was observed, it was found that the dyads either supported or directly criticized the main thesis with, on average, 3.6 arguments (*Breadth*; Table 5). Although the variation in the means of the different types of diagrams was fairly high – from 2.3 in the modified diagrams on vivisection to 5.0 in the free diagrams on gender equality – the diagrams did not differ statistically significantly from each other ($\chi^2 = 4.48$; d.f. = 3; $P = 0.215$). The diagrams were to some extent unbalanced (total mean of *Balance of argumentation*, M = 1.3). The differences between the different types of diagrams were not statistically significant ($\chi^2 = 2.16$; d.f. = 3; $P = 0.539$). Moreover, the students further elaborated their lines of reasoning relating to arguments for and counter-arguments against the main thesis. The argument chains (*Depth*) ranged in length from 2.2 to 4.4 with a mean of 2.9. The different types of diagrams did not differ from each other ($\chi^2 = 5.79$; d.f. = 3; $P = 0.122$).

Almost all the claims and arguments in the diagram had been rebutted by a counter-argument (*Counter-argumentativeness*, M = 0.8). The differences between the diagrams were statistically significant ($\chi^2 = 8.32$; d.f. = 3; $P = 0.040$). The two-by-two comparisons showed that the modified diagrams on vivisection were

Table 5. Means and standard deviations of parameters of argument diagrams in four groups.

Type of diagram	*n*	Structure of argumentation							
		Breadth		Balance		Depth		Counter-argumentativeness	
		M	SD	M	SD	M	SD	M	SD
Free diagrams on vivisection	4	3.5	1.9	1.0	0.0	2.3	0.8	0.5	0.4
Modified diagrams on vivisection	4	2.3	1.3	0.8	1.0	4.4	1.7	1.3	0.4
Free diagrams on gender equality	4	5.0	2.2	2.0	1.4	2.2	0.6	0.8	0.3
Modified diagrams on gender equality	4	3.5	1.3	1.5	1.7	2.5	0.7	0.4	0.3
Total	16	3.6	1.8	1.3	1.2	2.9	1.3	0.8	0.5

on average more counter-argumentative than the modified diagrams on gender equality (Means 1.3 and 0.4; $U = 0.00$; $P = 0.029$).

Origin of ideas

When the origin of the ideas presented in the diagrams was tracked, it was found that 59.1% of the content of the free diagrams and 90.1% of the content of the modified diagrams originated from the related chat debates. In the free diagrams 30.3% of the content was associated with the texts the students had read before their dyadic discussion, and 10.7% was based on the students' prior knowledge (associated neither with the chat debates nor with the texts). In the modified diagrams 7.3% of the content was based on students' prior knowledge and 2.7% on the texts.

For example, in the diagram in Fig 1 eight boxes are based on the students' previous chat debate, four boxes (light grey) are associated with the texts, and the content of one box (white) is based on prior knowledge.

Transfer and elaboration of arguments

The students' most common way of constructing arguments in the diagrams was to revise the contents of the arguments presented in their previous chat debates (39.5%, see Table 6). The second most common way was to add a new argument to the diagram (29.3%), and the third most common way was to copy the content of argument boxes directly from the related chat debates (26.3%).

In the free diagrams, the revising of existing arguments (44.4%) and adding a new argument (44.4%) were both common ways of further developing argumentation. In the modified diagrams, in turn, the students most often either left intact the arguments automatically copied by the computer (50.5%) or revised them (34.0%). The proportion of new arguments was 12.8%.

Visual modification of automatically constructed diagrams

When examining more closely how the students modified the diagrams, it was noticed, first, that they rearranged the arguments the computer had presented vertically and in a chronological order. Second, the students separated the argument boxes from each other so that the different argument chains could be seen more easily. Third, they deleted redundant, non-argumentative, and request boxes (M = 4.5; *SD* = 3.3).

Fig 2 illustrates an automatically constructed argument diagram on gender equality based on a structured chat debate and Fig 3 shows how the students have

Table 6. Transfer and elaboration of arguments.

Category of arguments	Free diagrams		Modified diagrams		Total	
	f	%	*f*	%	*f*	%
Revised	48	44.4	33	34.0	81	39.5
Added a new argument	48	44.4	12	12.8	60	29.3
Copied	5	4.6	49	50.5	54	26.3
Slightly modified	7	6.9	3	3.1	10	4.9
Total	108	100	97	100	205	100

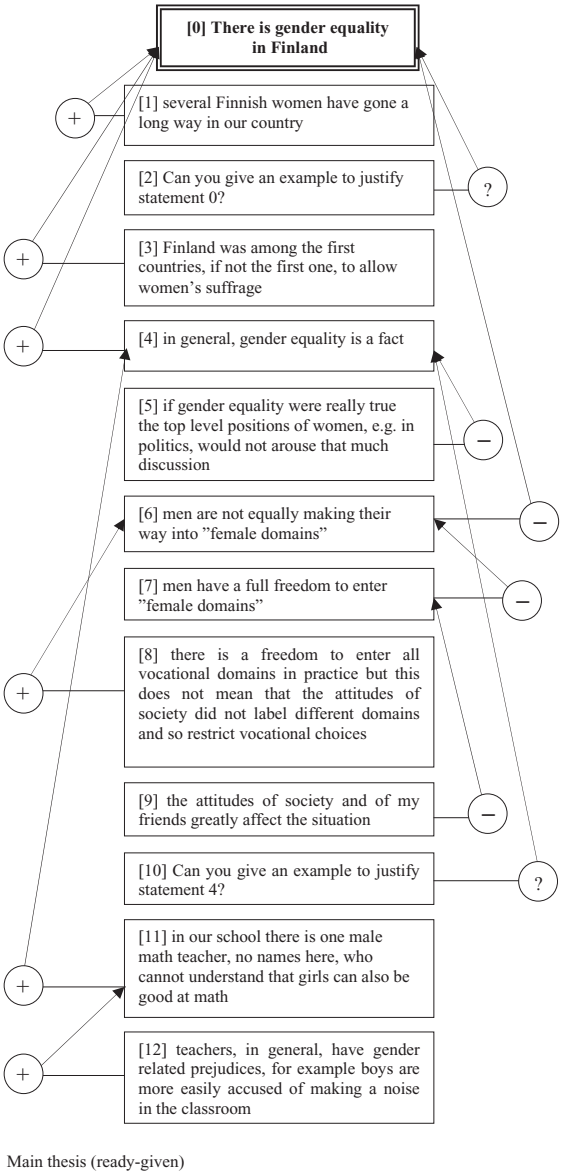

Fig 2 An automatically constructed argument diagram on gender equality based on structured chat debate.

modified it. Comparison of these two diagrams shows that the students have rearranged the vertical and chronological structure of argumentation (Fig 2) into a more illustrative form (Fig 3). The students have also separated the argument boxes from each other so that the different chains of arguments can be seen more easily. Furthermore, they have deleted one explorative argument box (8 in Fig 2) and two boxes (2 and 10 in Fig 2), which were request templates. Finally, the students have added two new boxes based on the texts and constructed a new higher level argument box ('teachers have different gender expectations') so that they have moved one already existing argument (11 in Fig 2) into a commentary box. This change, where a distinction is made between a general level argument and an example justifying it, indicates higher-order thinking. In the same way, the students have distinguished an argument from the example by dividing one argument box (number 12 in Fig 2) into an argument and an example (box 12 and comment in it in Fig 3). In addition, the students have added two new comments: one exemplification (box 9 in Fig 3) and one caveat note (box 7 in Fig 3).

Students' feedback on usefulness of the different chat and argument diagram tools

Half of the students (8 of 16) found it easier to chat freely than face-to-face, and 7 students found the reverse. Most of the students did not like the idea of choosing their speech turns from ready-made templates (13 of 16). They also found it difficult to find a suitable response option (12/16). Furthermore, a majority (14/16) of the students would have wanted the structured chat tool to include more response templates. Most of the students also reported that they often chose the same templates (10/16). The same number of students, however, reported that it was easy to refer to statements with the help of numbers.

A majority of the students found it easy to construct (12/16) or to modify (11/16) the argument diagrams. More than one-half of the students (10/16) reported that constructing argument diagrams helped them to understand the topic of the debate from more diverse viewpoints. Accordingly, many students (11/16) reported that it was useful to construct argument diagrams when learning argumentation skills. Furthermore, nearly all the students (14/16) felt that argument diagrams helped them to understand the structure of an argumentative debate.

The students mentioned that constructing argument diagrams has the following advantages: it clarifies their thinking (6/16), it is useful and interesting (5/16), it helps one to structure and sum up the debate (4/16), and facilitates understanding of how an argument proceeds (3/16). Half of the students (8/16), however, found constructing the diagram difficult and also somewhat boring and time-consuming.

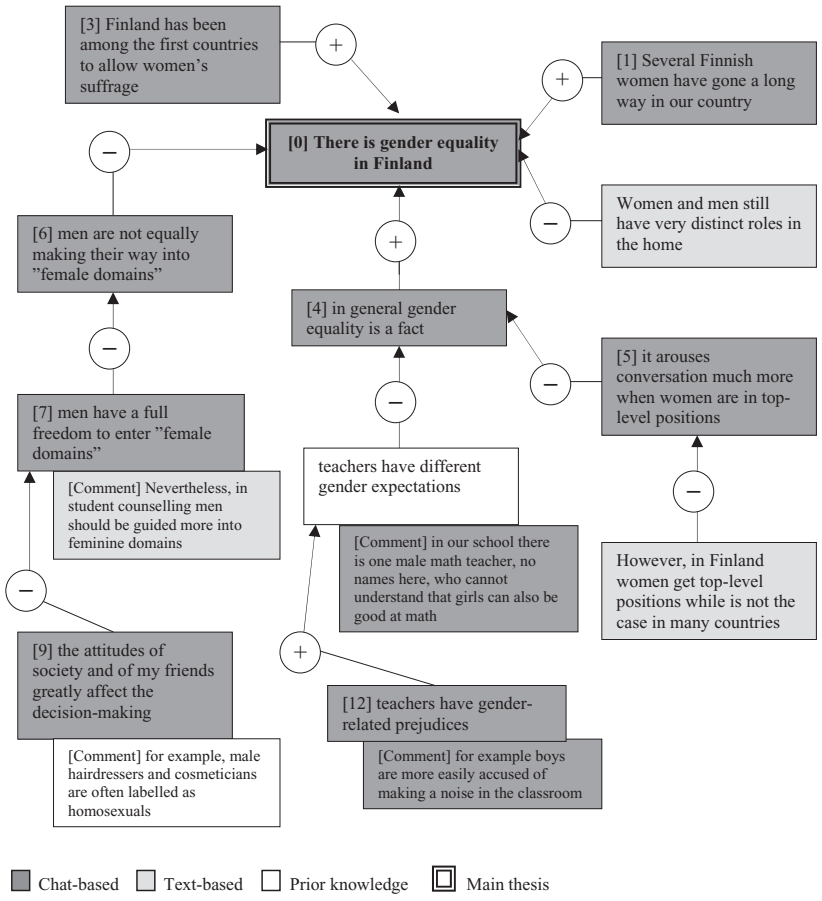

Fig 3 A modified argument diagram on gender equality based on structured chat debate.

Discussion

In this study, the students constructed argument diagrams on the basis of free chat debates or they modified automatically constructed diagrams on the basis of structured chat debates. The different types of diagrams did not differ from each other in terms of breadth, depth, and balance of argumentation. In addition, all the diagrams contained mostly counter-argumentation (M = 0.8). The resemblance of the different types of diagrams (free vs. modified) indicates that students themselves are able to analyse the salient argumentative content of their debate and thereby capture its argumentative structure.

Almost a third (30.3%) of the content of the free diagrams was based on the texts the students had read beforehand, whereas the respective proportion in the modified diagrams was only 2.7%. Thus, free construction of diagrams seems to activate students to integrate what they have read previously into their co-constructed diagrams (see also Marttunen & Laurinen 2007). This is in line with Mayer's (2001) statement that a combination of text and graphics supports learning.

In constructing and modifying their diagrams, the students mostly presented their arguments in the same order as they were presented in their debates. This result is in accordance with the finding that students usually take a narrative approach in designing argument diagrams (van Amelsvoort *et al*. 2007). Further, the students focused mainly on the content of the boxes and less on interlinks between the argument boxes in different argument chains. When modifying automatically constructed diagrams, the students had to work on the linear structure of the argumentation process to make sense of it. They broke up the chronological order of the arguments presented during their debates and rearranged the arguments into separate chains. To encourage students to pay more attention to the interlinks between argument chains in their diagrams, they could be asked to concentrate more on the visual organization

of arguments by clustering boxes on the same topic together, or by locating positive and negative arguments on different sides of the diagram (van Amelsvoort 2006; van Amelsvoort *et al*. 2008).

The purpose of combining two modes of representations (chat and diagram) in practising argumentation was to prompt students to integrate both their previous ideas and ideas presented in the texts they had read with the arguments put forward during the chat debates. The combining of ideas obtained from different sources has been shown to promote text comprehension (Stahl *et al*. 1996; King 2007). In this study, the combining of different text sources, chat and previously read texts, promoted students' deeper understanding of the discussion topics.

It was assumed at the outset of the experiment that the automatically constructed diagrams would reduce students' cognitive load and thus enable them to focus more on their previous knowledge; however, this was not the case. In fact, the freely constructed diagrams contained more previous knowledge (41% = 30.3% from the texts + 10.7% from the students' existing knowledge) than the modified diagrams (10% = 7.3% + 2.7%, respectively). Making diagrams by writing text into empty boxes that are easy to move and link with other boxes seems to support knowledge construction. In this study, the automatic construction of argument diagrams did not help the students in their knowledge work. In learning contexts, it is extremely important that technical tools are not allowed to do cognitive work on behalf of students. Even the attempt to decrease the cognitive load on students by transferring their ideas mechanically from structured chat debates to argument diagrams did not help them to develop their ideas further. Whether the use of templates and sentence openers designed to help students to concentrate solely on the argumentative content of texts fosters learning when practising argumentation remains a topic for further studies.

