DOCTORAL THESIS IN EDUCATION AND COMMUNICATION
IN THE TECHNOLOGICAL SCIENCES
STOCKHOLM, SWEDEN 2015

Online coaching as a Relationship of Inquiry

Exploring one-to-one online education

STEFAN STENBOM

KTH ROYAL INSTITUTE OF TECHNOLOGY
SCHOOL OF EDUCATION AND COMMUNICATION
IN ENGINEERING SCIENCE

ROYAL INSTITUTE
OF TECHNOLOGY

Online coaching as a Relationship of Inquiry

Exploring one-to-one online education

STEFAN STENBOM

Doctoral Thesis
Stockholm, Sweden 2015

This doctoral thesis consists of an introduction and the following papers:

I Hrastinski, S., & Stenbom, S. (2013) Student–student online coaching: Conceptualizing an emerging learning activity. *The Internet and Higher Education, 16*, 66–69.

II Stenbom, S., Hrastinski, S., & Cleveland-Innes, M. (2012). Student–Student Online Coaching as a Relationship of Inquiry: An Exploratory Study from the Coach Perspective. *Journal of Asynchronous Learning Networks, 16*(5), 37–48.

III Stenbom, S., Cleveland-Innes, M., & Hrastinski, S. (n.d.). Emotional presence in a relationship of inquiry: The case of one-to-one online math coaching. *Manuscript submitted.*

IV Stenbom, S., Jansson, M., & Hulkko, A. (in press). Revising the Community of Inquiry framework for the analysis of one-to-one online learning relationships. Accepted for publication in *The International Review of Research in Open and Distributed Learning*.

The papers are not included in this electronic version of the thesis. The papers can be found either in the printed version of the thesis or via http://stefanstenbom.se.

KTH Royal Institute of Technology
School of Education and Communication in Engineering Science
Department for Learning
SE-100 44 Stockholm
Sweden

Typeset with LaTeX.
Printed by Universitetsservice US-AB, Stockholm.

ISBN 978-91-7595-526-1
TRITA-ECE 2015:04

Abstract

In educational development, much focus is put on the use of computers and other digital tools to enhance teaching and learning. One of the most used digital communication forms is one-to-one communication using text, images, and video. One-to-one communication for educational purposes has, however, so far received only modest attention in research.

The purpose of this thesis is to explore inquiry-based one-to-one online education. An additional purpose is to explore opportunities and limitations with the Community of Inquiry framework, one of the most used models for analysis of online learning, when analyzing one-to-one online education. A particular interest is put on the role of emotions in the analyses. The empirical case used in the thesis is the Math Coach program who employs one-to-one education for k–12 students in mathematics via chat and a shared digital whiteboard.

The thesis consists of an introduction and four papers. First, in Paper I online coaching is defined, explained, and discussed through a review of previous research and a study of the establishment and operation of the Math Coach program. Secondly, the Community of Inquiry framework is adapted for use in one-to-one settings forming the Relationship of Inquiry framework. Paper II initiates the adaption using a survey study, Paper III evaluates the role of emotions in the framework, and Paper IV consolidates the Relationship of Inquiry framework with a comprehensive description of its components and a transcript coding procedure.

The findings indicate that inquiry-based one-to-one online education can be explored utilizing *Online coaching as a Relationship of Inquiry*. Online coaching is theoretically grounded in collaborative constructivism, critical thinking, and proximal development. It is defined as an inquiry-based learning activity where a person gets support on a specific subject matter from a more knowledgeable person using the Internet. The Relationship of Inquiry is a conceptual connection that is built between two persons that engage in a critical discourse in order resolve an educational issue. Central for the framework is the elements of cognitive presence, teaching presence, social presence, and emotional presence. Emotional presence is especially examined and confirmed as a critical interdependent element of the framework.

Keywords: *online learning · online coaching · one-to-one online education · Community of Inquiry · Relationship of Inquiry*

Sammanfattning (Swedish abstract)

En stor del av det utvecklingsarbete som idag bedrivs inom utbildningsväsendet handlar om hur datorer och annan digital teknik kan användas för att förbättra undervisning och lärande. Digital kommunikation mellan två individer – en-till-en-kommunikation – i form av text, bilder och video har fått stort genomslag i samhället, men det finns begränsat med forskning om dess användning och användbarhet i utbildningssammanhang.

Det primära syftet med denna avhandling är att utforska nätbaserad en-till-en-utbildning. Ett ytterligare syfte är att undersöka möjligheter och begränsningar med användandet av ramverket ”Community of Inquiry” vid analys av nätbaserad utbildning. I avhandlingen studeras särskilt den emotionella dimensionen av ramverket. Som studieobjekt används Mattecoach på nätet, en verksamhet där grundskole- och gymnasieelever får stöd – coachas – i sina matematikstudier genom att chatta med lärarstudenter via textmeddelanden och en delad digital skrivtavla.

Avhandlingen är skriven på engelska och består av en inledning och fyra vetenskapliga artiklar. I artikel I definieras, förklaras och diskuteras läraktiviteten nätcoachning. I artikel II introduceras ramverket ”Relationship of Inquiry”. Detta bygger på ”Community of Inquiry”, som är ett väletablerat hjälpmedel för att analysera kommunikation inom större grupper, men har anpassats för en-till-en-kommunikation. I artikel III utvecklas ramverket vidare genom att speciellt studera den emotionella aspekten av lärande. I artikel IV bekräftas ramverket genom en fullständig beskrivning av dess ingående delar och en transkriptionsanalys.

Studien indikerar att nätbaserad en-till-en-utbildning kan utforskas utifrån läraktiviteten nätcoachning och ramverket ”Relationship of Inquiry” (Online coaching as a Relationship of Inquiry). Nätcoachning definieras som en undersökande läraktivitet där en person via Internet får stöd i sin kunskapsutveckling från en annan individ som är mer kunnig inom området. Dess teoretiska grund bygger på kollaborativ konstruktivism, kritiskt tänkande och proximal utveckling. I avhandlingen studeras den relation som bildas mellan coach och elev som genom en kritisk och reflekterande dialog löser elevens matematikproblem. Ramverket är uppbyggt kring fyra delar: det kognitiva elementet, lärarelementet, det sociala elementet samt det emotionella elementet. Det emotionella elementet har särskilt studerats och visade sig vara ett viktigt element.

Acknowledgements

First and foremost, I wish to thank my supervisor, associate professor Stefan Hrastinski, assistant supervisor professor, Martha Cleveland-Innes, and additional assistant supervisor, professor Inga-Britt Skogh. This research has been financed by KTH Royal Institute of Technology, for which I am thankful. Thanks also to my family, colleagues, and especially to the people involved in the Math Coach program. Their support is gratefully acknowledged.

I dedicate this work to the memory of my beloved father, Curt-Georg Knutsson (1943–2010). As a school teacher, principal, and educational developer, he constantly engaged me in discussions about teaching and learning that have formed me in a profound way. Oh, how I wish that you could be here today to share this moment.

Contents

Acknowledgements **v**

Contents **vi**

Introduction

1 Introduction 1
2 Theoretical foundation 4
3 Research approach 18
4 Overview of the papers 25
5 The Relationship of Inquiry 30
6 Discussion 37
7 Conclusion 45
8 References 46

Papers

I Student–student online coaching: Conceptualizing an emerging learning activity
II Student–Student Online Coaching as a Relationship of Inquiry: An Exploratory Study from the Coach Perspective
III Emotional presence in a relationship of inquiry: The case of one-to-one online math coaching
IV Revising the Community of Inquiry framework for the analysis of one-to-one online learning relationships

Introduction

1 Introduction

With the introduction of the Internet, many new ways to communicate have emerged. One area that has made use of the Internet is education. During the last decades, diplomas, programs, courses, and single learning activities utilizing online environments have been established. Online learning has also emerged as an important research area both within computer science and educational research. Design, implementation, and analysis of online learning environments are seen as crucial in order to support technological improvement and pedagogical progression.

One of the most commonly used communication forms online is one-to-one interaction, when one person is engaging with one other person (Dron & Anderson, 2014). Technology supporting one-to-one interaction are online chat services such as short message services (SMS) and instant messaging. Nardi, Whittaker, and Bradner (2000) described chat as a near-synchronous computer-based one-to-one communication tool. They argued that a central use of chat is to support quick questions and clarifications about ongoing work tasks using an informal, lightweight communication mode. Online chat services can be mediated using text, images, and video. The potential of using chat to support learning has been shown in numerous studies (Bagley & Shaffer, 2015; Contreras-Castillo, Pérez-Fragoso, & Favela, 2006; Hrastinski, 2006; Hwang, Huang, & Wu, 2011; Kopp, Matteucci, & Tomasetto, 2012; Nicholson, 2002; Segerstad & Ljungstrand, 2002).

An implementation of chat-based communication in an educational context is online coaching. The term online coaching is in this thesis defined as an inquiry-based learning activity where a person gets support on a specific subject matter from a more knowledgeable person using the Internet. This learning activity is in this thesis theoretically grounded in collaborative constructivism, critical thinking, and proximal development (Dewey, 1933; Lipman, 1991, 2003; Vygotsky, 1978). It is motivated by the possibility to address the 2 sigma problem (Bloom, 1984).

One example of online coaching is the Math Coach program. In the Math Coach program, students get help with their math studies from pre-service teachers. Coachees range from the sixth to ninth year of compulsory school and upper secondary school (aged 12–19). Coaches are enrolled from students at teacher training colleges. The technology used a is text-based chat service complemented with a shared digital whiteboard.