The results of the study indicated that when modifying an automatically constructed diagram the students concentrated mostly on checking that the diagram was meaningful in content. This result suggests that revising automatically constructed diagrams was an insufficient task to evoke students' higher-order thinking. It seems that students should have a more specific purpose for reformulating diagrams, such as utilizing the revised diagram in a writing task. Another way to utilize the computer's automatic construction of argument diagrams is to ask students to look at the diagrams simultaneously when they are discussing. This might support their reasoning processes. For example, students can focus on the differences in their opinions and elaborate their arguments by giving examples either to justify or criticise them. This may also broaden and deepen their discussion and foster co-construction of knowledge. The study by Munneke *et al*. (2003) showed that students discussed differences in their opinions and broadened the space of their debate more often when inspecting than when constructing diagrams.

Collaborative creation of new argument diagrams and revision of already existing diagrams seem to provide opportunities to students for both learning to argue and arguing to learn. When creating new diagrams on the basis of previous discussions, students have to analyse their discussions in order to find out the salient arguments and visualize them. These activities favour students' co-elaboration of knowledge (arguing to learn). When revising existing diagrams, students have to examine the structure of their argumentation and they should be explicitly prompted to elaborate their reasoning further, for example, by giving examples to justify their arguments (learning to argue). Thus, both creation and revision of argument diagrams can be regarded as useful means to support students' learning.

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II

ARGUMENTATION IN SECONDARY SCHOOL STUDENTS' STRUCTURED AND UNSTRUCTURED CHAT DISCUSSIONS

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ARGUMENTATION IN SECONDARY SCHOOL STUDENTS' STRUCTURED AND UNSTRUCTURED CHAT DISCUSSIONS

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ABSTRACT

Joint construction of new knowledge demands that persons can express their statements in a convincing way and explore other people's arguments constructively. For this reason, more knowledge on different means to support collaborative argumentation is needed. This study clarifies whether structured interaction supports students' critical and elaborative argumentation.The study compares the quality of secondary school students' argumentation during structured and unstructured chat interaction. The data consist of 16 dyadic chat discussions: 8 discussions concerned vivisection and 8 gender equality. Half of the discussions were carried out through structured chat, and the other half through unstructured chat. The results suggest that a structured chat environment evokes counterargumentation, also in topics that do not spontaneously provoke conflicting viewpoints. Further, structured chat seems to equalize communication between females and males. Overall, the results indicate that the further investigation and design of pedagogical means to structure collaborative argumentation is a worthwhile enterprise.

Today's social, cultural, political, and environmental realities have implications for thinking and learning, business and politics, human rights, and human conflicts (Paul & Elder, 2002). These realities are so complex and dynamic that advanced

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thinking skills are required to make sense of the world. Such thinking skills include the ability to express our thoughts in a convincing way, as well as to judge other people's views and arguments constructively. For this reason, the ability to put forward, develop, and evaluate arguments has been regarded as an important academic goal in secondary school (e.g., Marttunen, Laurinen, Litosseliti, & Lund, 2005).

Argumentation can also be seen as a means to learn. Engaging in argumentative discussion with peers helps students to broaden and deepen their viewpoints (see van Amelsvoort, 2006). Furthermore, Zohar and Nemet (2002) stated that argumentation skills are transferable, as reasoning abilities learned through argumentative discussions on a particular topic can also be applied in discussions in other areas. However, it has been shown that both adolescents (e.g., Chan, 2001) and university students (Marttunen, 1997) have difficulties in mastering argumentation skills.

Consequently, there is a need for learning environments which both promote students' argumentation skills and foster the acquisition of dialogical communication skills. In addition, formal learning environments should be meaningful for students in their everyday lives in one way or another. According to Dons (2008), a bridge must be built to span the digital gap between the culture of school and the technology culture of young people. Collaborative argumentation-based learning environments with chat facilities could bring these two cultures closer. However, in addition to utilizing new learning technologies, pedagogical practices need to be developed. This study responds to these challenges by focusing on the question of whether structured chat interaction promotes secondary school students' critical and elaborative argumentation and knowledge co-construction. The study compares secondary school students' argumentation during structured and unstructured chat discussions.

ARGUMENTATION AND LEARNING

Argumentation and learning are often intertwined, and their relationship is twofold (Schwarz, 2009). On the one hand, *learning to argue* means the acquisition of the skills needed during argumentation, such as being able to justify one's own claims, challenge others' claims and arguments, and respond to challenges by presenting counterchallenges. On the other hand, *arguing to learn* entails, for example, learning new ideas or clarifying old misconceptions through argumentation. When one student challenges his/her peer in a classroom debate, s/he is simultaneously both practicing argumentation and constructing new knowledge (Schwarz, 2009).

Argumentation has an important role in collaborative learning, as joint reflective and critical reasoning through dialogue has been seen as a prerequisite for collaborative learning (e.g., Mercer, 1996). Collaborative learning can be achieved by means of *collaborative argumentation* in which the participants strive

toward the common goal of attaining a better understanding of the issues in question by putting forward different points of view, claims, and arguments, and by exploring them in a deep and critical way (Litosseliti, Marttunen, Laurinen, & Salminen, 2005). Accordingly, Golanics and Nussbaum (2008) stated that collaborative argumentation is a social process in which individuals work together to construct, critique, and judge arguments.

Learning has often been seen as an active knowledge construction process, and argumentation has been seen as an essential means to keep this process alive (Dillenbourg & Schneider, 1995). Nussbaum (2008) emphasizes the importance of sociocognitive conflict and cognitive elaboration, as mechanisms associated with collaborative argumentation, in fostering knowledge construction and learning. From the Piagetian point of view, *sociocognitive conflicts* are essential in a person's learning. Such conflicts arise when one notices a difference between one's prior knowledge and one's new knowledge obtained through dialogue with other people (e.g., Webb, 1995). Sociocognitive conflicts are typical of argumentative dialogue when various opinions, and arguments in support of them, are presented. During the conflict-solving process, people explore the controversial issue together and refine their earlier conceptions to gain more elaborated and better reasoned knowledge. According to the *cognitive elaboration* theory, argumentation stimulates deeper learning (O'Donnell & King, 1998). Argumentation may trigger students to generate connections between concepts and prior knowledge (Wittrock, 1992), to repair their mental model about the learned domain (deLeeuw & Chi, 2003), and to examine and adopt alternative conceptions (Reiser, Tabak, Sandoval, Smith, Steinmuller, & Leone, 2001). In other words, argumentative elaboration can be seen as knowledge integration (Linn & Elyon, 2000). Constructive engagement in collaborative and elaborative argumentation requires those involved to carry out two processes: justification and negotiation (Leitão, 2000). The participants need to support their claims by giving reasons to justify their positions, and they need to examine and refine their claims when opposing claims have been presented.

From the Vygotskian point of view, *counterargumentation* connects interpersonal and intrapersonal processes. The interplay between these two processes leads to the construction of knowledge. Counterarguments enable students to move on from old to new perspectives on a topic (Leitão, 2000), that is, to broaden and deepen the space of debate, as van Amelsvoort (2006) put it. Leitão (2000, p. 336) emphasizes that the value of a counterargument is to call a speaker's point into question and give people grounds for examining their own views, not to falsify a claim. According to Nussbaum and Kardash (2005), people do not usually realize that rebutting opposite points of view also often increases the persuasiveness and credibility of their own arguments. In the study by Leitão (2003), for example, more than a half of the sample of college students (aged 18-19 years) viewed counterargumentation as a negative rhetorical strategy and thought that it would reduce the probability of the viewpoint being acceptable.

On the other hand, it has been shown that examining counterarguments may polarize positions (Leitão, 2000) and create social inhibition that may hinder learning (Andriessen & Schwarz, 2009). For example, if students adopt an adversarial style of communication, in which disagreements are overt, they are unlikely to consider their conflicting views together (Asterhan & Schwarz, 2007). Such an adversarial style does not promote understanding of an issue.

Leitão (2000) presented three strategies to formulate counterarguments, each of which has different implications for learning. The first counterargumentation strategy proposed by Leitão (2000) is that counterarguments can be used to *refute either the other person's position or arguments associated with it*. Through this kind of counterargumentation a person can indirectly support his/her own claim or position. This strategy is not a dialogical and constructive way to think critically, as it does not call into question the merit of the speaker's own argument. It also enables one to shift the focus of argumentation to the views expressed by the other person. Thus, this strategy is not a productive way to construct knowledge collaboratively.

Second, counterarguments can also be used to *question the truth of a claim or a statement the other person has presented*. This means that a person can dismiss a point merely by denying it or s/he can put forward a statement that may reverse the claim. The successful use of this counterargumentation strategy requires that a person has sufficient knowledge on the topic under discussion to be able to express a justified disagreement. The arguer should also consider how defensible his/her opposing view is. Nevertheless, the use of this strategy enables students to bring more relevant and accurate knowledge into discussion.

Third, a person may also use counterarguments to *question a reason-position link* included in the interlocutor's speech. When using this strategy the person has to use his/her knowledge of argument schemes, that is, the logical structure of informal arguments (e.g.,Walton, 2006), to challenge the other person's grounded position by indicating weaknesses in the link that connects the grounds with the position. In argumentative discussions, these links are frequently implicit, but during discussions on controversial topics the links between positions and arguments are likely to be questioned when they are made explicit and thus defensible. This strategy challenges a person to express more valid grounds to strengthen his/her arguments. The arguers also get practice in how to use such argument schemes more accurately.

HIGH QUALITY ARGUMENTATIVE DISCUSSION

High quality argumentative discussion is task-focused (Veerman, Andriessen, & Kanselaar, 2000). This means that students have to maintain a shared thematic focus during the discussion. Veerman et al. (2000) stressed that task-focused discussion enables students to engage both in critical argumentation, when they check, assess, challenge, and counter information, and in the production of

constructive activities such as adding, explaining, evaluating, summarizing, and transforming information. A good argumentative discussion is also balanced (Baker, Quignard, Lund, & van Amelsvoort, 2002). This means that there must be arguments both for and against the topic under discussion.

According to Felton (2004), the quality of argumentative discussion relies on the mastery of two sets of cognitive skills: argument construction and discourse strategy. *Argument construction* entails that a person can produce claims, arguments, justifications for arguments, counterarguments, and rebuttals to counterarguments. In a reciprocal interaction, topically related argumentative moves constitute argument sequences. The more argumentative moves in argument sequences, the more elaborative the argumentation is (Andriessen, Erkens, van de Laak, Peters, & Coirier, 2003). This facilitates learning, that is, co-construction of knowledge in order to gain a better understanding of the topic.

The purposeful use of *discourse strategies* means that a person is able to direct and manage discussion with questions, critiques, and rebuttals (Felton, 2004). This skill is also required to gain profit by argumentation in a dialogic context. Felton and Kuhn (2001) compared adolescents and young adults in the use of argumentative strategies when they discussed capital punishment in pairs. They found that extending or elaborating the partner's preceding utterance, and asking clarifying questions were more frequent strategies among adolescents than young adults, whereas interpreting (paraphrasing), counterarguing, and rebutting were more frequent strategies among young adults. The strategies of young adults were characteristic of more advanced argumentative discourse, as well as expert discourse.

CHAT-BASED ARGUMENTATIVE INTERACTION

It has been indicated that participants' engagement in cognitively high-level collaborative activities such as questioning, negotiation, reasoning, and argumentation is rare in virtual collaborative environments (e.g., Arvaja, Rasku-Puttonen, Häkkinen, & Eteläpelto, 2003). Synchronous computer-based interaction compared to asynchronous interaction may, however, offer advantages in promoting students' argumentative activities. According to Condon and Cech (1996), synchronous chat interaction clarifies students' thinking because the need for brevity during interaction may cause students to articulate their opinions and arguments more precisely. Morgan and Beaumont (2003) also found that chat interaction helped students to express more relevant, well-grounded, and logical arguments, and to offer examples and justifications more sharply to the point. Furthermore, in the experimental studies by Veerman (2000), synchronous computer-mediated communication contained more counterargumentative speech acts than asynchronous communication.

Chat-based communication may also cause a number of problems for knowledge construction and learning.

Chat-based interaction may suffer from incoherence of contributions, lack of coordination and focus, and insufficient feedback due to the lack of non-verbal communication (Herring, 1999; Pimentel, Fuks, & de Lucena, 2003). Furthermore, Burnett (2003) points out that due to the nature of chat as a communication channel, it is difficult to explore ideas in any depth or to explain the argumentative relations between claims, reasons, and justifications. Weger and Aakhus (2003) also found that arguments during chat interaction tended to be underdeveloped or unresponsive to those raised by other participants.

The problems encountered during chat communication can be overcome using both didactical and communicational means (Oehl & Pfister, 2010). *Didactical means* may include the use of particular combinations of collaborative activities, such as task sequencing, role-playing, scripting, or structuring. For example, students' interaction processes have been structured by using scripted collaboration and this has been shown to be beneficial for learning (Hämäläinen, 2008; Weinberger, Ertl, Fischer, & Mandl, 2005). Furthermore, Baker and Lund (1997) found that students' structured interaction was more reflective than their unstructured communication.