A framework that is widely used when analyzing the process of learning in online learning environments is the Community of Inquiry introduced by Garrison, Anderson, and Archer (2000). This theoretical framework represents a process of creating a deep and meaningful learning experience in groups. The Community of Inquiry framework consists of three interdependent elements. These are cognitive, teaching, and social presence that together outline an online learning experience within a community. In addition to the original elements, Cleveland-Innes and Campbell (2012) suggested that the Community of Inquiry should be expanded with a fourth element reflecting emotions in the learning setting. The Community of Inquiry framework has been extensively studied and confirmed. Two empirical instruments are often used: a standardized survey among participants and a transcript coding procedure (Arbaugh et al., 2008; Garrison et al., 2000; Swan et al., 2008). The Community of Inquiry framework is seen as one of the most prominent models for analysis of online learning (Akyol et al., 2009; Jézégou, 2010; Swan & Ice, 2010). The framework has, however, been used to examine learning only within a group setting. It has not been tested for one-to-one online education.

Purpose

The purpose of this thesis is to explore inquiry-based one-to-one online education. An additional purpose is to explore opportunities and limitations with the Community of Inquiry framework when analyzing one-to-one online education. A particular interest is put on the question of to what extent the role of emotions should be included in the analyses of the studied one-to-one educational setting. This since the aspect of emotions is much discussed in educational research in general and in research about the Community of Inquiry framework in particular. The empirical case of an online coaching setting used in the thesis is the Math Coach program. Together, online coaching as a Relationship of Inquiry outlines the process of teaching and learning in a one-to-one online education setting. The purpose is addressed using this introduction and four papers.

Research questions

The study is guided by three research questions. The first question relates to the learning activity, the second to the framework, and the third to the role of emotions in the framework.

Research question 1 (RQ1):
How can online coaching be conceptualized?

Research question 2 (RQ2):
How can the Community of Inquiry framework be adapted for analysis of one-to-one online education?

Research question 3 (RQ3):
What role do emotions play in inquiry-based one-to-one online education?

Structure of the papers

In Paper I (addressing RQ1), online coaching is defined, explained, and discussed in relation to related learning activities. Paper II (addressing RQ2) introduces the Relationship of Inquiry framework as an adaptation of the Community of Inquiry and employs a survey instrument. Paper III (addressing RQ2 and RQ3) specifically examines the aspect of emotions in the framework using both the survey and transcripts. Finally, Paper IV (addressing RQ2) consolidates the adapted framework and adds a transcript coding procedure for systematic analysis of one-to-one online learning relationships.

Structure of the thesis

The thesis consists of an introduction and the four papers. Following this *introduction*, the theoretical foundations are presented. The *theoretical foundations* consist of the definition of online coaching and the theories underpinning the learning activity. The section also includes a review of the Community of Inquiry framework. In *research approach*, the Math Coach program is presented together with the procedures that have been used to address the purpose of the thesis. *Overview of the papers* is a summary of each paper with a focus on the contribution from each paper to the thesis. *The Relationship of Inquiry* section presents the framework created in the thesis. Finally, the *discussion* and *conclusion* sections comment on the methodology and result of the thesis, states limitations, and make recommendations for future implementations and future research.

2 Theoretical foundation

In this section, the theoretical rationale for the thesis is presented. First, online coaching as a learning activity is defined, explained, and discussed. Secondly, the Community of Inquiry framework is reviewed.

Online coaching

Online coaching is in this thesis defined as *an inquiry-based learning activity where a person gets support on a specific subject from a more knowledgeable person using the Internet*. The learning activity outlines a process in which an individual, in this thesis labeled the *coachee*, get support in order to achieve an educational goal. The support is given by the other person, in the thesis labeled the *coach*, by promoting higher-order thinking. Online coaching can be illustrated with the example in Figure 1 on this page from the Math Coach program.

A review of the literature and research in the area of education reveals that four attributes of effective learning processes can be identified as valuable for the examination of online coaching. These are: (i) the inquiry-oriented approach to learning, (ii) a foundation in Vygotsky's (1978) theory of the Zone of Proximal Development, (iii) that the interaction is fostered online, and (iv) the possibility to address Bloom's 2 sigma problem. Following these four attributes, it is argued that online coaching is a learning activity grounded in the constructivist paradigm of learning.

> The coachee in this example is a high school student. Her math homework for this week deals with derivatives. One of the problems is: Calculate the derivative of $f(x) = 2x^3$ using the definition of a derivative. She already knows how to solve problems like the one in the homework by following the rule for derivatives of power functions but has no clue about how to solve this problem using the definition. Therefore, she contacts Math Coach in order to get help. She does this by entering the Math Coach website and connecting to a coach. Over the course of one hour she engages in a text-based chat session. The coach does not take the approach of just showing her how derivatives are solved. Instead, the coach tries to identify what issue the coachee is having and then helps her to understand how the definition is used in order to solve any derivative.

Figure 1: Example of online coaching.

Constructivist paradigm of learning

Several theoretical perspectives and models have historically been acknowledged as valuable for the understanding of the processes of learning. These perspectives and models have often been combined to form paradigms. Examples of well-known paradigms throughout the last century are behaviorism, cognitivism, and constructivism.

The foundation for constructivism is the notion that individuals construct their own knowledge. In order to construct knowledge, constructivism views the learning as an active process. During the process, the learner actively creates their personal knowledge (Jonassen, 1999; Leidner & Järvenpää, 1995; Schunk, 2012).

Constructivism is a paradigm that gathers several philosophical explanations about the nature of learning. Examples of important contributors to this paradigm are Jean Piaget's (1896–1980) theory of cognitive development, Lev Semyonovich Vygotsky's (1896–1934) social development theory, and John Dewey's (1859–1952) philosophy of pragmatism. Two approaches in constructivism in general are whether learning is an individual or a social process. The individual perspective of constructivism emphasizes that achieving understanding is done through personal active discovery, while the social perspective highly values the achieving of understanding through dialog and collaboration (Mayes & De Freitas, 2004). It has been debated whether individual and social constructivism are in conflict or if constructivism is both individual and social simultaneously (Brown, Collins, & Duguid, 1989; Cobb, 1994).

Online coaching is argued to be connected to constructivism. In constructivism, people are expected to actively construct their personal understanding of a situation and, by doing this, learn new insights. When a coachee engages in online coaching, she does so as an active action to experience situations and to reflect on them. By doing so, the coachee constructs her personal meaning of the session's content. In order to prompt constructivism, the asking of questions, exploration, and assessment of previous knowledge are essential (Prince & Felder, 2006).

Education as inquiry

Constructivist learning often starts with an identified problem. This problem triggers a process that hopefully leads to a resolution of the problem (Hmelo & Ferrari, 1997; Jonassen, 2000). In the example in Figure 1 on page 4, the coachee's inability to solve a derivative triggers her to think critically and discuss with a coach in order to be able to solve the problem. The process that the coachee undergoes when solving the problem is called an inquiry.

Inquiry is an operation for examining information about something with the aim to augment knowledge (Lipman, 1991). It is done by reflecting critically, with a deep approach to learning, about the issue and possible solutions (Spronken-Smith & Walker, 2010). The process of inquiry can be understood through Dewey's (1933) generalization from the scientific processes. He compares the process of achieving knowledge for students with the research process of scholars. When researchers develop new knowledge, they formulate problems, purposes, procedures, findings, and evaluations in order to understand new situations. Inspired by this process, Dewey presented a problem-solving procedure named 'the reflective thinking model' for inquiry.

In the process of inquiry, the two approaches to constructivism, the individual and the social, are seen as complementary. The individual component centers around the cognitive processes of thinking. Several terms such as critical thinking, higher-order thinking, or reflective thinking have been used. In general, inquiry involves "thinking that strives to be impartial, accurate, careful, clear, truthful, abstract, coherent, and practical" (Lipman, 2003, p. 58). The social component centers around critical discourse. Ever since the era of the classical Greek philosophers Socrates and Plato, it has been acknowledged that the spoken language is a valuable tool for thinking. According to several theorists, dialogue is the heart of education (Bakhtin, 1981; Wells, 1999).

Despite the learner-oriented approach in inquiry, some guidance is valuable. The guidance can, however, be both self-regulated and directed by an educator. A self-regulated direction is what learners does themselves as "metacognitively, motivationally, and behaviorally active participants in their own learning process" (Zimmerman, 1990, p. 329), while an educator, if present in the inquiry, can offer structure and topic knowledge. In order to promote inquiry, an educator's role is both to guide the interaction and to provide instructions (Kirschner, Sweller, & Clark, 2006).

Online coaching is argued to be based on an individual's critical thinking, but emphasize that learning takes place in an intimate interaction with the environment. It is noted that the "educational process has two sides—one psychological and one sociological; and that neither can be subordinated to the other or neglected without evil results following" (Dewey, 1959, p. 20). A term that describes this learning activity's foundation well is collaborative constructivism. This orientation recognizes the co-existence of both the individual and social aspects of constructivism (Garrison, 2013). The trigger for initiating online coaching is argued to be based on the complementary view of the individual and collaborative components of constructive inquiry. The conversation is assumed to be preceded by a learner's individual reflective thinking in a learner-content interaction—e.g., when the coachee is trying

to solve a mathematical problem—and initiated by adding a learner-instructor interaction (Moore, 1989). A very common first message from a coachee is: 'Hi I need help!'. The guidance of online coaching includes both self-regulation and direction from an educator. By simply contacting a coach, the coachee self-regulates their learning. During a conversation, the self-regulation continues when the learner monitors and regulates the discourse. The role of the coach is following the notion of inquiry to support, structure, and facilitate the conversation as well as, when needed, to provide content knowledge.