Communicational means may comprise the use of particular discourse units, such as adjacency pairs (question-answer, counterargument-rebuttal), prompts, or sentence openers to produce successful learning interaction. Hron, Hesse, Cress, and Giovis (2000) showed that structuring discussion by using prompts (microscripts), such as questions or rules for discussion, can help to maintain focus on the subject matter, decrease off-task talk, and lead to a more coherent discussion. McAlister (2004) used the AcademicTalk tool with sentence openers (such as "Can you give an example . . . ?", "I disagree because . . .") and found that students addressed previous arguments more clearly and examined and challenged more arguments compared with students using unstructured chat. However, students do not always use sentence openers in an intended way (Robertson, Good, & Pain, 1998), but instead tend to use the most generic sentence openers like "I think . . ." (McManus & Aiken, 1996). Students also reported that sentence openers excessively restrict their communication (Lazonder, Wilhelm, & Ootes, 2003). For these reasons, more attention should be paid to the creation of appropriate conditions and suitable tasks when using chat for constructive argumentation.

RESEARCH HYPOTHESES

In this study, upper secondary school students studied vivisection and gender equality by engaging in argumentative discussions through chat facilities. The study aims at clarifying whether dyadic discussions through structured and unstructured chat affect the quality of students' argumentation. The structured chat used in this study was based on the use of sentence openers designed to stimulate argumentative discussion between students. The quality of the students'

argumentative discussions was examined by clarifying how they constructed arguments, dealt with disagreements (counterargumentation), and directed and managed their interaction during chat discussions. The following research hypotheses were addressed:

1. Secondary school students are able to construct arguments and manage argumentative chat discussions (see Litosseliti et al., 2005; Veerman, 2000).
2. Students use constructive counterargumentation strategies (Questioning the truth of a claim or a statement, Questioning a reason-position link) more than the strategy "Supporting the opposite position" that is not a dialogical strategy to construct knowledge together (see Leitão, 2000).
3. The mode of chat (structured vs. unstructured; see McAlister, 2004), the discussion topic (vivisection vs. gender equality; see Golder & Pouit, 1999), and gender are associated with the quality of the discussions.

METHOD

Participants

The participants were 10 female and 7 male (aged 16-17 years) upper secondary school students enrolled in a course on Finnish language (mother tongue) and literature in a Finnish secondary school. Before participating in the study, the students had already been taught the main principles of argumentation and the main features of the technological tools used in the course.

Teaching Arrangements

A quasi-experimental counterbalanced design (Borg & Gall, 1989) was applied in the study. The students were divided into two groups and their discussions were carried out in two sessions on different days with two chat tools and two topics (Table 1). The discussion topic for the 1st session was vivisection and gender equality for the 2nd session. In the 1st session, group 1 engaged in the discussions through unstructured chat, and group 2 through structured chat. In the 2nd session, the order was reversed.

Table 1. Design of the Study

	Session	
Group	1st session, day 1	2nd session, day 2
Group 1	Vivisection, unstructured chat	Gender equality, *structured chat*
Group 2	Vivisection, *structured chat*	Gender equality, unstructured chat

The chat discussions consisted of introduction, preparation, and debate phases (Table 2). During the *introduction phase* (20/35 minutes), the students were taught how to use the unstructured and structured chat tools. To enhance the students' motivation toward the topics, they were asked to fill in a cloze test on vivisection and discuss gender-related topics on working life and vocational counseling. During the *preparation phase* (20 minutes) the students read three articles containing arguments both for and against the topic. The students were asked to think about the different viewpoints on the topics presented in the texts and how the viewpoints were supported.

During the *debate phase* the students engaged either in structured or unstructured chat discussions in pairs for 15 minutes. The teacher formed the student pairs so as to maximize the number of mixed gender pairs (see Swann, 1992). She also paired students whom she knew could work well together (see Blatchford, Kutnick, Baines, & Galton, 2003). There were six girl-boy pairs and two girl-girl pairs in the 1st session and seven girl-boy pairs and one girl-girl pair in the 2nd session. The students were asked to discuss the topic-related claims *Vivisection should be allowed / There is gender equality in Finland* on the basis of the articles they had read.

Chat Tools Used by the Students

The unstructured chat used by the students was regular synchronous textual chat integrated into an Internet-based learning environment (see Corbel, Girardot, & Jaillon, 2002). The structured chat tool (see Hirsch, Saeedi, Cornillon, & Litosseliti, 2004) consisted of four categorized sets of either full or partial sentences called templates (Table 3): (a) *Argument* (ask for and express an

Table 2. Organization of the Chat Discussions

Phase	Activity
Introduction (20/35 min)	Students trained with the unstructured and structured chat tools (1st session, 25 min). To motivate students to the topics they filled in a cloze test on vivisection (1st session, 10 min) and engaged in general discussion on gender equality (2nd session, 20 min).
Preparation (20 min)	Students read three articles on the topic in both sessions.
Debate (15 min)	Half of the students engaged in debate through unstructured chat and the other half through structured chat in both sessions.

Table 3. Examples of the Use of the Templates of the Structured Chat

Template set	Template	
Argument	1) Can you give an argument for statement X?	
	2) I support statement X because *several Finnish women have gone a long way in our country.*	
	3) Can you give an argument against statement X?	
	4) I attack statement X because *men are not yet equally making their way into "female domains."*	
Explore	5) Can you clarify statement X?	
	6) I would like to clarify statement X by saying that *in general gender equality is a fact.*	
	7) There is a problem between statement X and statement Y because *men have full freedom to enter "female domains."*	
	8) I retract statement X because *the attitudes of society and of my friends greatly affect the situation.*	
	9) Can you give an example to justify statement X?	
	10) I would like to justify statement X by saying that *in our school there is a nameless male teacher of maths who cannot understand that girls can be good in maths as well.*	
Opinion	11) I don't agree with statement X.	
	12) I agree with statement X.	
	13) I changed my opinion about statement X.	
	14) What is your opinion about statement X?	
Comment	15) Hello!	19) Hurry up!
	16) Bye!	20) Slow down!
	17) My turn.	21) I would like to talk about statement X.
	18) Your turn.	22) I see what you mean.

argument for or against a statement; (b) *Explore* (ask for and express a clarification of or justification for a statement, discover a problem between statements, or retract a statement); (c) *Opinion* (ask for an opinion, express agreement or disagreement without giving reasons, and express changed opinions about a statement without giving reasons); and (d) *Comment* (expressions relating to social, task or interaction management of the debate). The templates are based on certain regular patterns of argumentative strategies and rhetorical moves, and contain a reference to one or more previous statements. In this study, the purpose of the templates was to structure students' interaction and to stimulate their argumentation.

Table 3 illustrates how the students used the templates in debating gender equality. The templates are given in regular font and examples of the students' contributions in *italics*; "X" refers to the number of a speech turn.

Data

The data consist of 16 dyadic chat discussions (Table 4): 8 debates were carried out by structured chat, and 8 by unstructured chat. The total number of speech turns was 609. The 10 female students presented 335 (55%) speech turns, and the 7 male students 274 (45%) speech turns.

Data Analyses

Quality of Discussions

In analyzing the quality of argumentative discussions, a speech turn was applied as a unit of analysis. A speech turn was defined as a single chat message that a student wrote and sent. Students' speech turns were classified into argument construction and discourse management categories (see Felton, 2004). The argument construction categories were argument and justified disagreement, and the discourse management categories were request, opinion, agreement/unjustified

Table 4. Data of the Study

Mode of chat	Topic	Number of chat discussions	Number of speech turns
Structured	Vivisection	4	94
	Gender equality	4	95
Unstructured	Vivisection	4	188
	Gender equality	4	232
Total		16	609

disagreement, comment, and off-task. These seven speech turn categories were mutually exclusive. The analytical categories are described below.

Argument construction categories—By putting forward speech turns in these two categories, students were able to broaden and deepen their argumentative knowledge on an issue.

1. *Argument.* This category includes speech turns in which students put forward arguments or explored arguments to support a claim or a statement.
2. *Justified disagreement.* When students put forward an argument against a claim or a statement, indicated a problem between two statements, or retracted a statement with a reason, the speech turn was classified as justified disagreement.

Discourse management categories—By the speech turns included in these categories, students maintained and/or directed the discussion.

3. *Request.* All speech turns in which students asked for an argument, a counterargument, a clarification, a justifying example, or an opinion on a statement were classified as a request.
4. *Opinion.* When students expressed an opinion on an issue, took a position on a statement or issue, or changed their opinion on an issue, without giving reasons, the speech turn was classified as an opinion. For example, during an unstructured chat one student expressed an opinion that "animal experiments should be allowed" (speech turn 424).
5. *Agreement/unjustified disagreement.* If a student expressed agreement or disagreement with a statement without giving reasons, the speech turn was classified as agreement or an unjustified disagreement respectively.
6. *Comment.* Students' speech turns concerning the social, interaction, or task management of the discussion were classified as comments.
7. *Off-task.* This category includes speech turns which were unrelated to the task.

In determining the reliability of the analysis, 10% of the speech turns (61 in total) encompassing both modes of chat were cross-analyzed by two judges. The inter-rater reliability of the analysis was .74 (Cohen's Kappa).

Example of the analysis of the chat discussion—Table 5 presents an extract from one debate on vivisection and an analysis of the speech turns exchanged between one student pair (Anna and Leo) using the structured chat tool. The students started their debate by stating their positions: Anna was against vivisection (speech turn 74) and Leo was in favor of it (speech turn 75). Next Anna asked Leo to support his position, and Leo responded to Anna by presenting his first argument (speech turns 77 and 78). Anna challenged this by presenting a counterargument (turn 80). Next, the students engaged in mutual argumentative discussion (speech turns 82-85). When Leo expressed agreement with Anna

Table 5. Example of an Analysis of a Structured Chat on Vivisection (translated from Finnish)

No. of speech turn	Student	Speech turn	Category of speech turn
—	—	Vivisection should be allowed (the already given main claim)	—
74	Anna	I don't agree with statement [Vivisection should be allowed].	Unjustified disagreement
75	Leo	I agree with statement [Vivisection should be allowed].	Agreement
76	Leo	I would like to talk about statement [Vivisection should be allowed].	Comment
77	Anna	Can you give an argument for statement [Vivisection should be allowed].	Request
78	Leo	I support statement [Vivisection should be allowed] because *without animal experiments we do not get new reliable knowledge for developing new medicines and medical treatments.*	Argument
79	Leo	Your turn.	Comment
80	Anna	I attack statement [*without animal experiments we do not get new reliable knowledge for developing new medicines and medical treatments*] because *the test results from animal experiments cannot be applied to humans because of differences between the species.*	Justified disagreement
81	Anna	Your turn.	Comment

82	Leo	I attack statement [*the test results from animal experiments cannot be applied to humans because of differences between the species*] because *without animal experiments medicines would have to be tested on humans.*	Justified disagreement
83	Anna	I attack statement [*without animal experiments medicines would have to be tested on humans*] because *the test results of animal experiments tell, for example, only about the injurious effects of certain chemical on a rat. Thus, the results are not reliable.*	Justified disagreement
84	Leo	Can you give an example to justify statement [*the test results of animal experiments tell, for example, only about the injurious effects to certain chemical received by a rat. Thus, the results are not reliable.*]?	Request
85	Anna	I would like to justify statement [*the test results of animal experimens tell, for example, only about the injurious effects to certain chemical received by a rat. Thus, the results are not reliable.*] by saying *that some of the injurious effects of chemicals occur only in humans, and thus do not occur in laboratory animals. Additionally, the tested and approved chemicals might alone or together with some other chemicals cause side effects for which a pharmaceutical company is no longer responsible.*	Argument
86	Anna	Your turn.	Comment
87	Leo	I agree with statement [*that some of the injurious effects of chemicals occur only in humans, and thus do not occur in laboratory animals . . .*].	Agreement
88	Anna	What is your opinion about statement [Vivisection should be allowed]?	Request
89	Leo	I agree with statement [Vivisection should be allowed].	Agreement

Note: Templates are given in regular font, the students' contributions in *italics*, and the brackets indicate the previously expressed speech turn.

(turn 87), Anna asked Leo to re-express his opinion (either agree or disagree) on vivisection. Leo has not, however, changed his opinion.

Table 6 illustrates an analysis of an unstructured chat discussion between a student pair (Jenni and Mari). In the discussion, both students had the same opinion on vivisection: they do not favor animal experiments. For this reason, they only put forward arguments that supported their congruent antagonistic opinions on vivisection (speech turns 468-471). Jenni expressed (turn 472) reluctance to think up any argument contrary to her own opinion. Finally, Mari composed an argument that supported animal experiments.

Counterargumentation Strategies

When the students put forward a justified disagreement they often simultaneously used a counterargumentation strategy. To examine the quality of the students' counterargumentation strategies, the students' speech turns classified earlier as justified disagreements (n = 121) were sub-categorized into three categories (see Leitão, 2000):

Supporting the opposite position—This counterargumentation strategy was used when a person disagreed with his/her interlocutor by expressing a counterargument that supports a position opposed to that of his/her interlocutor.

In the example below, Nora expressed a counterargument against Ari's statement. Ari was in favor of vivisection and he supported his position by the argument that *he wants to take safe and tested medicines*. Nora's counterargument (justified disagreement) was not directed at Ari's argument for vivisection; instead, she supported the opposing position (vivisection should *not* be allowed) by saying that *there are alternatives to animal experiments*.

> Ari: Vivisection should be allowed because *I want to take safe and tested medicines.* [speech turn 64]
>
> Nora: I attack statement [I want to take safe and tested medicines] because—*okay, everyone does, but there are more reliable alternatives to animal experiments.* [turn 65]

Questioning the truth of a claim or a statement—This counterargumentation strategy was used when a person wanted to prove that the interlocutor's claim or statement is incorrect. In the example below, Iiro disagreed with the statement that *test animals will suffer from experiments* by presenting the counterargument that *if test animals are given enough strong stuff before experiments they do not suffer from these experiments*. Janita in turn questioned the truth of Iiro's statement by saying that *animals are not given any other drugs because they could affect the test results*. Consequently, Iiro's earlier argument was invalid, so he cannot use it any more.