Zone of Proximal Development

A theoretical foundation for online coaching is Vygotsky's (1978) theory of the Zone of Proximal Development (ZPD). This theory is represented as three levels of knowledge. The inner level represents what a learner is able to do without help, and the outer level represents what a learner is not able to do at all. Between these two levels is the Zone of Proximal Development, which corresponds to what a learner can do with guidance. Vygotsky defines the Zone of Proximal Development as the "distance between the actual developmental level as determined by independent problem solving and the level of potential development as determined through problem solving under adult guidance or in collaboration with more capable peers" (Vygotsky, 1978, p. 86).

This implies that the purpose of each online coaching conversation is for the coach to support the intellectual development of the coachee. The support is done by identifying the coachee's Zone of Proximal Development for the present issue and completing the learning activities together with the coachee that range within the coachee's actual Zone of Proximal Development. For each problem, the Zone of Proximal Development must be re-identified while the level of what a learner can do without help increases.

Online text-based discourse

When the process of inquiry occurs online, the shared discourse is facilitated using computer mediated means of communication instead of face-to-face. The conventional face-to-face education setting offers many communication modes. These communication modes include oral communication with the addition of visual tools such as a digital whiteboard. Furthermore, face-to-face education includes several physical and non-verbal cues such as facial expressions. In an online learning environment, the traditional communication modes include audio, video, and text communication (Anderson, 2008). For online coaching, all three modes can be represented using audio/video conferencing and text messaging. However, this

thesis focuses on communication using text and images. Text messaging alone is a single-mode communication tool since the text provided in the chat is the only communication between the participants. The text in chat services can, however, often be described as a hybrid of several communication modes. A post can include both written language, text similar to speech, and representations of physical and non-verbal cues. Chat services and other electronic media have generated an expanded language. The language includes both the actual message, often with abbreviations, and cues such as emoticons and special words in order to establish a dialogue with several modes of communication (Herring, 1999; Varnhagen et al., 2010; Walther & D'Addario, 2001; Werry, 1996).

Despite the similarities of spoken language and written language used in chat services, a difference is that spoken language is delivered orally, while text messaging is typed. The written text can, in comparison with spoken, be seen as more complicated since the actual typing is more tiring compared to speaking. The written text is also longer lasting due to the perceived permanent mark of text. However, these arguments that initially can be seen as disadvantages for written communication have "some inherent and demonstrable advantages over speech when engaged in critical discourse and reflection" (Garrison & Anderson, 2003, p. 26). This since a higher consciousness is needed in order to discuss using written text than to speak (Wells, 1999). Following these assumptions about text-based communication, "mentoring via online chat can be as effective as mentoring face-to-face" (Bagley & Shaffer, 2015, p. 1).

Online communication is often classified as either synchronous or asynchronous. In synchronous communication, the interaction between the participants occurs at the same time, while in asynchronous communication there is a delay. When comparing the two modes, researchers have found them to be complementary (Haythornthwaite & Kazmer, 2002). While asynchronous communication benefits from the independence of time, synchronous communication better fosters the social component of learning (Hrastinski, 2008). Online coaching using text messaging and a shared digital whiteboard can be classified as a near-synchronous learning activity (Nardi et al., 2000). This since coachees in online coaching have immediate access to a coach, which is characteristic of synchronous learning. At the same time, a coachee can, when needed, pause and reflect without a pressure to immediately respond, which is a characteristic of asynchronous learning environments.

The 2 sigma problem

A potential of online coaching is the opportunity to address the 2 sigma problem. The 2 sigma problem identifies that most students can reach a high level of learning if they are supported with one-to-one tutoring instruction. However, this would be

too expensive to bear on a large scale (Bloom, 1984). In the study of the 2 sigma problem, student learning was compared under three conditions of instruction. These were conventional, mastery learning, and tutoring. Conventional is presented as instruction where students learn the subject matter in a class with about 30 students per teacher. Mastery learning is conventional education with the addition of formative assessment components. Tutoring is when students learn a subject matter with a (good) tutor for each student (or for two or three students simultaneously). This instruction also includes formative assessment.

To compare these three instructional conditions, Bloom (1984) collected the average and standard deviation of students' result in the examination. The result for tutoring instruction exceeded the result of conventional instruction by two standard deviations, or two sigma. Bloom argues that most students can reach a high level of learning using one-to-one methods but that it would not be economically feasible to provide each student with a teacher. Therefore, Bloom identified alternative ways to realize tutoring under more practical and realistic conditions as an important task for scholars. In this thesis, it is argued that online coaching is an alternative way to realize high order one-to-one education under practical and realistic conditions.

Community of Inquiry

The Relationship of Inquiry framework presented in this thesis is based on the Community of Inquiry (CoI) framework. The first known use of the term Community of Inquiry was to define the community that forms among scientific scholars (Peirce, 1955). The notion of a community of inquiry in a learning context was introduced by Lipman (1991, 2003). This work was inspired by Dewey's understanding of thinking and generalization from the scientific process. The idea was that a group of students could build a community in support of learning just as scholars develop research communities.

In a Canadian research project between 1997–2001, entitled *A Study of the Characteristics and Qualities of Text-Based Computer Conferencing for Educational Purposes*, the Community of Inquiry was put in an online context. The keystone article, Garrison et al. (2000), introduced the Community of Inquiry framework. Their work had the aim "to provide conceptual order and a tool for the use of computer-mediated communication" (Garrison et al., 2000, p. 87), hence to analyze the process of educational inquiry in a text-based online environment.

According to the Community of Inquiry framework, the educational experience originates from the reflection and discourse among students and teachers. The framework represents a process of creating a deep and meaningful (collaborative–constructivist) learning environment. This experience emerges from three distinguishing and interdependent elements—cognitive presence, social presence, and

Figure 2: Community of Inquiry.
Garrison et al. (2000). Used with permission.

teaching presence—as illustrated in Garrison's three sets Venn diagram (Figure 2 on this page). Each of the elements in the Community of Inquiry framework is also divided into categories. The elements and categories are presented below and listed in Table 1 on page 14.

Along with the keystone article, the Canadian research project produced three additional papers. These papers continued the conceptualization with an extensive description of cognitive, social, and teaching presence (Anderson, Rourke, Garrison, & Archer, 2001; Garrison, Anderson, & Archer, 2001; Rourke, Anderson, Garrison, & Archer, 2001).

Cognitive presence

Cognitive presence is defined as "the extent to which learners are able to construct and confirm meaning through sustained reflection and discourse" (Garrison et al., 2001, p. 11). The element is grounded in the assumptions of critical thinking and inquiry. Cognitive presence is formed from the generalized scientific process. Dewey's (1933) problem-solving procedure was reviewed and refined by Garrison et al. (2000, 2001) with the establishment of the Practical Inquiry model. This model interprets the process of inquiry for educational problem-solving as a four phase sequence illustrated in Figure 3 on the facing page.

The first phase is a *triggering event*. This is what starts an inquiry process and typically consists of the identification and demonstration of a problem or issue to be investigated. The following phase, *exploration*, is characterized by an examination.

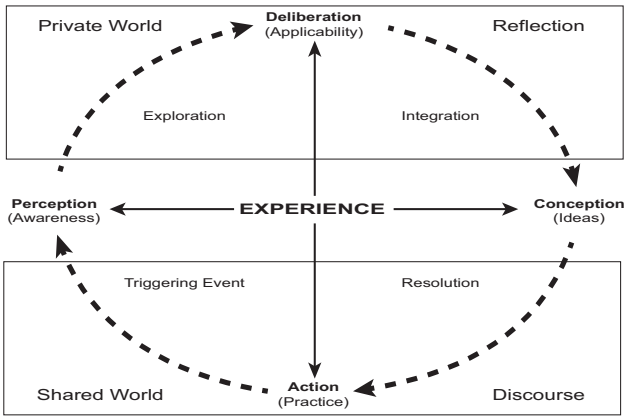


Figure 3: Practical Inquiry model.
Garrison et al. (2001). Used with permission.

It includes a broad, brainstorming oriented search where the problem or issue is investigated. The third phase is *integration*. Here the explored ideas are put together to form meaning. Finally, *resolution* is when the problem or issue is solved. This phase includes both the display and evaluation of a solution to the problem highlighted by the trigger. (e.g., Akyol & Garrison, 2011b; Garrison & Anderson, 2003; Garrison et al., 2000, 2001; Garrison & Cleveland-Innes, 2005)

A central feature of cognitive presence is that the process involves both the individual and the social components of constructivism. The participants in the educational experience should be both individually involved in the critical inquiry process and share their inquiry in a discourse. The phases in the model are presented following the logical sequence of inquiry. In reality, the stages of cognitive presence not always follow the logic order they are presented in (Garrison et al., 2001; Garrison & Arbaugh, 2007).

Teaching presence

Teaching presence represents the moderation and guidance of the inquiry. It is defined as "the design, facilitation, and direction of cognitive and social processes for the purpose of realizing personally meaningful and educationally worthwhile learning outcomes" (Anderson et al., 2001, p. 5). Teaching presence does not consist of sequential phases. Instead, the teaching roles in online learning have been classified. It was found that three roles are essential for the support of inquiry. The roles in Garrison et al. (2000) had other names, but the labels presented here have been used since Anderson et al. (2001).

Design and organization is the process of structuring and planning the educational experience. Examples are the selection of material, setting parameters, and selecting methods. In essence, design and organization emulate instructional management. *Facilitating discourse* is the monitoring and promotion of students' inquiry. It typically consists of the non-content oriented support of students and is manifested by the actual establishment and sustained progression of a discourse. *Direct instruction* is the lecturing role of the teacher. It is when "teachers provide intellectual and scholarly leadership and share their subject matter knowledge with students" (Anderson et al., 2001, p. 8). (e.g., Anderson et al., 2001; Arbaugh & Hwang, 2006; Ice, Curtis, Phillips, & Wells, 2007)

Using the term teaching presence implies that the moderation and guidance is not limited to a specific person: the teacher. Despite the fact that the teacher is responsible for this element, anyone can act as an educator by directing the community (Garrison & Anderson, 2003).

Social presence

Social presence is the element that reflects the human experience of learning (Rovai, 2002). Rourke et al. (2001) defined social presence as "the ability of learners to project themselves socially and emotionally in a community of inquiry" (Rourke et al., 2001, para. 2). This definition has, however, been slightly modified, and the current general agreed upon definition is the one suggested by Garrison (2009). He defines social presence as "the ability of participants to identify with the community (e.g. course of study), communicate purposefully in a trusting environment, and develop inter-personal relationships by way of projecting their individual personalities" (Garrison, 2009, p. 352). This re-definition clarifies that social presence is not only for purely social purposes but underpins the process of inquiry.

The classifications of social presence involve three categories identified through a review of the literature (Garrison et al., 2000). *Personal/Affective* consists of emotions, feelings, moods, and the use of humor. *Open communication* is mutual and reciprocal exchange of ideas and recognition of other's observations. *Group cohesion* is the component that is present when participants actively connect to other persons in the community. (e.g., Richardson & Swan, 2003; Rourke et al., 2001; Swan, Garrison, & Richardson, 2009)

The term social presence was introduced before the Community of Inquiry framework (Gunawardena & Zittle, 1997) and has been extensively studied since its introduction. It is also the element that has been questioned more than the rest (Annand, 2011). Several names for the categories are in use, although the defined expressions are almost identical. The uncertainty applies to the category of personal/affective. Garrison and Akyol (2013a) report that "after a decade of

research into the community of inquiry theoretical framework, it would appear that affective responses may not be the defining characteristics of social presence" (Garrison & Akyol, 2013a, p. 107).

Interrelations

The elements of cognitive, teaching, and social presence in the Community of Inquiry are argued as core components. Besides illustrating the elements, the three sets Venn diagram, in Figure 2 on page 10, also visualizes the interrelations between them. These overlaps indicate that the elements are not only autonomous but also cooperative. One example is, as reported in the figure, that selecting content involves both cognitive and teaching presence. According to Garrison et al. (2000), it is the union of all elements that outline the educational experience. Some research has been undertaken to examine the interrelations. Shea and Bidjerano (2009), along with Kozan and Richardson (2014), found positive correlations between the elements. Garrison, Cleveland-Innes, and Fung (2010) suggested that "social presence is a mediating variable between teaching presence and cognitive presence. That is, it is a responsibility of teaching presence and a condition for creating cognitive presence (i.e., collaborative inquiry)" (Garrison et al., 2010, p. 32).

Instruments

Two methods have been broadly applied in order to evaluate a learning environment using the framework. These are transcript coding and a survey study.

Transcript coding

Transcript coding is a content analysis research method where records of conversations are collected and analyzed in order to gain knowledge. Coding is a process where a part of a conversation is replaced with a code that represents the properties of that interaction (Krippendorff, 2013; Neuendorf, 2002). The method is heavily used in analyses of online learning since all communication in the environment can be gathered (Fahy, Crawford, & Ally, 2001; Gunawardena, Lowe, & Anderson, 1997). Transcript coding was the instrument used for the initial creation of the Community of Inquiry (Anderson et al., 2001; Garrison et al., 2000, 2001; Rourke et al., 2001).

Three components are necessary in order to perform a sound transcript analysis: framework, coding scheme, and unit of analysis (De Wever, Schellens, Valcke, & Van Keer, 2006). The framework in this case is naturally the Community of Inquiry framework. A coding scheme consists of "a strict and systematic set of procedures for the rigorous analysis" (Cohen, Manion, & Morrison, 2011, p. 563).

Table 1: Community of Inquiry coding scheme.

Element	Category	Indicators (examples only)
Cognitive presence	Triggering event	Sense of puzzlement
	Exploration	Information exchange
	Integration	Connecting ideas
	Resolution	Apply new ideas
Teaching presence	Design and organization	Setting curriculum and methods
	Facilitation	Sharing personal meaning
	Direct instruction	Focusing discussion
Social presence	Personal/Affective	Expressing emotions
	Open communication	Risk-free expression
	Group cohesion	Encouraging collaboration

The coding scheme is assembled from the elements and categories, as displayed in Table 1 on this page. For all categories, example indicators are provided in order to support the coding process. The unit of analysis is the entity replaced by a code. Two approaches are to either predetermine a fixed unit, such as a sentence, or to identify themes in the material and have variable units based on the content. Several units have been used with the Community of Inquiry framework (De Wever et al., 2006).

The accuracy of content analysis can be measured using inter-rater reliability. This measurement is done by performing several examinations independently on the same material and then comparing the codings and calculating the level of agreement (Cohen, 1960).

The transcript coding method is "an invaluable technique to understand interaction patterns and the quality of the discourse in online communities of inquiry ... It is through the use of transcript analysis that educators can investigate beyond what students *say they do* to reviewing what *they actually do*" (Garrison, Cleveland-Innes, Koole, & Kappelman, 2006, p. 8). That said, transcript coding contains only the outspoken discourse of an inquiry process and not the individual's critical thinking.

Survey study

The survey study method was introduced in Arbaugh et al. (2008) and Swan et al. (2008). This instrument consists of 34 statements about the learning experience that a participant responds to using a Likert scale (e.g., 1='strongly disagree' to 5='strongly agree'). Each of the questions was constructed so that it relates to one category and its corresponding element. For example, the first question in the survey is: "1. The instructor clearly communicated important course topics" (Arbaugh et

al., 2008, p. 135). That question represents the category design and organization in teaching presence.

The validation of this instrument was done using factor analysis. Arbaugh et al. (2008) reports that a confirmatory principal components analysis with oblimin rotation is done with the elements—cognitive, teaching, and social presence—as factors. The factors' suitability are calculated using the Kaiser-Meyer-Olkin measurement of sampling adequacy. Kaiser (1974) recommends 0.5 as a minimum value, 0.7–0.8 as acceptable, and values above 0.9 as very high. The reported value for the study of the Community of Inquiry survey was 0.96 for the three element factors. However, "when allowing for any possible number of factors in the analysis, eigenvalues indicate a potential fourth factor, while the scree plot yields inconclusive results" (Arbaugh et al., 2008, p. 134).

A survey study has the benefit (compared with transcript coding) that it includes both the individual and social component of an inquiry. It does, however, not cover the actual learning experience but only the participants' interpretation of it.

Reconstructions, critique, and extensions

The Community of Inquiry has been used extensively over the 15 years since it was introduced. In April 2015, Garrison et al. (2000), the keystone article, had been cited more than 2,500 times according to Google Scholar. That makes it one of the most used articles in the field of online learning.

During this period, the framework has also been challenged, and changes have been suggested both in terms of the conceptualization of the framework and how it can be used.

Emotional presence

Following the ambiguity of emotions in social presence, Cleveland-Innes and Campbell (2012) suggested that emotions are so fundamental that a fourth element—emotional presence—is needed. Emotional presence is defined as "the outward expression of emotion, affect, and feeling by individuals and among individuals in a community of inquiry, as they relate to and interact with the learning technology, course content, students, and the instructor" (Cleveland-Innes & Campbell, 2012, p. 283). The addition of this fourth presence removes the category personal/affective in social presence and has implications for all elements.

Learning presence

This extension of the Community of Inquiry is prompted by the self-direction of learning. Shea et al. (2014) argue that "while the construct of self-regulation has increasingly been found essential to online learning, it has not been well integrated

into the currently available theoretical frameworks that seek to explain successful online education" (Shea et al., 2014, p. 10). Examining this issue, learning presence was suggested within the Community of Inquiry. Learning presence refers to the extent to which online learners are metacognitively, motivationally, and behaviorally involved in the learning experience (Shea & Bidjerano, 2010).

Metacognition

This reconstruction is also founded in the self-direction of learning but does not involve an extension in terms of elements or categories. Instead, a comprehensive review was conducted, and an instrument was suggested to examine the metacognitive aspect of learning in terms of knowledge, monitoring, and regulation of learning (Akyol & Garrison, 2011a; Garrison & Akyol, 2015). Garrison and Akyol (2013b) also question the construct by Shea et al. (2014) of learning presence. They argue that the theoretical considerations of learning presence violate the fundamental assumptions of the Community of Inquiry framework.

Prescriptive use of Community of Inquiry

Originally, the Community of Inquiry framework was constructed as a "template and an essential tool to analyze and code transcripts from a computer conference" (Garrison et al., 2000, p. 103). The use of the framework has, over the years, expanded beyond that use.

Archer (2010) is calling for research where the framework is used to analyze not only the online forum interactions, but to analyze entire courses. Other initiatives endorse the statement from the keystone article that the Community of Inquiry can be seen "as a guide to educators for the optimal use of computer conferencing as a medium to facilitate an educational transaction" (Garrison et al., 2000, p. 87). A large number of the published studies use the Community on Inquiry framework as an instructional approach. Examples are Ke (2010), Szeto (2015), and Vaughan, Cleveland-Innes, and Garrison (2013), where the framework is used in online, blended, and face-to-face environments. The framework has also been used as a theoretical foundation for learning in several studies (Anderson & Dron, 2011; Gašević, Adesope, Joksimović, & Kovanović, 2015).