Table 6. Example of an Analysis of an Unstructured Chat on Vivisection (translated from Finnish)

No. of speech turn	Student	Speech turn	Category of speech turn
466	Jenni	Okay . . I. What do you think about animal experiments? Should they be allowed?	Request
467	Mari	No.	Unjustified disagreement
468	Jenni	I agree. One good reason is that they are not that useful.	Agreement
469	Mari	Right. Only rarely have some real results been reached.	Argument
470	Jenni	Exactly, and in spite of that that animals are continually tortured without any good reason. However, I do not really love rats that much.	Argument
471	Mari	Yeah. I wouldn't take a big rat as a pet either, but nevertheless they also have a right to a meaningful and nice life.	Argument
472	Jenni	You can say that again! I can't think of anything to say that would support animals experiments.	Comment
473	Mari	I'm trying right now to think of an argument in supporting of it: veterinary medicine needs animal experiments of course.	Justified disagreement

Iiro: I attack statement [test animals suffer also from experiments] because *test animals do not suffer if they get enough strong stuff in their veins.* [turn 50]

Janita: I attack the statement [test animals do not suffer if they get enough strong stuff to veins] because *test animals are not given any other drugs because they could affect the test results.* [turn 52]

Questioning a reason-position link—This counterargumentation strategy was used when a person wanted to indicate that the interlocutor's argument (or a reason) for his/her position is inefficient. The argument used may be true as such but its argumentative power to support the position in question is weak.

In the example below, taken from a structured chat discussion, Erika attacked the statement that the benefits from animal experiments are small by pointing out that *through experiments we can produce new information about diseases and develop new medicines* (a reason). The reason she presented indicates that she is for permitting animal experiments (a position).

Jari questioned the efficacy of the Erica's justification of animal experiments by putting forward a counterargument stating that *animals are different to humans, and that medicines suitable for animals may be dangerous to humans*. In this way Jari questioned Erika's implicit reason-position link, that is, animals and humans are similar.

Erika: I attack statement [the benefit from experiments is very small] because *we get new information about diseases and we can develop new medicines by animal experiments.*[turn 13]

Jari: I attack statement [We get new information from diseases and we can develop new medicines by animal experiments] because *animals are different to humans, and drugs which are suitable to/for animals can be dangerous to humans.* [turn 17]

The inter-rater reliability of the analysis of the counterargumentation strategies (10% of the data) was .71 (Cohen's Kappa).

Statistical Analysis

The purpose of the statistical analyses was to clarify whether the independent variables, that is, the mode of chat (structured vs. unstructured), topic (vivisection or gender equality), and gender (female/male) were associated with the dependent variables of the quality of argumentative discussion, that is, the variables of argument construction, discourse management, and counterargumentation strategies. The dependent variables divided the speech turns into two categories according to whether the property in question appeared in the speech turn or not. Since the study interest was explanatory, that is, the independent and dependent variables were pre-determined and categorical in

nature, the use of logit models (Kennedy, 1988) was an appropriate way to clarify the associations between the variables. (The statistical analyses were performed with PASW Statistics 18.)

Ten separate logit analyses were carried out. The dependent variable varied in the different analyses, while the independent variables were the same. The variables used in the analyses are described in Table 7. The logit analyses were implemented by starting from the saturated model, in which all the possible main and interaction effects of the independent variables with the dependent variable were taken into account. Next, all the statistically non-significant parameters were dropped from the model step-by-step according to the hierarchy principle, by starting from the higher order terms and ending with the minimal acceptable model that fit with the data ($p > .05$) and included as few statistically significant parameters as possible. The minimal acceptable models of the logit analyses, including statistically significant parameters, are summarized in Appendix.

RESULTS

Quality of Argumentative Discussions in Structured and Unstructured Chat

The students constructed arguments in 37% of their speech turns, and 63% of their speech turns belonged to the discourse management categories (see Table 8).

Argument Construction

During the chat discussions, 121 (20%) of the students' speech turns were in the category justified disagreements and 106 (17%) were arguments (Table 8).

Logit analysis 1 (Appendix) revealed that both topic (X12) and gender (X13) were associated with the number of arguments (X1): the students put forward more arguments in the discussions on gender equality than in the discussions on vivisection (21% vs. 14%; Table 9) and the female students produced more arguments than the male students (21% vs. 13%; Table 9).

Logit analysis 2 (Appendix) showed also that the mode of chat (X11) was associated with the students' production of justified disagreements (X2). In addition, in logit analysis 2 (Appendix), an interaction effect of the mode of chat (X11) and topic (X12) on justified disagreement (X2) was found. This result indicated that during the unstructured chat discussions, justified disagreements (X2) were more common on the vivisection than gender equality topic (28% vs. 12%; Table 9). However, during the structured chat discussions, the students expressed justified disagreements nearly as often on both topics (22% vs. 21%; Table 9).

Table 7. Variables Used in the Logit Analyses

	Dependent variables		
Independent variables	Argument construction variables	Discourse management variables	Counterargumentation strategy variables
X11 Mode of chat	X1 Agrument	X3 Request	X8 Supporting the opposite position
X12 Topic	X2 Justified disagreement	X4 Opinion	X9 Questioning the truth of a claim or a statement
X13 Gender		X5 Agreement/unjustified disagreement X6 Comment X7 Off-task	X10 Questioning a reason-position link

Table 8. Frequencies and Proportions of Speech Turn Categories in Structured and Unstructured Chat

	Structured chat		Unstructured chat		Total	
Analysis categories	f	%	f	%	f	%
Argument construction						
Justified disagreement	41	22	80	19	121	20
Argument	28	15	78	19	106	17
Total	69	37	158	38	227	37
Discourse management						
Comment	54	29	124	30	178	29
Opinion	5	3	67	16	72	12
Request	33	17	28	7	61	10
Agreement/unjustified disagreement	28	15	12	3	40	7
Off-task	0	0	31	7	31	5
Total	120	63	262	62	382	63
Total	189	100	420	100	609	100

Table 9. Significant Associations (Logit Analyses) of Argument Construction and Discourse Management

	Independent variables			
Dependent variables	Main effect: Mode of chat (X11)	Main effect: Topic (X12)	Main effect: Gender (X13)	Interaction effect: Mode of chat by Topic (X11 by X12)
Argument construction				
Argument (X1)		V: 14% GE: 21%	M: 13% F: 21%	
Justified disagreement (X2)	SC: 22% UC: 19%			Vivisection: SC: 22%, UC: 28% Gender equality: SC: 21%, UC: 12%
Discourse management				
Request (X3)	SC: 17% UC: 7%		M: 7% F: 13%	
Opinion (X4)	SC: 3% UC: 16%			
Agreement/unjustified Disagreement (X5)	SC: 15% UC: 3%			

Note: SC = Structured chat; UC = Unstructured chat; M = Male; F = Female; V = Vivisection; GE = Gender equality; the unit of analysis was a speech turn (N = 609).

Discourse Management

To manage and maintain the discourse during the chat discussions 178 (29%) of all the students' speech turns were in the category comments, 72 (12%) were opinions, 61 (10%) were requests, 40 (7%) were agreements or unjustified disagreements, and 31 (5%) were off-task speech turns (Table 8).

Logit analyses 3, 4, and 5 (Appendix) showed that the mode of chat (X11) was associated with the students' expressions of requests (X3), opinions (X4), and agreements or unjustified disagreements (X5). When the students were engaged in the structured chat environment, they presented both requests (17% vs. 7%; Table 9) and agreements or unjustified disagreements (15% vs. 3%) more often than in the unstructured chat environment. In contrast, the students presented more opinions in the unstructured than structured chat environment (16% vs. 3%).

Gender (X13) was also found to be associated with requests (X3; analysis 3 in Appendix). The female students presented more requests than the male students during the chat discussions regardless of the mode of chat (13% vs. 7%; Table 9).

Counterargumentation Strategies

When the students presented justified disagreements (n = 121), they most often used "Questioning a reason-position link" (46%; Table 10) and "Supporting the opposite position" (32%) as their counterargumentation strategies. Their least used strategy was "Questioning the truth of a claim or a statement" (22%).

Logit analysis 8 (Appendix) revealed that both topic (X12) and gender (X13) were associated with the counterargumentation strategy "Supporting the opposite position" (X8): the students used this strategy more often in the chat discussions on vivisection than on gender equality (9% vs. 4%; Table 11), and this strategy was more common among the male than the female students (9% vs. 5%; Table 11).

Logit analysis 9 (Appendix) showed that the mode of chat (X11) and gender (X13) had a statistically significant interaction effect on "Questioning the truth of a claim or a statement" (X9): the female students questioned the truth of a claim or a statement more often than the male students during the structured chat discussions (9% vs. 1%; Table 11), whereas, during the unstructured chat discussions, the male students used this strategy more often than the female students (5% vs. 3%; Table 11).

Logit analysis 10 (Appendix) also showed that topic (X12) was associated with the counterargumentation strategy "Questioning a reason-position link" (X10): this strategy was more common in the discussions on vivisection than those on gender equality (12% vs. 7%; Table 11).

Table 10. Frequencies and Proportions of Counterargumentation Strategies in Structured and Unstructured Chat

	Structured chat		Unstructured chat		Total	
Counterargumentation strategy	f	%	f	%	f	%
Questioning a reason-position link	16	39	39	49	55	46
Supporting the opposite position	15	37	24	30	39	32
Questioning the truth of a claim or a statement	10	24	17	21	27	22
Total	41	100	80	100	121	100

Table 11. Significant Associations (Logit Analyses) of Counterargumentation Strategies

	Independent variables			
Dependent variables	Main effect: Mode of chat (X11)	Main effect: Topic (X12)	Main effect: Gender (X13)	Interaction effect: Mode of chat by Gender (X11 by X13)
Counterargumentation strategy				
Supporting the opposite position (X8)		V: 9% GE: 4%	M: 9% F: 5%	
Questioning the truth of a claim or a statement (X9)	SC: 5% UC: 4%		M: 4% F: 5%	Male: SC: 1%, UC: 5% Female: SC: 9%, UC: 3%
Questioning a reason-position link (X10)				

Note: SC = Structured chat; UC = Unstructured chat; M = Male; F = Female; V = Vivisection; GE = Gender equality; the unit of analysis was a speech turn (N = 609).

DISCUSSION

In this study, we focused on the question of whether secondary school students' argumentation can be promoted by structuring synchronous network interaction. The question was answered by examining the quality of argumentative discussions through argument construction, discourse management, and the use of counter-argumentation strategies.

Quality of Argumentative Chat Discussions and the Use of Counterargumentation Strategies

The results were in line with Hypotheses 1 and 2: The secondary school students were able to construct arguments and manage their argumentative chat discussions. They also used more constructive counterargumentation strategies (Questioning a reason-position link; Questioning the truth of a claim or a statement) than the unconstructive strategy "Supporting the opposite position" (68% vs. 32%; Table 10).

The conclusion that secondary school students are able to construct arguments and manage their chat discussions is supported by the results that in 37% of their speech turns the students constructed arguments and presented justified disagreements, and in 17% of their speech turns they stimulated argumentative discussion by presenting requests, for example, for arguments, counterarguments, and justifications. The students' interaction was also quite counterargumentative as one-fifth of their speech turns were categorized as justified disagreements. There were also very few off-task speech turns (31 in total; 5%) in the students' chat discussions.

Using a structured chat tool based on templates developed in particular to target argumentative and reciprocal dialogue, the students engaged in communication that was task-focused in nature, as no off-task speech turns were observed. In the unstructured chat environment, the proportion of off-task talk was also low (7%). The students were well-prepared for engagement in argumentative discussions as they had read topic-related texts and engaged in motivating activities before the discussions. The argumentative nature of the discussions and the small proportion of off-task talk suggest that in this study the students avoided the typical problems of chat discussions, such as lack of coordination and focus (Pimentel et al., 2003), and difficulties in exploring and developing ideas and arguments (Burnett, 2003; Weger & Aakhus, 2003).

Associations of the Mode of Chat, Topic, and Gender with the Quality of Chat Discussions

The results verified Hypothesis 3: The mode of chat, topic, and gender are associated with the quality of the discussions. These associations will be discussed

in the following sub-sections: Argument construction, discourse management, and counterargumentation strategies.

Argument Construction

The results indicated that the proportion of arguments presented during the chat discussions was related to both the discussion topic and gender, but not to the mode of chat. The proportion of arguments proved higher when the discussion topic was gender equality compared to vivisection, although similar preparation phases were conducted in order to achieve a comparable basis for discussion on each topic. One explanation for this difference might be that gender equality is a common and everyday life topic. It does not necessarily presume more information than everyone has. On the contrary, vivisection as a discussion topic might not be so interesting and the students might not have enough prior knowledge on it. These results are in line with the study by Means and Voss (1996), who found that prior knowledge has an effect on the number of reasons generated.

The female students expressed more arguments than the male students (21% vs. 13%). One explanation for this might be that, in general, female students both excel in verbal skills (e.g., OECD, 2009) and tend to be more diligent than male students; this could mean that they might also prepare themselves more carefully for discussions and hence be able to produce more arguments than male students. Females have also been found to produce more justifications than male students both online and offline (Herring & Martinson, 2004). Both of the discussion topics used in the present study may also have inspired female students more than male students to present arguments.

The results of the statistical analyses indicated that the mode of chat and topic had an interaction effect on the proportion of *justified disagreements* in the students' discussions: justified disagreements were more common during the unstructured chat discussions on vivisection than that on gender equality (28% vs. 12%). During the structured chat discussions, the students put forward justified disagreements nearly as often on both topics (22% vs. 21%). These results suggest that a structured chat environment evokes counterargumentation also on topics that do not spontaneously provoke different conflicting viewpoints, like gender equality in this study. Topics of this kind do not by their nature offer debaters clear for or against positions. In the case of vivisection, the students probably found it easier to take either the role of a proponent or an opponent, favoring or rejecting animal experiments. Thus, a structured discussion seems to be an appropriate method for practicing argumentation also on topics which do not necessarily polarize debaters into the roles of proponents and opponents.