Critique

Since the Community of Inquiry has become well-known and extensively used, it is necessary to critically review the assumptions about learning that underpin the framework. Rourke and Kanuka (2009) reviewed 200 reports published about the framework. Their evaluation reports that only five of the reviewed studies actually investigates student learning. They also question the instruments validated with the

Community of Inquiry regarding that they detect only perceived learning. Based on their review, Rourke and Kanuka (2009) call for "researchers to conduct more, substantial investigations into the central construct of the popular framework for e-learning and theorists to respond to the mounting body of disconfirming evidence" (Rourke & Kanuka, 2009, p. 19).

Rourke and Kanuka (2009) along with Jézégou (2010) also review the theoretical foundations of the model. Both papers argue that the basis for the framework is too weak and needs to be described in more detail. In response to the critique, Garrison (2013) and Swan et al. (2009) outlined a foundation and an epistemology for the Community of Inquiry with community, collaboration, constructivism, reflection, and inquiry as key terms.

3 Research approach

In this section, the participants and procedures are presented. First, the Math Coach program is described. Secondarily, the strategies that were employed to address the purpose and research questions of the thesis are presented.

The Math Coach program

The empirical data for this thesis were collected from an online coaching program named Math Coach [1]. The Math Coach program started in 2009 and offers help with mathematics by coaching using a chat service with text messaging and a shared digital whiteboard. The service is open from 5 p.m. to 8 p.m. every Monday to Thursday during semesters. Coachees range from the sixth to ninth year of compulsory school and upper secondary school (aged 12–19). Coaches have been enrolled at the universities of Karlstad, Linköping, Stockholm, and the KTH Royal Institute of Technology, also located in Stockholm. Three locations have been used—in Stockholm, Linköping, and Karlstad—where coaches work sitting together. One benefit of this is that the coaches can support one another if a coach encounters problems in a conversation. From the start of the program, the coaches have conducted 20,000 conversations. All conversations are captured, and transcripts stored on a server. A start of a typical math coach conversation is presented in Figure 4 on the next page.

The entry requirements for a coach are that they must have studied math at university level and studied how to teach math. There is also a mandatory introductory course in math coaching that must be completed in order to work as a coach. The introductory course includes theory and practice in online coaching. In the theoretical part, coaches are introduced to an inquiry-based coaching model. The model for a conversation is based on three steps—introduction, problem solving, and closure. In the *introduction*, the coach aims to identify what the coachee needs help with and why they need help. The coach also strives to interpret the Zone of Proximal Development of the coachee in this stage. The second phase is *problem-solving*. In this stage, the coach engages in a dialogue in order to help the coachee solve the problem. The conversation ends with the *closure*, where the coach is encouraged to generalize from the problem and inspire the coachee to move forward. In the practical part of the coach training, coaches are introduced to the software and put their theoretical knowledge into practice. First, coaches work in pairs coaching each other, and then they have an in-training period working in the regular service.

[1] The Swedish name of the program is 'Mattecoach på nätet'. The website of the program is http://www.mattecoach.se

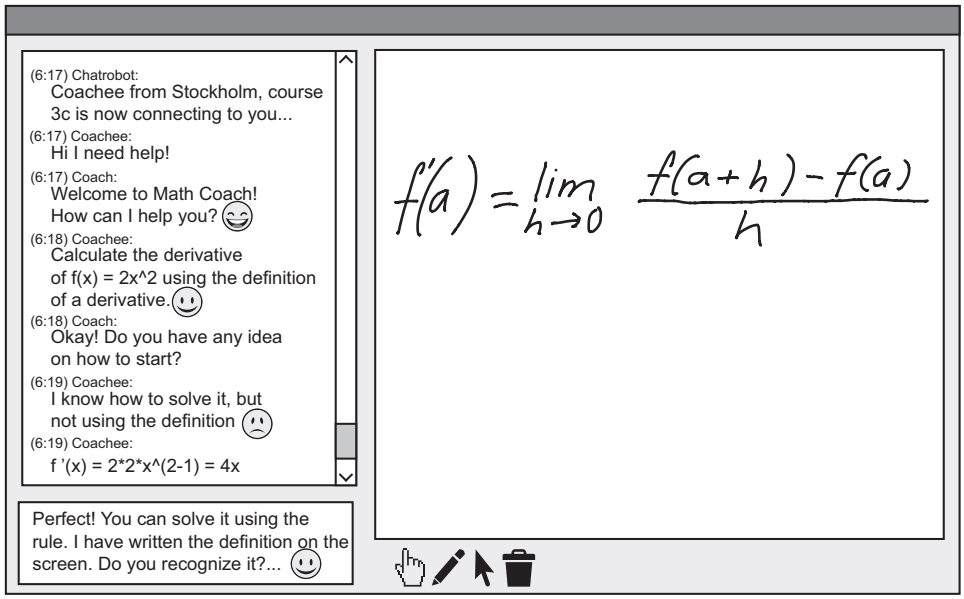


Figure 4: Example of a Math Coach conversation.

The Math Coach program has, since its start in 2009, used two generations of software. The first generation was Windows Live Messenger, an instant messaging software that in 2009 was commonly used by young people. The second (in use at the time of writing) is a software developed directly for the Math Coach program by combining a professional instant messaging system, Microsoft Lync, and a customer relationship management software, Microsoft Dynamics CRM. Both generations of the software are primarily text-based with possibilities to share whiteboards. The second generation adds features such as queues and sorting based on what course the coachee is studying. It also features automatic storage and basic analysis of the transcripts. In generation one, the storage and analysis was done by hand.

The evaluation of Math Coach has involved data collected from the transcript of each conversation and studies among both coaches and coachees. All transcripts are analyzed to get elemental information, such as the length of conversations. Survey studies among the coachees and coaches have been used intermittently in order to evaluate the learning experience. The coaches have also been interviewed as part of a previous study (Hrastinski, Edman, Andersson, Kawnine, & Soames, 2014).

Procedures

The purpose of this thesis is to explore inquiry-based one-to-one online education. This is done by establishing online coaching, adapting the Community of Inquiry, and an extended examination of emotions in online learning. The thesis addresses the purpose guided by three research questions presented on page 3.

Establishment of online coaching

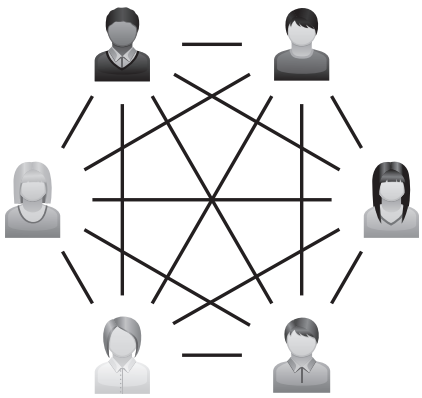
The first research question is examined by the definition and motivation of the learning activity of online coaching. This was done by a study of the establishment and operation of the Math Coach program. Online coaching was then characterized by a review of other well-known theoretical concepts. The study of the Math Coach program and the literature review was published in Paper I.

Although Paper I explained the value of online coaching with Vygotsky's Zone of Proximal Development, it did not further position the activity. The work of founding online coaching as an inquiry-based collaborative constructivist activity is expanded in this introduction's theoretical foundations (see section 2 starting on page 4).

The adapted framework

The second research question is examined with the adaptation of the Community of Inquiry framework to a one-to-one Relationship of Inquiry framework. This question is primarily addressed by this introduction, Paper II, and Paper IV. Secondarily, Paper III also provides insights for the second research question by examining the role of emotions in the Relationship of Inquiry.

A review of previous research informed that several frameworks for the analysis of educational interaction already exist. Examples of frameworks are Dysthe's (2002) analysis of web-mediated discussions using dialogue theory (based on Bakhtin, Rommetveit and Lotman), Critical Discourse Analysis in Education (Rogers, Malancharuvil-Berkes, Mosley, Hui, & Joseph, 2005), and the Community of Inquiry framework (Garrison et al., 2000). Several of the reviewed frameworks were found valuable, but no framework was found that examined the setting of online one-to-one interaction for educational purposes. The Community of Inquiry framework did, however, meet most of the requirements. Therefore, this framework was selected to form the theoretical base. The rationale for this is that the Community of Inquiry: (i) has a comprehensive view of a learning activity, (ii) is grounded in constructivism, (iii) reflects a collaborative inquiry process, (iv) was specifically created and validated for the online context, and (v) has two validated instruments (transcript coding and a survey).



Community

Relationship

Figure 5: Illustration of a Community and a Relationship.

The research about the Community of Inquiry framework has primarily been focused on a higher education setting but has been suggested to provide insights also for k–12 online learning (Borup, Graham, & Drysdale, 2014; Duncan & Barnett, 2009). The coachees that uses Math Coach are aged 12–19, and it is therefore assumed that they have reached the final stages of Piaget's theory of cognitive development (Piaget, 1977). Following this, it is expected that the constructivist processes of the coachees can achieve the cognitive reasoning of an adult.

The main difference between the learning environment that the Community of Inquiry represents and the learning environment of online coaching is the one-to-one setting. An illustration of a community and a relationship can be found in Figure 5 on this page. The term *relationship* was used since it is a "generic term for connections and disjunctions" (Lipman, 2003, p. 23). A central condition of the Community of Inquiry framework is that the inquiry process is situated within and between a group of persons, a community. Garrison (2013) defines the term community, in a community of inquiry, as a "group of individuals who are connected and communicate with regard to mutual interests and similar expectations as to process and outcomes" (Garrison, 2013, p. 10). A pair that communicates can to some extent be seen as a small group consisting of two people. However, "one-to-one conversation is different from other forms of learning conducted with more than one person" (Dron & Anderson, 2014, p. 74). For example, a learning activity that consists of only one educator and one learner is exclusive in the aspect that the learning activity is focused on one, and only one, person. Two other differences are

that coalitions between learners are absent and that the activity is interrupted if a single individual leaves (Rainie & Wellman, 2012). The differences between pairs and larger groups are fundamental (Dron & Anderson, 2014), and therefore the Community of Inquiry cannot be directly applied without a revision.