Zohar and Nemet (2002) point out that the nature of both the argumentative task and the topic affect the quality of argumentation. They differentiate tasks

and topics according to features which cause persons to commit themselves to a position on a topic and to express opposing views. For example, asking for evidence or reasons for a causal phenomenon is a different task from asking a person to justify his/her opinion on an issue. In addition, the nature of the topic might affect the students' task performance. Hence, it is crucial whether the topic to be discussed is authentic in nature, having a connection to the students' daily lives, or an arbitrary one without any such connection. In our study, both topics offered students the possibility to take a subjective stand. However, the nature of the dilemma contained in the topics may have been different. Gender-related topics have relevance to students' daily lives whether they are male or female, but these topics also invite objective as well as subjective examination. Vivisection, in turn, was not necessarily a daily topic for all the students. Maybe it was a more familiar topic for the female than male students, as several studies have reported that women have stronger environmental attitudes and behaviors compared to men (Zelezny, Chua, & Aldrich, 2000), such as in relation to cosmetics (Kim & Chung, 2011). Thus, female students' opinions on animal experiments, which have been strongly connected with the cosmetics industry, may also affect their argumentation.

Previous studies have shown that using authentic problems, which relate to students' lives, may foster students' argumentative abilities (Patronis, Potari, & Spiliotopoulou, 1999; Zeidler, Sadler, Applebaum, & Callahan, 2009). Udell (2007) found that adolescent girls' argument skills transferred only if they first focused on a personally relevant topic (teenage pregnancy), and then on a less personal topic (capital punishment). When designing future research, it would thus seem to be important to pay attention to discussion topics from the point of view of gender.

Discourse Management

The students expressed more requests and unjustified agreements or disagreements, but fewer opinions, during the structured than unstructured chat. These results can be explained by the use of the templates during the structured chat: the structured chat tool included templates both for requesting (templates 1, 3, 5, 9, and 14 in Table 3) and for expressing agreement or unjustified disagreement (templates 11 and 12).

The results also indicated that the female students presented more requests than the male students. This can be explained in accordance with the notion that female students seem to take on some responsibility for furthering knowledge. Female students have also previously been shown to focus more on collaboration than male students when they argue via chat (Carr, Cox, Eden, & Hanslo, 2004). Furthermore, Li (2002) found that female students' interaction contained more

requests for information than male students' interaction when an online learning environment was used.

Counterargumentation Strategies

The results indicated that both topic and gender were associated with the students' counterargumentation strategies. When the discussion topic was vivisection compared to gender equality, the students more often supported the opposing position or questioned the reason-position link. These results suggest that the students may have had quite strong opinions on vivisection already before the chat discussions. During the discussions they merely sought to defend their own positions. In addition, the students seem to have had sufficient knowledge on vivisection to be able to question the links between reasons and positions. These results suggest that the students may be capable of engaging in informal reasoning if they have both enough knowledge and strong attitudes on the topic.

However, supporting the opposite position as a counterargumentation strategy is not a dialogical and constructive way to think critically because it does not bring the merit of the interlocutor's arguments into question (see Leitão, 2000). In this study, this strategy seems to be typical of male students in particular, albeit the difference between males and females (9% vs. 5%) was quite small.

The results also showed that the female students questioned the truth of a claim or a statement more often than their male peers during the structured chat discussions (9% vs. 1%; Table 11). The male students, in contrast, used this counterargumentation strategy more often during the unstructured chat discussions (5% vs. 3%; Table 11).

These results are in line with the findings of previous studies that male students are inclined to engage in conflict and they have a more assertive, competitive, and adversarial conversation style compared to females (Carr et al., 2004; Herring, 1996). In the structured chat environment, the use of an adversarial conversation style by the male students was not supported because the structured chat guided them, not necessarily to attack but, first, to consider what they want to say, and then to choose a suitable template with which to express their statement. The templates were rather neutral, that is, not very emotionally loaded. In contrast to the male students, the structured chat templates seemed to help the female students to employ a more adversarial communication style than they normally use. In other words, the templates render this kind of discussion style more socially acceptable for females. Thus, structuring a discussion seems to level out gender differences in communication. This can also make an argumentative discussion between males and females more explorative and thus more beneficial for students' learning. Explorative talk has been shown to promote co-construction of knowledge (Mercer, 1996). However, as observed by Robertson, Hewitt, and Scardamalia (2003), gender differences in communication

styles should not be seen as a problem but as a facilitator of the construction of knowledge. The adversarial style of males can provide a challenging space for knowledge construction, while the collaborative style of females can facilitate the sharing of ideas and their further elaboration.

Limitations of the Study

The results of this study should be interpreted cautiously since the number of students was small. Another limitation is that the task might have caused cognitive overload for a novice arguer (see Kuhn & Udell, 2003), as both argumentation and counterargumentation are demanding cognitive tasks. The students also had to manage several parallel processes: formulating one's own arguments, judging interlocutor's arguments, and managing the discussion. In addition to engaging in a demanding argumentation task, the students used structured chat for the first time. Thus, they might have needed more training in order to be able to use the structured chat tool more successfully as a learning aid.

Implications of the Study

This study offers many possibilities to design and examine further the pedagogical structuring of collaborative argumentation and counterargumentation processes when students engage in argumentative discussion in computer-based learning environments for the purpose of improving their understanding of specific learning issues. Despite the limitations of the study, it showed that structured and unstructured chat environments are suitable for argumentation-based studies of learning content in secondary school. It must, however, be borne in mind that not only the learning environment, but also the learning task and discussion topic are important factors in facilitating student engagement in effective argumentative discussion in order to co-construct knowledge.

Students' argumentation could be supported by more specific prompts than were used in this study. In further studies, it would be interesting to examine whether specific prompts designed to support, in particular, students' counterargumentation during online discussions broaden and deepen their argumentation on a learning issue.

The study also showed that the discussion topic is an important factor when practicing argumentation. Even if structured chat seemed to moderate the effects of the topic to bring about constructive argumentative discussion among students, it did not take into account the gender-related nature of the topic. Therefore, comparisons between discussions on female-related, male-related, and gender-neutral topics from the point of view of collaborative argumentation are also an important area for future research.

APPENDIX
Summary of Logit Analyses (Minimal Acceptable Models)

Parameter	Estim.	*SE*	*z*	*p*
Argument construction variables				
Analysis 1: (*G2* = 7.16, *df* = 5, *p* = .209)				
X1 (Argument)	1.09	.17	6.62	***
X1 by X12 (Topic)	.53	.22	2.36	*
X1 by X13 (Gender)	.60	.23	2.67	**
Analysis 2: (*G2* = 7.75, *df* = 4, *p* = .101)				
X2 (Justified disagreement)	1.32	.25	5.25	***
X2 by X11 (Mode of chat)	.66	.32	2.06	*
X2 by X12 (Topic)	–.08	.35	–.22	ns
X2 by X11 by X12	–.95	.44	–2.17	*
Discourse management variables				
Analysis 3: (*G2* = .19, *df* = 5, *p* = . 999)				
X3 (Request)	1.24	.22	5.71	***
X3 by X11 (Mode of chat)	1.11	.28	4.03	***
X3 by X13 (Gender)	.78	.30	2.61	**
Anaysis 4: (*G2* = 7.89, *df* = 6, *p* = .246)				
X4 (Opinion)	3.61	.45	7.96	***
X4 by X11 (Mode of chat)	–1.94	.47	–4.12	***
Analysis 5: (*G2* = 2.56, *df* = 6, *p* = .862)				
X5 (Agreement/unjustified disagreement)	1.75	.21	8.54	***
X5 by X11 (Mode of chat)	1.78	.36	4.97	***
Analysis 6 (X6 Comment) and 7 (X7 Off-task) (no statistically significant parameters)				
Counterargumentation strategy variables				
Analysis 8: (*G2* = 7.01, *df* = 5, *p* = .220)				
X8 (Supporting the oppositive position)	3.56	.36	10.01	***
X8 by X12 (Topic)	–.85	.35	–2.44	*
X8 by X13 (Gender)	–.79	.34	–2.31	*
Analysis 9: (*G2* = 8.45, *df* = 4, *p* = .076)				
X9 (Questioning the truth of a claim or a statement)	2.34	.35	6.69	***
X9 by X11 (Mode of chat)	1.14	.52	2.20	**
X9 by X13 (Gender)	2.12	1.07	1.99	*
X9 by X11 by X13	–2.72	1.18	–2.31	*
Analysis 10: (*G2* = 3.14, *df* = 6, *p* = .791)				
X10 (Questioning a reason-position link)	2.63	.22	11.91	***
X10 by X12 (Topic)	–.61	.29	–2.11	*

*$p < .05$; **$p < .01$; ***$p < .001$.

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III

DEFENDING EITHER A PERSONAL OR AN ASSIGNED STANDPOINT: ROLE PLAY IN SUPPORTING SECONDARY SCHOOL STUDENTS' ARGUMENTATION FACE TO FACE AND THROUGH CHAT

by

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Defending either a personal or an assigned standpoint

Role play in supporting secondary school students' argumentation face to face and through chat

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This study clarifies whether a specific type of role play supports upper secondary school students' collaborative argumentation. Data consist of 12 dyadic face-to-face and 12 chat debates. Data analysis focused on the quality of students' argumentation. Comparisons were made between students who defended standpoints at variance with their personal opinions on the topics, between the two study modes and topics, and by gender. When the students defended a standpoint differing from their personal opinion, the male students engaged in counterargumentation more often than the female students. When, in turn, the students defended their personal standpoint, they produced both counterargumentative and non-argumentative speech turns equally often, and their arguments were more poorly elaborated than when they defended an assigned standpoint. The study suggests that role play in which both counterargumentation and students' personal standpoints on an issue are taken into account is a viable means to support students' high quality argumentation.

Keywords: argumentation, collaborative learning, computer chat, role play, standpoint, upper secondary school

1. Introduction

In public debates on many societal topics, such as environmental and ethical issues, we are often asked to take a stand on the issue at stake. For discussion to be productive, it would be important to evaluate the validity and adequacy of the arguments put forward by other people before deciding what side to take

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in the argument. This evaluation process requires ability in argumentation, and is often mentioned as one of the most important aims of education at different school levels (e.g., Marttunen, Laurinen, Litosseliti, and Lund 2005). University and secondary school students' argumentation skills have, however, been found to be rather weak (Larson, Britt, and Larson 2004; Marttunen 1997; Marttunen et al. 2005). Further, because the skills involved in argumentation appear to be complex (Kuhn and Udell 2007; Walton 1989), argumentation is a demanding competence both to learn and teach (Chinn 2006).

Argumentation, as a demanding socio-cognitive task, rarely occurs spontaneously in school contexts (Andriessen and Schwarz 2009). Namely, motivation to engage in argumentation depends on who you are arguing with, what you are arguing about, what context you are arguing in, and why you are arguing (Muller Mirza, Perret-Clermont, Tartas, and Iannaccone 2009). The topics to be learned in school may not always be that motivating; the knowledge-centered school context might lack the emotional aspects central to engagement in argumentation (Andriessen, Baker, and van der Puil 2011; Baker, Andriessen, and Järvelä 2013; Ben-Ze'ev 1995), and students may feel that argumentative situations in school are artificial and unconnected to their daily lives (Zohar and Nemet 2002). Consequently, students may see no point in arguing.

Moreover, even in cases where students are willing to engage in argumentation, the result might not always be effective from the point of view of learning (e.g., Arvaja, Rasku-Puttonen, Häkkinen, and Eteläpelto 2003; Schwarz 2009). Such debates may, for example, be biased, with students tending to put forward more arguments in favour of a position they personally support than arguments on the other side (Stein and Bernas 1999). This is problematic for the collaborative sharing and constructing of knowledge, and for sustaining and maintaining productive argumentation from different perspectives on the issue at stake.

Many studies showed also gender differences in peer-to-peer argumentation. For example, females seem to focus more on collaboration during argumentative discussions than males (Asterhan, Schwarz, and Gil 2012; Erkens and Janssen 2008; Salminen, Marttunen, and Laurinen 2012). On the other hand, males seem to be more inclined to respond to critiques, expressed by females, in particular, with rebuttals (Jeong and Davidson-Shivers 2006) and show more openness to argue in general (Jeong 2007) than females. However, Allan Jeong (2006) point out that other factors, such as task structure and group composition by gender, may also affect the way men and women engage in argumentation.

Over the past 15–20 years many online environments and software tools have been developed and used successfully when teaching and supporting argumentation (e.g., Scheuer, Loll, Pinkwart, and McLaren 2010; Noroozi, Weinberger, Biemans, Mulder, and Chizari 2012). However, as argumentation as such is a

demanding activity which requires high-level interaction and hard cognitive endeavours, the use of instructional technology as an arena for argumentation may cause extra cognitive load to students (van Bruggen, Kirschner, and Jochems 2002). For example, the need to coordinate discussions, and establish and maintain common ground induces additional cognitive burden for students in collaborative online learning situations (Dillenbourg and Bétrancourt 2006). The lack of non-verbal cues in online environments, compared to face-to-face communication, may also hinder to achieve productive argumentative interaction among students (Burnett 2003).

All these factors indicate that schools currently face challenges for creating practices that support productive argumentation and that more research on pedagogical means to promote students' engagement in collaborative argumentation is urgently needed (Chinn and Clark 2013). This study contributes to remedying this situation by experimentation with a specific type of role play carried out face-to-face and through online chat.