The role of emotions

The third research question examines the role emotions play in inquiry-based one-to-one online education. The reason for investigating emotions is motivated by the general attention paid to this area of research, a finding from the empirical case of Math Coach and an ambiguity in the Community of Inquiry. First, it is noted that emotions are critical components of the learning process (Phan, Wager, Taylor, & Liberzon, 2004; Plutchik, 2003; Sutton, 2004; Sutton & Wheatley, 2003). Emotions have, however, often been ignored in the analysis of learning (Artino, 2012; Schutz & Lanehart, 2002; Värlander, 2008). In recent years, the role emotions play in learning has gain attention among researchers calling for more substantial research within this field (Dirkx, 2008). Secondly, in the study of the establishment and operation of the Math Coach program (reported in Paper I) it was found that the emotional aspect of learning was much more prominent than expected. Practically all conversations in Math Coach included a considerable emotional aspect where coachees and coaches used emotional words and emoticons in order to share their emotion, affect, and feeling during the coaching. Thirdly, the most substantial extension of the Community of Inquiry framework is the suggestion by Cleveland-Innes and Campbell (2012) that the aspect of emotions, originally a part of social presence, should be expanded to a separate element called emotional presence.

Following these arguments is the research question addressed in Paper III. Here, the role of emotions in the Relationship of Inquiry framework is examined by evaluating Cleveland-Innes and Campbell's (2012) addition to the Community of Inquiry framework.

Reasons for not reviewing the role of the learner

The role of the learner in the Community of Inquiry is especially investigated both in the work of Shea et al. (2014), which suggests a learning presence, and in the work of Garrison and Akyol (2015), which evaluates metacognition. The work of Shea et al. (2014) was not assessed in the formation of the Relationship of Inquiry. This because learning presence has not been recognized by the research community around the Community of Inquiry. Garrison and Akyol (2013b) claim that the construct of a learner presence element violates some fundamental assumptions about the framework. The research about metacognition does not include changes in the framework but instead uses the original three-element version to explore learners'

self-direction. This work was not considered in the formation of the Relationship of Inquiry since the work is in progress and uses the framework as the theoretical base without suggesting changes to it.

Development of the Relationship of Inquiry framework

The adaptation of the Community of Inquiry framework to a one-to-one Relationship of Inquiry framework, including the examination of emotional presence, is performed in Paper II, Paper III, Paper IV, and this introduction. The first description of the Relationship of Inquiry was published in Paper II. The framework was grounded in inquiry-based teaching and learning and includes cognitive, social, and teaching presence. This was done using the 34-item survey study with modified questions. The following article, Paper III, evaluates the suggested emotional presence extension. The data for this paper included additional items in the survey study and a transcript analysis. In Paper IV, the framework was enhanced with descriptions of all components of the Relationship of Inquiry. This paper also included a transcript coding template, which was developed and tested. Finally, this introduction summarizes the adaptation with a consolidated description of the Relationship of Inquiry and a discussion of the design and implications for research and education.

Empirical data

The empirical data for this thesis were collected from the Math Coach program. The data collected consists of transcripts from conversations, a survey among coaches, and a post-conversation survey for coachees.

For Paper I, a post-conversation survey for coachees and transcripts from conversations were used. The post-conversation survey included questions about how satisfied a coachee was with the conversation and the coachee's reason for contacting a coach. The transcripts were used to give some statistical data, such as length of conversations and mathematical contents of the conversations. In Paper II, a modified version of the Community of Inquiry survey was used. The survey was formulated with modified questions that reflect a relationship instead of a community. All items were also written to inform from the educators point-of-view. The survey was complemented with descriptive questions and items reflecting emotional presence. These items were used in Paper III (but not in Paper II). For Paper IV, a transcript coding analysis was conducted. In this analysis, conversations were selected and coded. Paper III involved no additional empirical data collection. Instead, the survey study from Paper II was re-examined with the additional items of emotional presence. A separate analysis of the transcript coding from Paper IV was also performed.

Ethical reflection

Since the empirical data for this thesis include information about peoples' learning activities, and especially since a majority of the coachees are minor, it is essential that the data is handled with care. The post-conversation survey for coachees used in Paper I included questions where they evaluate the quality of the conversation and their reason for contact. The survey was optional to respond to and did not include any data that could identify the coachee. The survey study among coaches, used in Paper II and Paper III, included personal data about the coach (name, gender, university, teacher program, and experience in coaching) and their responses to the Relationship of Inquiry survey. All questions in the survey were optional to respond to, and any information that could identify a person was not published.

The Math Coach program collects all conversations held with students. In the first generation of the software, transcripts were saved by hand and stored on a server for manual analysis. In this version, the transcripts consisted of the coachee's username and e-mail, the name of the coach, and the conversation. The second generation of the software automatically archives the transcripts. The conversation, name of the coach and the coachee's municipality and math course are collected while the name of the coachee is automatically removed. In order to start a conversation, the coachee or her parent gives informed consent to the fact that the conversation is saved for the development of the program and research. The instructions attached to the consent form includes information about what data the program collects and how the data are used.

This thesis uses transcripts from the first generation of the software. Data were exported from the Math Coach program server and handed over to the authors, which the informed consent allows. The first step of all analysis has been to remove everything that could identify an individual.

The author's involvement in the Math Coach program

My involvement in the Math Coach program is as its founding manager (2009–2011). I am also the individual responsible for the design of the coach introductory course and still the course examiner. I believe that my background as active in Math Coach is of benefit for the exploration due to my practical knowledge of constructing online coaching environments. Since the thesis is focused on the process of learning in online coaching and not to evaluate any benefit of the case, any negative influence related to my role in the program should be small.

4 Overview of the papers

This thesis consists of this introduction and four papers. Each paper's contribution to the thesis is displayed in this overview.

Paper I: Student–student online coaching: Conceptualizing an emerging learning activity

Co-written with Stefan Hrastinski. Published in The Internet and Higher Education 16:66–69 (2013).

The contribution from this paper to the thesis is to describe and explain online coaching. The term used in this paper was student–student online coaching. It was defined as an online service where a student gets support on a specific subject matter from a more experienced student. The use of 'student–student' specifies in this definition that both the coach and the coachee are learners. In the Math Coach program, the coachee learns mathematics, and the coach learns how to perform online coaching in math. The definition was presented in relation to other well-known concepts, such as teacher and peer coaching (Ackland, 1991; Barth, 1988; Kohler, Crilley, Shearer, & Good, 1997; Showers & Joyce, 1996), tutoring (Graesser, Person, & Magliano, 1995; Wood, Bruner, & Ross, 1976), and e-tutoring (Denis, Watland, Pirotte, & Verday, 2004). The potential of student–student online coaching was supported by Vygotsky's (1978) theory of the Zone of Proximal Development and the possibility to address Bloom's 2 sigma problem (Bloom, 1984).

The Math Coach program was in this paper used as an illustrative example. A result of a post-conversation survey among the coachees was presented along with a basic transcript analysis of conversations. An agenda for future research was also outlined. This was based on three areas: software research and development, teaching and learning in online coaching, and learning analytics.

Comment on the published paper

The term 'student–student online coaching' has after publication of this paper, been revised to 'online coaching'. This was done in order to align with the more generic approach of the Relationship of Inquiry as a framework for analysis of online coaching without specifying the student–student context. It is still clear that in the Math Coach program, both the coachee and coach learn from the discourse—the coachee learns math and the coach learns how to teach math—but the learning process of the coach is not examined in the thesis.

Paper II: Student–Student Online Coaching as a Relationship of Inquiry: An Exploratory Study from the Coach Perspective

Co-written with Stefan Hrastinski and Martha Cleveland-Innes. Published in Journal of Asynchronous Learning Networks 16(5):37–48(2012).

The contribution from this paper to the thesis is to establish the Relationship of Inquiry framework and to perform a survey study using the framework among coaches. The framework was created in order to gain an understanding of online coaching using cognitive, social, and teaching presence as core elements for the communication that occurs between the coach and the coachee. The framework was an adaptation of the Community of Inquiry framework created by Garrison et al. (2000). The fourth element of emotional presence was not considered in this paper.

To test the Relationship of Inquiry framework, a survey was developed and tested in an exploratory study with all coaches in the Math Coach program. The established survey instrument of the Community of Inquiry (Arbaugh et al., 2008; Swan et al., 2008) was revised. A questionnaire was then distributed in order to collect data describing the coaches as well as descriptive data of their coaching practices and their perceptions of being part of a relationship of inquiry. The participants consisted of all 41 active coaches in the Math Coach program in spring 2012.

Since the number of respondents was too few compared to the number of items, no factor analysis could be performed. Instead, the reliability of the survey was tested using Cronbach's alpha. The teaching presence achieved a high level of reliability, while cognitive presence and social presence achieved acceptable levels of reliability. The mean value and standard deviation were calculated for all items and categories. Statistical tests were used also to test differences between categories in an element. The findings indicated that all categories in cognitive presence are equally common. This suggests that all areas of cognitive presence are of importance in this case of online coaching. In social presence, the category of open communication had a greater rank. This indicates the importance of establishing an open climate. In teaching presence, design and organization was of less importance. This was interpreted as since software and structure is set on program level it is not seen as a part coach's teaching presence. The result of some individual items also confirmed the problem-based inquiry approach of the Math Coach program.

A test was done to examine correlations between the characteristics of the coaches and their responses to the Relationship of Inquiry survey. Significant correlations were found between all elements and the coaches' student target groups, between social presence and the university location of the coaches, as well as between cognitive presence and the coaches' work experience.

Paper III: Emotional presence in a relationship of inquiry: The case of one-to-one online math coaching

Co-written with Martha Cleveland-Innes and Stefan Hrastinski. Manuscript submitted for publication.

The contribution from this paper to the thesis is to expand the Relationship of Inquiry with the element of emotional presence. Garrison et al. (2000) and Rourke et al. (2001) positioned the aspect of emotion, affect, and feeling as a category within social presence called emotional or affective expression. This was questioned by Cleveland-Innes and Campbell (2012). They support an addition of a new separate emotional presence element in the Community of Inquiry. In this paper, the role of emotional presence in the Relationship of Inquiry was tested.

The empirical data supporting this paper consisted of an add-on to the survey study from Paper II, and a new analysis of the transcript coding procedure from Paper IV. In the survey, five additional items measuring emotional presence were developed following the items in Cleveland-Innes and Campbell (2012). These items were answered by the coaches during the survey in Paper II but were not included in that paper. The transcript coding procedure published in Paper IV was performed in parallel with Paper III. Therefore, a coding scheme for emotional presence was developed in Paper III and implemented and tested in Paper IV, and then a new analysis of the emotional presence element was undertaken for Paper III. The coding scheme was designed with three categories of emotional presence: activity emotions, outcome emotions, and directed affectiveness. Activity and outcome emotions were built on the control-value theory of achievement emotions (Pekrun, 2006; Pekrun, Goetz, Titz, & Perry, 2002), and directed affectiveness was built to reflect directed emotions (Derks, Fischer, & Bos, 2008; Rourke et al., 2001).

For the survey, statistical tests showed that emotional presence was rated lower than cognitive, teaching, and social presence. Particularly, significant differences were found between items evaluating emotions expressed by the coachee and the coach, where coaches rated themselves as less emotional. A test between emotional presence and the gender of the coach showed no significant difference. In the transcript coding procedure, emotional presence was rated at a similar level as social presence, while cognitive and teaching presence were more prominent. The two categories activity emotion and directed affectiveness were clearly reported, while outcome emotion was almost absent.

The conclusions of the paper are that emotional presence does enhance the exploration of online coaching. That said, further research is needed in order to fully describe this element.

Paper IV: Revising the Community of Inquiry framework for the analysis of one-to-one online learning relationships

Co-written with Malin Jansson and Annelie Hulkko. Forthcoming in the International Review of Research in Open and Distributed Learning.

The contribution from this paper to the thesis is to enhance the theoretical base of the Relationship of Inquiry framework. This was done by enhancing the framework, developing a coding scheme, and performing a transcript coding procedure.

The design of the framework in this paper consisted of definitions of the four elements and the twelve categories. It was argued that the elements of cognitive, teaching, social, and emotional presence do guide the systematic analysis of one-to-one educational discourse. For all elements, descriptions were provided with a special focus on the modifications to the Community of Inquiry that were needed to reflect the difference between a relationship and a community. In order to enable transcript analysis, a coding template was developed with indicators of the different categories. Also, a review of the unit of analysis was conducted. It was decided that 'a message' as unit of analysis best served the analysis of this case. Each message was also permitted to be coded with combinations of categories in order to reflect the interactions of the elements.

In the paper, 60 conversations from the Math Coach program performed during the year 2012 were selected and coded using the coding template. In total, 3,109 messages were coded with 4,013 instances of the different categories. The reliability of the coding procedure was tested on 10 conversations coded by two persons. Cohen's (1960) kappa were 0.71 for categories and 0.85 for elements, which supports a high level of reliability.

Statistical tests were applied in order to test the framework and to gain insight into the content of the online coaching case of Math Coach. The coach and coachee seem to share the space equally as no difference in the number of messages was found. According to the coding procedure, all elements are viable, but cognitive and teaching presence are more common than social and emotional presence in the Math Coach program.

Noteworthy results are that cognitive presence is dominated by exploration and teaching presence by direct instruction. It was expected that exploration would be prominent since the transcripts only cover the outspoken inquiry. The excess of direct instructions was surprising since too many instructions may inhibit the inquiry process. Regarding social presence, the coachee highly values in the open communication, while the coach seems to be responsible for the relationship cohesion. The interrelation of several categories in one message is seen most often for relationship cohesion, followed by directed affectiveness and design and organization.

The author's contribution to the papers

The papers underpinning this thesis were written in collaboration with four co-authors: Stefan Hrastinski, Martha Cleveland-Innes, Malin Jansson, and Annelie Hulkko. It was an intentional choice to write the research papers with others due to the presumed enhanced quality gained by working together with others. The first three papers were written with supervisors in order to learn how to perform research. The fourth paper was written independently of the supervisors in order to show autonomy. For each paper, the authors' names are written in descending order according to the level of contribution to the paper. I was the first author on all papers except one.

Paper I was written with Hrastinski as the first author. This occurred because Hrastinski performed a key part of the literature review and wrote the majority of the text. My contributions to Paper I were to provide a comprehensive description of online coaching and the Math Coach program as well as the data needed to describe the Math Coach program (e.g., the survey and preliminary transcript analysis). I also conducted a second literature review filling gaps from the general review. The final work of defining student–student online coaching was done together.

For Paper II, Cleveland-Innes suggested the use of a modified Community of Inquiry framework. Together we formed the first version of the framework and formulated the items in the survey. The data collection and analysis was performed by me with support from the other authors, and we all contributed equally to the text of this paper.

In Paper III, my contribution was to review the literature about emotions and learning as well as emotions in the Community of Inquiry and to perform the data analysis. I also wrote the vast majority of the text. For this paper, the co-authors served the role of reviewing all material to ensure quality level.

Paper IV was written with two master's students. I continued the theoretical work forming the Relationship of Inquiry framework, and together we created the coding scheme. Jansson and Hulkko performed the coding procedure and initial analysis. This work was presented in in their joint master's thesis titled, *Education through instant messaging: A content analysis in an online coaching project* (Hulkko & Jansson, 2013). Following this, I conducted the comprehensive analysis and wrote all text.

5 The Relationship of Inquiry

This section presents the Relationship of Inquiry framework. The framework was developed in three papers: Paper II, Paper III, and Paper IV. In this section, the findings from the three papers are presented together.

The proposed framework is an adaptation of the Community of Inquiry to a one-to-one online coaching setting. It is argued that the theoretical framework of the Community of Inquiry by Garrison et al. (2000) offers the structure needed to analyze the complexities of online learning. The Community of Inquiry has been verified in hundreds of studies as a representation of an effective online learning environment (Akyol et al., 2009). In online learning, a group of learners and teachers are encouraged to create a community of inquiry. In online coaching, the coach and the coachee are encouraged to create a relationship of inquiry.

The suggested Relationship of Inquiry framework consists of four elements. These are cognitive presence, social presence, teaching presence, and emotional presence. The elements are listed in Table 2 on the current page. The Relationship of Inquiry was in Paper IV defined as "a conceptual connection that is built between two persons that engage in a critical discourse. This relationship is labeled to consist of a coachee and a coach. A coachee is someone that needs assistance in their inquiry in order to construct personal meaning. The coach is someone assigned to support the learning process by enabling insights through conversation. Together they construct a collaborative relationship aimed to resolve an educational issue" (Paper IV, p. 3).

Table 2: Relationship of Inquiry.

Element	Category
Cognitive presence	Triggering event
	Exploration
	Integration
	Resolution
Teaching presence	Design and organization
	Facilitating discourse
	Direct instruction
Social presence	Open communication
	Relationship cohesion
Emotional presence	Activity emotion
	Outcome emotion
	Directed affectiveness

Each element is, just as in the Community of Inquiry, divided into categories. These are modified in order to reflect the one-to-one environment. All elements and categories of the Relationship of Inquiry are presented below and listed in Table 3 on page 36.

Cognitive presence

Cognitive presence is the intellectual ability of the coachee. Following the assumptions of online coaching, the cognitive processes are grounded in a collaborative constructivist inquiry-based process. Therefore, it is assumed that the Practical Inquiry model, Figure 3 on page 11, applies also for a one-to-one relationship.

The categories of cognitive presence are: triggering event, exploration, integration, and resolution. A *triggering event* within a conversation is the formulation of a problem or issue. It is also displayed with the decision of a coachee to contact a coach. *Exploration* is a broad phase characterized by brainstorming and information exchange. This also includes a coachee's expression of her prior understanding of the subject. *Integration* is when the broad search is concentrated and the pieces from the exploration are put together. In the Math Coach case, mathematical calculations are a typical example of integration. *Resolution* is when solutions are suggested and evaluated as well as the final settlement of a solution to the problem.

In the construction of the Relationship of Inquiry, the aspect of cognitive presence has been studied from the coachee's point-of-view. The possible learning achievements for a coach (e.g., to improve coaching skills) were left out at this stage in order to focus on the coachee's inquiry.

Teaching presence

Teaching presence is the work of the coach in order to establish and maintain a relationship of inquiry. The element could have been named 'coaching presence' instead since that term better describes the coaching approach emphasized in this setting. Despite that, the original name was kept in order to align with the Community of Inquiry. The same aspects that Anderson et al. (2001) suggested to guide the teaching role are found to also be legitimate in a one-to-one context. In a relationship of inquiry, teaching presence serves to support the critical inquiry of only one person, the coachee. Therefore, this element is exclusively formed for each conversation to serve that coachee's need.