2. Role play as a means to stimulate argumentation

Role play refers to arranged learning situations in which students participate in 'as if' or 'simulated' actions and situations by assuming a viewpoint or character identity that they would not normally adopt (Yardley-Matwiejczuk 1997). As engaging students in productive argumentation is a demanding task, role play is often used as a pedagogical stimulus to this end. Role play promotes argumentation by providing a clear socio-cognitive structure for argumentative discussion and an atmosphere that allows emotional engagement for considering multiple perspectives on the issue at hand (Marttunen and Laurinen 2001).

From the socio-cognitive perspective, discussions through role play seem to generate argumentation, develop arguments further, and reduce cognitive load (e.g., Holsbrink-Engels 2001). The results of the study by Laurence Simonneaux (2001) indicated that in discussions on animal transgenesis, role characters (like a fish farmer, a researcher, a young mother) helped upper secondary vocational students to develop their arguments on the topic. The pre- and post-tests showed that the students used stronger arguments after the role play than before it. Respectively, the results by Miika Marttunen and Leena Laurinen (2001, 2002) suggest that role play (protagonist vs. antagonist) carried out face-to-face or by email is an effective means to promote argumentation skills in higher education. According to the students who took part in the studies, it was easier to engage in a discussion when the standpoint was fixed in advance and the other students knew that the position assigned to a student did not necessarily represent her/his own per-

sonal opinion on the issue in question. As the students had the possibility to hide behind a role, they presented stronger and clearer arguments than would otherwise have been the case. Furthermore, computer-based role play seems to decrease high cognitive load during the solving of social problems by giving opportunities for reflection and by developing interpersonal skills (Holsbrink-Engels 2001).

Role play, however, is not always an appropriate means to support argumentation and knowledge construction. In the study by Maarit Arvaja et al. (2003), secondary school students used historical role characters in studying imperialism in a Web-based environment. It was found that shared knowledge construction was rather weak among the students, as cognitively high-level activities, such as explaining, challenging, and reasoning, rarely occurred in their discussions. Further, the students' social relations in the classroom seemed to guide their online interaction more than their role characters. The students' existing social relations directed with whom and how actively they discussed issues with each other. Sue O'Connor and Anne Ross (2004), in turn, compared role play in face-to-face and asynchronous computer-mediated (WebCT) learning environments. In their study, university students working in groups liked playing non-familiar roles and appreciated the range of stakeholder views in both environments. However, the problem in the computer-mediated environment was the lack of immediacy. The students put a wide range of contributions on the bulletin board that made it difficult to follow multiple discussion threads and to respond to all the other students' comments. As a result, the students' knowledge construction from multiple perspectives was not supported despite the use of role play as a learning method.

In general, when comparing computer chat and face-to-face interaction, it has been found that during a face-to-face discussion it is easier for the students to maintain coherent discourse when a variety arguments are put forward (Schweizer, Paechter, and Weidenmann 2003). On the other hand, chat interaction may help students to express more relevant, well-grounded, and logical arguments (Morgan and Beaumont 2003), and to produce more counterargumentative speech acts (Veerman 2000).

From an emotional aspect, role play offers the possibility to understand other people's points of views, as you have to place yourself in their situation (Kolstoe 2000). For example, Andrew Vincent and John Shepherd (1998) found that in learning about Middle East politics students' empathy improved when they assumed role play characters with views strongly opposing to their own political attitudes. Mei Lim et al. (2011) conclude that technology-enhanced role play seems to be a good means to support social and emotional learning in complex social situations without risks that learners face in authentic social situations.

3. Role play in this study

In this study, students' argumentative debates were stimulated by means of a role play carried out face-to-face and through synchronous chat. The students were divided into a protagonist and an antagonist roles such that they defended either their personal standpoint on an issue or a standpoint opposed to their own.

From the point of view of learning, getting students to genuinely collaborate and successfully carry on mutually argumentative dialogues is a widely acknowledged problem (e.g., Arvaja et al. 2003). Supporting the counter-argumentative nature of debate is one means to foster argumentative discussion. Disagreements, diverging viewpoints, or alternative proposals may evoke argumentative discussion and lead to learning gains (Dillenbourg and Schneider 1995). However, argumentative discussion, even in cases of disagreement, cannot easily be sustained between students (e.g., Asterhan and Schwartz 2009). Learning through argumentation may be hindered by myside bias (Perkins 1985) in argument production. Myside bias refers to the tendency of people to generate more arguments in favour of a position they personally support than one they do not support (Perkins 1985; Toplak and Stanovich 2003). Nancy Stein and Ronan Bernas (1999) found that arguers, independent of age, generated approximately twice as many reasons for support of their own position as they generated for support of the opposite position. Thus, to trigger productive argumentation it may be appropriate to use a role play in which students defend standpoints contrary to their personal opinions on the issue discussed.

On the other hand, myside bias is not necessarily a problem in argumentation-based learning. The significance of discussion topic and situation for students' argumentation has been noticed in many studies. Topics which include authentic problems or provide relevant connections to students' lives may foster their argumentation performance (Salminen, Marttunen, and Laurinen 2012; Udell 2007; Zeidler, Sadler, Applebaum, and Callahan 2009; Zohar and Nemet 2002). Previous studies have also shown that even young children understand and are able to generate the main components of an argument in social situations personally significant to them (see Stein and Albro 2001). Personally significant situations may be those which connect to a person's daily life and goals. Stein and Elizabeth Albro (2001) point out that in situations where the arguers believe that their own position is better than their opponent's position, their argumentation includes more overt justifications and explanations for their own position. Thus, it seems that persons are well motivated to argue as long as the situation or the discussion topic is personally meaningful to them.

Further, when arguers are allowed to defend their personal opinion their mental load (cognitive load theory; Sweller, van Merriënboer, and Paas 1998) may

be reduced, as they may find the learning situation more authentic than otherwise. The participants may also produce more arguments when they can support their own standpoints (Stein and Bernas 1999), which may broaden the discussion. Thus, to evoke productive argumentation it would also be appropriate for students to retain their own standpoints on personally meaningful topics in debates. Consequently, in the present study we compared argumentation produced by students who defended their personal standpoint in an argumentative discussion with students who were asked to support a standpoint contrary to their personal opinion.

4. Research questions

In this study, upper secondary school students studied two environmental topics (nuclear power, genetically modified organisms) by engaging in argumentative debates in dyads face-to-face and through synchronous chat. The discussions were carried out within a role play design in which the students defended either their personal standpoint or a standpoint assigned to them. The study aimed in particular to clarify whether the use of this kind of role play would be associated with the quality of the students' argumentation in terms of argumentativeness and argument elaboration. Furthermore, the study aimed to clarify whether topic (nuclear power, genetically modified organisms), study mode (face-to-face, chat), or gender affected argumentation quality. The following research questions were addressed:

1. What was the quality (argumentativeness, argument elaboration) of the argumentation generated in the students' debates?
2. What kinds of effects did the role play design (personal or assigned standpoint) have on students' argumentation?
3. What associations, as a part of the role play design, gender, topic, and study mode had on students' argumentation?

5. Method

5.1 Teaching experiment

The subjects, 27 Finnish upper secondary school students (18 females and 9 males; aged between 16 and 17 years; 2nd study year), took part in a cross-curricular teaching experiment to practice argumentative discussion. The experiment was conducted in a course that combined curricular content from the subjects of

Finnish Language and Religious Education. The course was planned and carried out in collaboration with the researchers and teachers of those subjects.

At the beginning of the teaching experiment, the students took a test on argumentation skills including four tasks: analysing an argumentative text, composing arguments, commenting on an argumentative text, and judging arguments and conclusions (see Marttunen et al. 2005). On the basis of the test results, the students were divided into two equal gender groups with similar skills in argumentation.

According to Caroline Golder and Delphine Pouit (1999), in order to bring about argumentative dialogue, the discussion topic must be debatable. A debatable topic leaves space for negotiation because it does not offer objective truths. For this reason, environmental issues – nuclear power, and genetically modified organisms – were selected as topics of argumentation as they offer multiple perspectives from which they can be viewed and good possibilities for ethical considerations. In addition, increasing nuclear power is constantly a topical issue in public discussion in Finland, whereas genetic modification is a current issue not only in Finland but also at the level of the European Union.

Table 1. Design of the study

Group	Day 1	Day 2
Group 1	Nuclear power (face-to-face)	GMO (computer chat)
Group 2	Nuclear power (computer chat)	GMO (face-to-face)

The experiment was carried out over two days (Table 1). On the first day the topic was nuclear power (NP), and on the second day genetically modified organisms (GMO). The study mode (face-to-face vs. computer chat) was different for each groups on the different days. The students' work was organized so that it proceeded in three phases during both days: (1) Reading and analysing source articles, (2) Presenting one's individual opinion on the topic, and (3) Engaging in dyadic discussion. Due to pedagogical reasons, the instructions provided to the students somewhat varied between the topics.

Phase 1: **Reading and analysing source articles (60 minutes)**. During the course, five articles on each topic, taken either from the newspapers or the Internet, were read and analysed. The students worked with the articles in two different ways. When the topic was nuclear power (Day 1), the students were divided into five small groups (5–6 students/group) and each group was given one article to read and analyse. For each article, the students were asked to identify the different stakeholders and their opinions, along with supporting arguments, on nuclear power. After having read and analysed the articles, each group presented the main

points of the article and the results of their analysis to the other students. When the topic was GMO (Day 2), the students worked in pairs ($n = 12$). Six pairs read and analysed the two longest articles while the other six pairs worked with the three shortest articles. In this way the all students had approximately an equal amount of text to read. The students were asked to find arguments for and against GMO. After working, the pairs presented their analyses of the articles to the whole class.

Phase 2: **Presenting one's individual opinion on the topic (30 minutes)**. When the topic was nuclear power, the students wrote their personal opinion on the topic following the instruction: "Write your opinion on building a new nuclear power station in Finland. Remember to carefully justify your opinion. Why should we increase nuclear power, or if not, why not? Consider also the points of views of different stakeholders, such as industry, politicians, conservationists. In addition, please offer a possible critique of your opinion." When the topic was GMO, the students expressed their personal opinion on the topic in the form of an argument diagram (e.g., Salminen, Marttunen, and Laurinen 2010). The students were instructed to include in their diagrams a claim, grounds in support of the claim, and counterarguments criticizing the claim.

Phase 3: **Engaging in dyadic discussions (20 minutes and 30 minutes)**. The students both in the face-to-face and computer chat groups were divided into pairs on the basis of their personal opinions on the topic (either for or against) defined on the basis of their opinion writings and diagrams produced in the previous phase. Working in pairs was chosen because it has been shown that dyadic interaction increases cognitive engagement in thinking and enhances the quality of reasoning about the topic (Kuhn, Shaw, and Felton 1997). The pairs were formed so that as many students as possible could defend their personal standpoint. Further, in each pair the students had to represent opposite standpoints (protagonist vs. antagonist). As a result (Table 2), 58% of the students defended their personal standpoint and 42% of the students defended an assigned standpoint when they engaged in the debates on both topics. Approximately a half (11 out of 24) of the student pairs were mixed gender pairs and another half (13 out of 24) same gender pairs: There were five girl-boy pairs, five girl-girl pairs, and two boy-boy pairs in the debates on nuclear power, and six girl-boy pairs and six girl-girl pairs in the debates on GMO.

Because of the differences between the communication media (oral vs. written), the time allocated for the debate varied: the face-to-face students discussed the topic for 20 minutes and the computer chat students for 30 minutes. In both topics the students' task was to defend their standpoint, whether personal or not, in the debate. In the case of nuclear power, the question discussed was "Does Finland

need a new nuclear power station?", while the GMO question was "Should we allow genetically modified organisms or not?" The face-to-face debates were carried out in a Finnish language classroom and the chat debates in a computer lab.

Table 2. Frequencies and proportions of students defending either their personal standpoint or an assigned standpoint during the debates

	Topic											
	Nuclear power						Genetically modified organisms					
	Face-to-face		Chat		Total		Face-to-face		Chat		Total	
Standpoint	*f*	%	*f*	%	*f*	%	*f*	%	*f*	%	*f*	%
Personal	7	58	7	58	14	58	6	50	8	67	14	58
Assigned	5	42	5	42	10	42	6	50	4	33	10	42
Total	12	100	12	100	24*	100	12	100	12	100	24*	100

* All students ($n = 27$) did not participate in the debates on both days.

5.2 Data

The face-to-face debates were tape-recorded and transcribed, and the chat debates were saved automatically to a file. The data consisted of 12 dyadic face-to-face and 12 chat debates (2 417 speech turns in total). The face-to-face debates comprised 1 044 speech turns (423 turns on nuclear power; 621 turns on GMO) and the chat debates 1 373 speech turns (474 turns on nuclear power; 899 turns on GMO). On average, the face-to-face debates contained 1 120 words, and the chat debates 674 words.

5.3 Data analysis

As the interest of the study focused not only on the quality of students' argumentative interaction but also on factors associated with it, both qualitative and quantitative methods were combined in the data analysis. To study the quality of argumentation in the students' debates, the students' speech turns ($n = 2\,417$) were analysed for argumentativeness and argument elaboration. The further analyses were conducted using statistical methods.

5.3.1 *Argumentativeness*

All the speech turns were categorized into one of the following categories: argumentative, counterargumentative, or non-argumentative. A speech turn was coded as *argumentative* if it included a claim or an argument that directly supported the student's personal or assigned standpoint, and if it included elaboration

of an argument on the topic. Further, a speech turn was coded as *counterargumentative* if it included a counterargument or either elaboration or refutation of the counterargument. Finally, a speech turn was coded as *non-argumentative* if it concerned descriptive topic-related non-argumentative interaction (e.g., stating, requesting, or clarifying opinions on the topic), managing the task (e.g., planning what is to be discussed), managing the interaction (e.g., who will speak and when, topic shifting, time management), managing social relations (e.g., establishing (un)friendliness, politeness, laughing, playful joking), or any interaction not related to the topic or the task (see Baker et al. 2007). Two coders cross-analysed 10% of the speech turns. The inter-rater reliability of the analysis was 0.88 (Cohen's kappa). Examples of the analytical categories are presented in Tables 3–5.

Table 3. Example of an argumentative speech turn

Claim	Argument	Interpretation
It would be profitable to build a 5th nuclear power station in Finland, because…	*it would make the price of energy cheaper* (speech turn 878)	An argument (in italics) directly supporting a claim relating to the discussion topic. (The student's role was to defend the need for a new power station.)

Table 4. Example of a counterargumentative speech turn

Argument	Counterargument	Interpretation
[It would be profitable to build a 5th nuclear power station in Finland, because…] it would lower the price of energy (speech turn 878)	*nuclear power stations destroy the natural environment, so that making the price of energy quite high* (speech turn 879)	A counterargument (in italics) against the argument produced in the previous speech turn (878). (The students's role was to oppose the building of a new power station.)

Table 5. Examples of non-argumentative speech turns

Non-argument	Interpretation
My role is that more nuclear power is needed in Finland and you are against it (speech turn 33)	A non-argumentative speech turn indicating managing the task.
ha-haa – you lost (speech turn 240)	A non-argumentative speech turn referring to managing social relations.

5.3.2 *Argument elaboration*

The students' speech turns were analysed according to the level of elaboration (poor, good, no elaboration) of arguments that directly supported the student's personal or assigned standpoint (see Baker, Quignard, Lund, and van Amelsvoort 2002). A speech turn was deemed to contain *poor elaboration* if the argument was

merely mentioned in the speech turn. If the argument mentioned in the speech turn also included at least one explanation, clarification, or example, or if the argument in question was further elaborated later during the dialogue, the speech turn was deemed to contain *good elaboration*. All speech turns not associated with arguments directly supporting or questioning the main claim were coded as *no elaboration*. The inter-rater reliability of the analysis was 0.81 (Cohen's kappa). Examples of poor and good elaboration are presented in Table 6.

Table 6. Examples of poor and good elaboration

Claim	Argument	Level of elaboration	Interpretation
It would not be profitable to build a 5th nuclear power station in Finland, because…	*nuclear waste is always a source of pollution* (speech turn 883)	Poor	The argument (in italics) is only mentioned.
	the building of nuclear power is risky, as we already saw in Russia [Chernobyl] *or somewhere there* (speech turn 886)	Good	The argument (in italics) includes an example (Chernobyl).

5.3.3 *Statistical analyses*

The purpose of the statistical analyses was to clarify whether the independent variables were associated with the dependent variables. Because the independent and dependent variables were predetermined and categorical in nature, logit analyses (Kennedy 1988) were used. The dependent variables were formed so that they divided the speech turns into two categories according to whether the property in question appeared in a speech turn or not. Three dichotomous dependent variables for measuring the argumentativeness of the speech turns were formed (Argumentative, Counterargumentative, and Non-argumentative; Table 7), and three such variables were formed for measuring argument elaboration (Poor elaboration, Good elaboration, and No elaboration). The independent variables were Standpoint, Topic, Study mode, and Gender.

Table 7. Variables used in the statistical analyses

	Dependent variables	
Independent variables	**Argumentativeness of the speech turns**	**Argument elaboration in the speech turns**
X7 Standpoint	X1 Argumentative	X4 Poor elaboration
X8 Topic	X2 Counterargumentative	X5 Good elaboration
X9 Study mode	X3 Non-argumentative	X6 No elaboration
X10 Gender		

Fifteen separate logit analyses were carried out. The logit analyses were performed by starting from the saturated model, in which all the possible main and interaction effects of the independent variables with a single dependent variable were taken into account. Owing to the limited amount of data, it was not possible to include all four independent variables in one single logit analysis. For this reason, several logit analyses were carried out for a maximum of three independent variables at a time. Next, all the statistically non-significant parameters were excluded from the model step by step, according to the hierarchy principle, by starting from the higher order terms and ending with the minimal acceptable model that fitted the data ($p > .05$) and included as few statistically significant parameters as possible. The minimal acceptable models of the logit analyses with statistically significant parameters are presented in the appendix. When interaction effects between independent variables were found, the main effects were not reported in the results (Kennedy 1988).

6. Results

6.1 Quality of students' argumentation in general

During the debates, 67% ($n = 1\,608$) of the students' speech turns were non-argumentative, consisting of descriptive topic-related (36%), interaction management (15%), task management (3%), social relations (3%), and off-task (10%) talk. The proportion of argumentative speech turns was 8% ($n = 197$), and 25% ($n = 612$) of the speech turns were counterargumentative (Table 8).

The results also showed that 83% ($n = 1\,998$) of the students' speech turns contained no elaboration of arguments and the remaining speech turns (17%, $n = 419$) were elaborative. Of the 419 elaborative speech turns, 74% ($n = 310$) showed good elaboration and 26% ($n = 109$) poor elaboration (Table 8).

6.2 Quality of students' argumentation by standpoint and gender

Gender played a significant role together with the standpoint (personal/assigned) when examining the quality of the students' argumentation. The logit analyses (analysis 5 in the appendix) showed that variables Standpoint and Gender had a significant interaction effect on the proportion of counterargumentative speech turns (variable 2 in Table 9): when the students defended an assigned standpoint (a standpoint contrary to their personal opinion) in the discussion, the male students produced counterargumentative speech turns more often than the female students (42% vs. 22%). However, when defending their personal standpoint, the

Table 8. Frequencies and proportions of speech turns in the different categories by Standpoint, study mode, topic, and gender

	Standpoint				Study mode				Topic				Gender					
	Personal		Assigned		Face-to-face		Chat		Nuclear power		GMO		Male ($n=9$)		Female ($n=18$)		Total	
Analysis category	*f*	%	*f*	%	*f*	%	*f*	%	*f*	%	*f*	%	*f*	%	*f*	%	*f*	%
Argumentativeness																		
Argumentative	133	9	64	7	80	8	117	9	53	6	144	10	77	9	120	8	197	8
Counter-argumentative	393	26	219	24	240	23	372	27	338	38	274	18	224	27	388	24	612	25
Non-argumentative	969	65	639	69	724	69	884	64	506	56	1102	72	516	63	1092	68	1608	67
Total	1495	100	922	100	1044	100	1373	100	897	100	1520	100	817	100	1600	100	2417	100
Argument elaboration																		
Poor elaboration	78	5	31	3	38	4	71	5	58	7	51	3	36	4	73	5	109	4
Good elaboration	194	13	116	13	144	14	166	12	110	12	200	13	113	14	197	12	310	13
No elaboration	1223	82	775	84	862	83	1136	83	729	81	1269	84	668	82	1330	83	1998	83
Total	1495	100	922	100	1044	100	1373	100	897	100	1520	100	817	100	1600	100	2419	100

Note. GMO = Genetically modified organisms

Table 9. Significant associations (logit analyses) of the independent variables with argumentativeness and argument elaboration

	Significant associations of independent variables						
	Main effects				Interaction effects		
Dependent variables	Standpoint	Topic	Study mode	Gender	Standpoint by Gender	Topic by Gender	Study mode by Gender
Argumentativeness							
Argumentative (variable 1)			NP 6% GMO 10%				
Counter-argumentative (variable 2)	PS 26% AS 24%	NP 38% GMO 18%	F2F 23% Chat 27%	Male 27% Female 24%	Male: PS 26%; AS 42% Female: PS 27%; AS 22%	Male: NP 34%; GMO 22% Female: NP 40%; GMO 16%	Male: F2F 31%; Chat 26% Female: F2F 21%; Chat 28%
Non-argumentative (variable 3)	PS 65% AS 69%	NP 56% GMO 73%	F2F 69% Chat 64%	Male 63% Female 68%	Male: PS 65%; AS 50% Female: PS 65%; AS 72%	Male: NP 59%; GMO 67% Female: NP 55%; GMO 75%	
Argument elaboration							
Poor elaboration (variable 4)	PS 5% AS 3%	NP 7% GMO 3%					
No elaboration (variable 6)				Male 83% Female 82%		Male: NP 84%; GMO 80% Female: NP 79%; GMO 85%	

Note. PS = Personal standpoint; AS = Assigned standpoint; NP = Nuclear power; GMO = Genetically modified organisms; F2F = Face-to-face

male and female students' speech turns were nearly equally often counterargumentative (26% vs. 27%).

Standpoint and Gender also had a significant interaction effect on the proportion of non-argumentative speech turns (logit analysis 8): when the female students defended an assigned standpoint in the discussion they produced non-argumentative speech turns (variable 3 in Table 9) more often than the male students (72% vs. 50%). However, when defending their personal standpoints, the male and female students produced non-argumentative speech turns equally often (65% vs. 65%).

Examples of speech turns by male and female students when their task was to defend an assigned standpoint are presented in Table 10.

Table 10. Examples of speech turns by students defending an assigned standpoint

Gender	Standpoint	Analysis category of the speech turn	Speech turn	Description
Male	Assigned (against nuclear power)	Counter-argumentative	*but in the long run, we will basically manage on them* [wind and water power] *and we could get ready for that situation* (speech turn 4)	A counterargument for the previously presented argument: *in this moment, wind and water power are not so effective that we will get enough power for the whole country* (speech turn 3).
Male	Assigned (for nuclear power)	Counter-argumentative	*nuclear waste should just be pushed so deep that there is no any harm of it* (speech turn 650)	A counterargument for the previously presented argument: *even one power station produces so much nuclear waste that we must stash it somewhere* (speech turn 649).
Female	Assigned (for nuclear power)	Non-argumentative	*yeah* (laughing), *this topic is quite difficult* (speech turn 244)	A non-argumentative speech turn indicating managing the task. The female student regards debating on nuclear power as a demanding task.
Female	Assigned (for nuclear power)	Non-argumentative	*nuclear power does not belong to my everyday life* (speech turn 534)	A non-argumentative speech turn indicating clarifying opinions on the topic.

The examples above show that it was easier for the male students to defend an assigned standpoint by counterarguments than for the female students who, by contrast, in that role often put forward non-argumentative speech turns.

Logit analyses 10 and 11 (see Appendix) also revealed that the variable Standpoint was associated with poor elaboration of arguments. The results indicated that when the students defended their personal standpoint they put forward poor elaboration of arguments (variable 4 in Table 9) more often than when their standpoint was assigned to them (5% vs. 3%). No statistically significant parameters were found neither for good nor for no elaboration of arguments.

6.3 Quality of students' argumentation by topic and gender

Logit analysis 1 (see Appendix) revealed that the variable Topic was associated with the appearance of argumentative speech turns (variable 1 in Table 9) in the students' discussions. The students put forward more argumentative speech turns on genetically modified organisms than on nuclear power (10% vs. 6%). Furthermore, logit analysis 10 (see Appendix) revealed that the variable Topic was also associated with poor elaboration of arguments (variable 4 in Table 9). The results indicated that the students' level of elaboration was poor more often in the discussions on nuclear power than in those on GMO (7% vs. 3%; Table 9).

Gender played also a significant role together with the topic when examining the quality of the students' argumentation. The logit analyses (analysis 6 in the appendix) showed that variables Topic and Gender had a significant interaction effect on the proportion of counterargumentative speech turns (variable 2 in Table 9): the male students more often put forward counterargumentative speech turns on genetically modified organisms than the female students (22% vs. 16%). When the topic was nuclear power, the situation was the reverse, favouring females (40% vs. 34%). Furthermore, logit analysis 9 revealed an interaction effect of Topic and Gender on the proportion of non-argumentative speech turns (variable 3 in Table 9). This result showed that the female students put forward more non-argumentative speech turns than the male students on genetically modified organisms (75% vs. 67%). However, during the discussions on nuclear power, the reverse was observed (55% vs. 59%).

Examples of speech turns illustrating interaction effects between gender and topic are presented in Table 11.

The examples above show that the male students are more inclined to put forward counterarguments on GMO than the females who, in turn, merely presented counterarguments for a topic nuclear power which provided them a possibility to engage emotionally in argumentation.

Table 11. Examples of speech turns illustrating interaction effects between gender and topic

Gender	Topic	Analysis category of the speech turn	Speech turn	Description
Male	GMO	Counter-argumentative	*but how well these new varieties will get along with each other when human being even now destroys varieties at a fast rate* (speech turn 1012)	A counterargument for the previously presented argument: *by gene technology we can develop new varieties that acclimatize to changing conditions* (speech turn 1011).
Female	Nuclear power	Counter-argumentative	*Don't you care your descendants at all? Their living will be quite hell if we now revel whichever way* (speech turn 485)	A counterargument for the previously presented argument: *in future, people will anyway think of a solution* (for nuclear waste). *Motto: Have now fun and die young!* (speech turn 484).
Female	GMO	Non-argumentative	*well, bear in mind that I don't know anything about the topic, I just put forward something…;)* (speech turn 2106)	A speech turn indicating non-argumentative interaction. The student feels that she does not have enough knowledge on GMO.
Male	Nuclear power	Non-argumentative	*should we still try to discuss that topic more?* (speech turn 587)	A non-argumentative speech turn indicating managing the interaction.

In addition, logit analysis 15 showed that the variables Topic and Gender had an interaction effect on the proportion of speech turns containing no elaboration (variable 6 in Table 9): the male students produced non-elaborative speech turns more often than the female students during the discussions on nuclear power (84% vs. 79%), whereas during the discussions on genetically modified organisms, the situation was the reverse (80% vs. 85%).

6.4 Quality of students' argumentation by study mode and gender

The results revealed that counterargumentative speech turns (variable 2 in Table 9) were more common among the male students during the face-to-face dis-

cussions (31% vs. 21%), whereas during the chat discussions the corresponding proportions were almost equal (26% vs. 28%).

In addition, logit analyses 7 and 9 (see Appendix) showed that the Study mode had a main effect on the proportion of non-argumentative speech turns (variable 3 in Table 9): the students produced non-argumentative speech turns more often during face-to-face than chat discussions (69% vs. 64%).

7. Discussion

The study showed that in designing classroom practices for enhancing argumentation complex patterns need to be taken into account. Namely, not only the standpoint defended (role play) but also gender in particular along with the discussion topic and the study mode were associated with the quality of the students' argumentation.

The results indicated that when the students defend their personal standpoint, their elaboration of arguments was poorer than when they defended non-personal, assigned standpoints. Regardless of the fact that elaboration of arguments among the students in the study was quite rare this result is interesting: Although previous studies indicate that people generate more arguments for their own position than for the opposing position (Perkins 1985; Stein and Bernas 1999; Toplak and Stanovich 2003), this study suggests that students tend to elaborate their arguments when they defend an assigned standpoint, rather when the standpoint defended is in line with their personal opinion. One reason for this result may be that when students defend assigned standpoints they are under more of an obligation to explicate and explain their position than students who defend their personal standpoints. This may be due to the need to structure their knowledge of the issue, to broaden their understanding of the issue, and to be better able to engage in argumentative discussion with their interlocutors (de Vries, Lund, and Baker 2002). Explaining, in turn, can be regarded as an activity that supports learning. Explaining can stimulate learners' understanding (Webb 1989) and self-explanations (Chi, Bassok, Lewis, Reimann, and Glaser 1989) of an issue. Learners can, for example, explain difficult things to each other or to themselves by using more familiar words or by giving examples. Further, explanation with argumentation has been linked to knowledge co-construction and conceptual understanding (de Vries, Lund, and Baker 2002). Thus, assigning students such positions in argumentative discussion that do not represent their personal opinions seems to be a suitable pedagogical means to enhance their understanding on the topic of interest.

When the students defended a standpoint assigned to them, the male students produced counterargumentative speech turns more often than the females, whereas the females produced non-argumentative speech turns more often than the males. When the students defended their personal opinions no gender differences existed. These results suggest that male students seem to be able to engage in argumentative debates whether or not they defend their personal opinion on the discussion topic. On the contrary, for female students it seems to be a bigger challenge to defend a standpoint at variance with their personal opinion. This gender difference may be explained by findings indicating that, in general, men have a greater preference for rational reasoning than do women, who, conversely, prefer more experiential reasoning (Epstein 2003; Sladek, Bond, and Phillips 2010). Experiential reasoning refers to faith in intuition, experiences of affects, positive emotions, and avoidance of negative emotions (Sladek et al. 2010). Further, on the relationship between emotions and argumentation, Aaron Ben-Ze'ev (1995:191) points out that emotions typically arise when individuals perceive highly significant changes in their situation. Michael Baker, Jerry Andriessen, and Sanna Järvelä (2013), in turn, emphasize that the way we represent given situations is related to our affects in those situations; in a collaborative learning situation this means that students' representations of the task and of co-learners will relate to the emotions felt, expressed, and regulated while interacting and performing the task, and this will associate with the quality of the task performance. In light of these notions, it is conceivable that the male students in this study tended mainly to ground their argumentation on evidence and the rules of logic, whereas the female students' argumentation was more often affected by their personal opinions on the discussion topic. Thus, for the female students to engage in constructive argumentative debate, it was important that they could defend a standpoint representative of their personal opinion.

From the point of view of learning, it seems that the female students' performance was hindered by myside bias (Perkins 1985). That females had difficulties in defending a standpoint which was not their own was manifested by a bigger number of non-argumentative and lower number of counterargumentative speech turns compared to males. In this kind of learning situation, the female students might also have experienced mental load, as the situation was neither authentic nor personally significant for them (Stein and Albro 2001). However, previous studies by Marttunen and Laurinen (2001, 2002) have shown that university students of education benefited rather than otherwise from arguing for a position counter to their personal opinions. However, it is worth noticing that in these studies the topics were drawn from the field of education and were, thus, both relevant and motivating for student debate.

The results also showed that, when the discussion topic was nuclear power, the female students produced more counterargumentative speech turns than the males whereas the reverse was found when the students discussed genetically modified organisms. The female students also produced more non-argumentative and non-elaborative speech turns than the males when the topic was GMO. However, during the discussions on nuclear power the proportion of non-elaborative speech turns was greater among the male students. These results suggest that nuclear power as a discussion topic, rather than GMO, stimulated the female students in particular to engage in elaborative argumentation. This gender difference is understandable, as a review of 36 studies by Debra Davidson and Wiluam Freudenburg (1996) found that females express more concern about nuclear power than males. In general, females (young people and adults) possess stronger attitudes and behaviors towards environmental responsibility than males (Uitto, Juuti, Lavonen, Byman, and Meisalo 2011; Zelezny, Chua, and Aldrich 2000). GMO, particularly for the females, was the less stimulating topic from the point of view of arguing and the elaboration of arguments. It is possible that the students did not have enough knowledge on GMO to be able to engage in broad and deep argumentation. In fact, Jerry Andriessen, Michael Baker, and Dan Suthers (2003) concluded that during an argumentative discussion participants do tend not to bring in more knowledge than they feel relatively certain about, often with the result that engagement in the discussion remains on a superficial level. In addition, females, compared to males, tend to be more critical of GMO, even to that extent that for females more knowledge on the issue often also means a more hesitant attitude (Moerbeek and Casimir 2005).

A review by Fleur Prinsen, Monique Volman, and Jan Terwel (2007) found that in the context of computer-supported collaborative learning female students tend to be more willing to share their intuitive conceptions in discussions while males prefer more authoritative statements. Such contributions by females seem to stimulate people to engage in constructive argumentative discussion. For example, females may start a discussion by expressing their personal experiences on the topic, which may have resonance for the other discussants. Thus, the use of mixed gender pairs, with a selection of such topics that inspire females in particular, would seem to be wise as a way of promoting learning. Topics of these kinds can be assumed to be personally meaningful. Using authentic problems, which are related to learners' daily lives, may foster learners' argumentation skills (e.g., Udell 2007; Zeidler et al. 2009).

Further, the results also showed that the male students produced more counterargumentative speech turns face-to-face than the females, whereas during the chat discussions this gender difference was absent. These results suggest that gender differences in argumentative communication may be levelled out when a

network environment is used. Previous studies have shown that students' counterargumentativeness increased when they practised argumentation in the electronic mode and this gain was also successfully transferred to the face-to-face mode (Iordanou 2013; Guiller, Durndell, and Ross 2008). On the other hand, while in the previous studies male students have been found to be dominating and to have a more assertive, competitive, and adversarial conversation style compared to females (Prinsen et al. 2007; Carr, Cox, Eden, and Hanslo 2004), female students have been found to be more attuned to the task and willing to collaborate (Prinsen et al. 2007). Thus, from the point of view of learning through constructive argumentation, gender differences in communication styles should not be seen as an obstacle but, rather, as a benefit for both male and female students (Robertson, Hewitt, and Scardamalia 2003; Salminen, Marttunen, and Laurinen 2012). Males, through their assertive and adversative communication style can provide a challenging space for knowledge construction, while females, for their part, can maintain argumentative discussion and facilitate argument elaboration through collaborative efforts.

To conclude, planning an appropriate educational design to promote argumentative activities is a rather demanding task (Andriessen and Schwarz 2009). Several factors, such as discussion topic, study mode, gender, prior knowledge and opinions, are all involved in such a learning task, and, thus, may either trigger or hamper students' engagement in productive argumentation. Nevertheless, the present study suggests that role play, in which both the dialectical nature of argumentation and the importance of students' personal standpoints on an issue are taken into account, is a workable means to support high quality student argumentation in the classroom. The study also suggests that, in particular, the emotional engagement of females in argumentation can be enhanced by offering them topics with personal relevance. Furthermore, a network environment seems to be a suitable study mode for productive argumentation, as it seems to level out gender differences in communication.

However, the results of this study should be viewed with caution since the number of participants was rather small ($n = 27$). Due to the small number of participants generalization to a larger population, to other ages, topics, and tasks is not warranted. Thus, the results should be viewed to characterize the discussions among the students of this study only. However, this study may guide further research.

The study also focused on examining whether a very specific role play setting used for pedagogical purposes stimulated students to argue, and did not assess whether students' argumentation skills improved or what they actually learned. Thus, future research might additionally focus on learning outcomes. Another limitation is that the students' topic beliefs might have affected their preparation

for the debates and their argumentation. Matthew McCrudden and Phillip Sparks (2014) found that argumentative task instructions may even polarise students' topic beliefs when their beliefs are already quite strong. This means that sometimes an argumentative task assignment is not enough to promote the learning of critical thinking. Although, in the present study, the students' personal standpoints on the topics were ascertained, it was not investigated how strong or weak their topic beliefs were. Thus, in future studies it may be important to measure students' topic beliefs as well. It would also be interesting to examine more closely the role of emotions in argumentation, particularly from the point of view of gender comparisons. Future research could also focus on the possible gender-relatedness of different discussion topics when seeking to induce productive argumentation. Overall, the results of this study point to efforts to design further argumentative activities for learning purposes.

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Appendix Summary of logit analyses (minimal acceptable models)

Parameter	Estim.	*SE*	*Z*	*p*
Argumentativeness variables				
Analysis 1 (X1 Argumentative, X7 Standpoint, X8 Topic, X9 Study mode): $G2 = 5.15$, $df = 6$, $p = .524$				
X1 (Argumentative)	2.26	.09	25.77	***
X1 by X8 (Topic)	.51	.17	3.07	**
Analysis 2 (X1, X7, X9, X10 Gender) and analysis 3 (X1, X7, X9, X10): no statistically significant parameters (ns.)				
Analysis 4 (X2 Counterargumentative, X7-X9): $G2 = 5.40$, $df = 5$, $p = .370$				
X2 (Counterargumentative)	1.40	.08	18.49	***
X2 by X8 (Topic)	−1.03	.10	−10.72	***
X2 by X9 (Study mode)	.30	.10	3.03	**
Analysis 5 (X2, X7, X9, X10): $G2 = .55$, $df = 2$, $p = .759$				
X2 (Counterargumentative)	1.17	.10	11.31	***
X2 by X7 (Standpoint)	−.79	.23	−3.47	**
X2 by X9 (Study mode)	−.30	.17	−1.75	ns.
X2 by X10 (Gender)	−.32	.14	−2.27	*
X2 by X7 by X10	1.03	.26	4.00	***
X2 by X9 by X10	.66	.21	3.13	**
Analysis 6 (X2, X8, X9, X10): $G2 = 4.41$, $df = 2$, $p = .110$				
X2 (Counterargumentative)	1.28	.12	10.68	***
X2 by X8 (Topic)	−.56	.16	−3.47	**
X2 by X9 (Study mode)	−.11	.18	−.63	ns.
X2 by X10 (Gender)	.15	.15	.98	ns.

Parameter	Estim.	*SE*	*Z*	*p*
X2 by X8 by X10	−.72	.20	−3.55	***
X2 by X9 by X10	.58	.21	2.70	**
Analysis 7 (X3 Non-argumentative, X7, X8, X9): $G2 = 1.35$, $df = 4$, $p = .853$				
X3 (Non-argumentative)	−.80	.07	−11.15	***
X3 by X7 (Standpoint)	−.21	.09	−2.27	*
X3 by X8 (Topic)	.74	.09	8.32	***
X3 by X9 (Study mode)	−.25	.09	−2.74	**
Analysis 8 (X3, X7, X9, X10): $G2 = 6.84$, $df = 3$, $p = .077$				
X3 (Non-argumentative)	−.57	.08	−6.95	***
X3 by X7 (Standpoint)	.62	.22	2.77	**
X3 by X9 (Study mode)	−.14	.09	−1.58	ns.
X3 by X10 (Gender)	.03	.11	.25	ns.
X3 by X7 by X10	−.91	.25	−3.67	***
Analysis 9 (X3, X8, X9, X10): $G2 = 3.03$, $df = 3$, $p = .387$				
X3 (Non-argumentative)	−.66	.10	−6.44	***
X3 by X8 (Topic)	.40	.15	2.73	**
X3 by X9 (Study mode)	−.24	.09	−2.64	**
X3 by X10 (Gender)	−.32	.13	−2.55	*
X3 by X8 by X10	.51	.19	2.74	**
Argument elaboration variables				
Analysis 10 (X4 Poor elaboration, X7, X8, X9): $G2 = 10.12$, $df = 5$, $p = .072$				
X4 (Poor elaboration)	3.21	.15	20.86	***
X4 by X7 (Standpoint)	.50	.22	2.28	*
X4 by X8 (Topic)	−.71	.20	−3.61	***
Analysis 11 (X4, X7, X8, X10): $G2 = 5.17$, $df = 6$, $p = .523$				
X4 (Poor elaboration)	2.90	.12	24.93	***
X4 by X7 (Standpoint)	.46	.22	2.12	*
Analysis 12 (X4, X7, X8, X9): ns.				
Analysis 13 (X5 Good elaboration, X7, X8, X9): ns.				
Analysis 14 (X6 No elaboration, X7, X9, X10): ns.				
Analysis 15 (X6, X8, X9, X10): $G2 = 1.37$, $df = 3$, $p = .713$				
X6 (No elaboration)	−1.38	.12	−11.54	***
X6 by X8 (Topic)	−.31	.19	−1.66	ns.
X6 by X9 (Study mode)	.05	.11	.40	ns.
X6 by X10 (Gender)	−.38	.15	−2.54	*
X6 by X8 by X10	.71	.23	3.05	**

* $p < .05$** $p < .01$*** $p < .001$

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