Design and organization is the configuration and arrangements made in order to structure a conversation. The design of coaching is to some extent decided with the selection of software and modes for communicating (e.g., video, audio, text, and images) and the category involves software support. The goals and feasible

methods to achieve them are also included in the design and organization of online coaching. *Facilitating discourse* is the effort that the coach puts in to monitor the process of inquiry that the coachee is in (cognitive presence) and to stimulate the coachee to improve each phase of the inquiry and the advancement in order to reach resolution. *Direct instruction* is the content information sharing of the coach. This is done by including material in the conversation. Examples of material are links to websites, references to books, or when the coach shares material in the chat (e.g., by lecturing). Direct instruction serves the purpose of giving the coachee something to reflect on.

In the Community of Inquiry, instructors are responsible for teaching presence, but anyone can act as an educator by, for example, sharing material (Garrison & Anderson, 2003). This is what outlines the self-direction of a one-to-one setting following the notion of metacognition (Akyol & Garrison, 2011a; Garrison & Akyol, 2015). In the development of the transcript coding procedure for the Relationship of Inquiry, this aspect of the experience was considered a part of the coachee's inquiry and therefore noted as cognitive presence.

Social presence

Social presence is the human dimension of learning. In a relationship of inquiry, this is the element that reflects participants' individualism and the interaction that outlines the interpersonal relationship. Social presence is displayed by an involvement with the other participant in the relationship as a person in order to prompt inquiry.

The content of the social element of online learning has been largely debated. The original classification involved affective, interactive, and cohesive as the three components of being social (Rourke et al., 2001). Recent research argues that the affective emotional aspect of learning is a separate element of the learning experience and not a part of being social (Cleveland-Innes & Campbell, 2012). In this thesis, the element of emotional presence is included in the Relationship of Inquiry (Paper III). Following this, the categories of social presence are open communication and relationship cohesion.

Open communication is the comfortable appearance of support and acknowledgment within the relationship. It also involves the basic interpersonal interaction with messages such as: 'Hello!'. *Relationship cohesion* is the efforts that are made in order to connect with the other person as well as the feeling of having an educational relationship. The name of this category has been changed from 'community cohesion' to 'relationship cohesion' to be aligned with the one-to-one conditions. The social element of the Relationship of Inquiry is shared between both the coach and coachee.

Emotional presence

Emotional presence is "the outward expression of emotion, affect, and feeling in a relationship of inquiry" (Paper III, p. 14). For the Community of Inquiry, this element was introduced in Cleveland-Innes and Campbell (2012) but did not include any suggested categories.

Therefore, new categories were developed in Paper III that reflect different inquiry-related emotions. The suggested categories were put forth by reviewing Pekrun's (2006) theory of control-value for achievement emotions and complemented with personally directed emotions (Derks et al., 2008; Rourke et al., 2001). The categories of emotional presence used in Paper III and Paper IV are: activity emotion, outcome emotion, and directed affectiveness.

Activity emotion is an emotion related to the inquiry. It includes emotions as a part of the process that the coachee and coach are undertaking when solving an issue. *Outcome emotion* is related to the result of the inquiry. This involves emotions about a perceived success or failure to reach resolution. *Directed affectiveness* is the personally guided expression of emotions between coach and coachee.

Emotions can include both emotional words and symbols (emoticons) that replace non-verbal communication in text-based interaction. The element can be demonstrated by both persons in the relationship.

Instruments

Two instruments are suggested in order to use the framework to evaluate online coaching. These are a survey study and a transcript coding procedure.

Survey study

The survey study serves the purpose of evaluating a learning experience by letting participants respond to a set of statements about their perception of the activity. The survey was developed and tested in an exploratory study from the coach perspective in Paper II. The survey consisted of 34 items. These items were derived from Arbaugh et al. (2008) and Swan et al. (2008) to an online coaching context from the coach perspective. Each question was formulated so that it reflected an element and a category. The full list of items for the Relationship of Inquiry survey is presented in Figure 6 on the following page. In the survey, the term 'student' was used instead of 'coachee' to avoid misunderstandings between the terms coach and coachee.

Cognitive presence

1. Coaching piques students' curiosity.
2. Students asking for coaching are motivated to explore content related questions.
3. Coaching is shaped around problems posed by the student.
4. Coaches and students use a variety of information sources to explore problems posed.
5. Brainstorming and searching relevant information helps students answer questions.
6. Online discussion is valuable in helping students appreciate different points of view.
7. I provide a learning activity that helps students construct explanations/solutions.
8. Reflection on content and dialogue helps students understand fundamental concepts.
9. Combining new information helps students answer questions raised in coaching discussions.
10. Students can describe ways to test and apply the knowledge provided when being coached online.
11. Students develop solutions to problems that can be applied in practice through online coaching.
12. Students can apply the knowledge gained in coaching to other areas of learning/work.

Teaching presence

13. I clearly communicate important information required to assist the student learn while coaching.
14. I clearly communicate important topics.
15. I clearly communicate important content goals.
16. Students are coached regarding the use of time as it applies to learning.
17. I focus discussion on relevant issues in a way that helps students to learn.
18. I provide feedback in a timely fashion.
19. I provide feedback that helps students understand her/his strengths and weaknesses.
20. I keep students engaged and participating in productive dialogue.
21. I keep students on task in a way that helps students to learn.
22. I guide students toward understanding topics in a way that is helpful to students.
23. I help to identify areas of accuracy and error regarding content understanding that helps students learn.
24. I encourage students to explore new concepts to solve problems.
25. My actions reinforce the development of a working relationship with students.

Social presence

26. Students feel comfortable interacting with coaches online.
27. Students feel comfortable conversing through the online medium.
28. Students feel comfortable sharing her/his need for assistance online.
29. Students feel comfortable disagreeing with coaches while maintaining a sense of trust.
30. Students' point of view is acknowledged during online coaching.
31. Online discussions with coaches helps students develop a sense of collaboration.
32. Getting to know students creates a connection important to the coaching relationship.
33. Students are able to form distinct impressions of the coach and the coach role.
34. Web-based communication is an excellent medium for coaching interaction.

Emotional presence

35. Emotion is expressed by students during coaching.
36. Expressing emotion in relation to math coaching is acceptable.
37. I acknowledged emotion expressed by students during coaching.
38. In my role as coach, I demonstrate emotion online during coaching.
39. I find myself responding emotionally about problems or issues that come up during coaching.

Figure 6: The Relationship of Inquiry survey.

The survey study that was conducted for Paper II also included items of emotional presence. These items were not included in the analysis used in Paper II but were considered in Paper III to form a 39-item survey. Here, the questions were reformulated from Cleveland-Innes and Campbell (2012).

In the papers underpinning this thesis, the Relationship of Inquiry survey was used with a five-point Likert scale (1 = 'strongly disagree' to 5 = 'strongly agree') among active coaches in the Math Coach program. For each item, the coaches responded to a statement about online coaching in order to evaluate their perception of the learning experience. The responses in total formed the data for the different elements and categories. These data were then assessed using statistical tests to look for significant differences between the categories and elements.

Transcript coding

The transcript coding procedure serves the purpose of evaluating a learning experience by reducing the actual conversation to a pattern that reflects the content of conversations. It was tested using 60 conversations with 3,109 messages from the Math Coach program.

The transcript analysis for online coaching consists of the Relationship of Inquiry framework, a coding scheme, and a selected unit of analysis. The framework was presented earlier in this section. The coding scheme was developed in Paper IV and presented in Table 3 on the next page. It consists of the coding categories, their corresponding elements, some of typical indicators of that category, and examples. For this study, 'a message' was used as the unit of analysis. This was decided because initial analysis revealed that each message consists of a couple of words that relate to one or a few aspects of learning. That said, it is argued that the unit of analysis must be set in relation to the number of interactions and amount of information in each interaction such that the accuracy of the instrument is maximized. In the study in Paper IV, the average number of messages per conversation was 51.82, and the words per message were on average 13.03 words.

The process of coding transcripts involves three steps—coding training, independent coding, and reliability calculation. Coding training is when the coders are educated to perform coding. This step usually involves discussions with the scheme constructor, trial coding, and negotiating. Coding is done following this structure. For each unit, first the content is investigated, and then all categories are reviewed and coded as existing or not existing in the unit. This allows coders to code more than one category and element to reflect the interrelations between the elements. When the coders are trained, they code a set of data independently. The last step is to calculate the reliability of the coding by percent agreement and Cohen's (1960) kappa.

Table 3: Relationship of Inquiry coding scheme.

Element	Category	Indicators (examples only)	Examples
Cognitive presence	Triggering event	Stating a problem, changing direction.	"Here's the problem: ..." "I have another issue."
	Exploration	Brainstorming, broad search for insights, information exchange.	"Perhaps I could use ..." "Am I thinking right here?" "What is a square root?"
	Integration	Connecting ideas, computations.	"I can combine ... with ..." "$7/12 - x = 1/4$"
	Resolution	Achieve solution, analysis of solution, implementation.	"The answer is 3!" "I made a mistake with ..." "Then the apple is cheaper ..."
Teaching presence	Design and organization	Establishing interaction, setting parameters for the inquiry.	"What can I help you with?" "You can type in the textbox or draw on the whiteboard."
	Facilitating discourse	Stimulating constructive inquiry, assessing process.	"Do you have an idea?" "What answer did you get?"
	Direct instruction	Providing steps to solution, summarizing the discussion.	"You should multiply with 10." "$1/3 + 1/4 = 4/12 + 3/12$"
Social presence	Open communication	Acknowledging, trivial expressions.	"Okay!", "Perfect." "I can't see the figure."
	Relationship cohesion	Greetings, vocatives, building links.	"Hello.", "Good luck." "What should *we* do now?"
Emotional presence	Activity emotion	Emotion about the inquiry.	"We solved it!! :-)"
	Outcome emotion	Emotion about consequences of the inquiry.	"Gah! I have a test on Monday that I will fail if I don't get this."
	Directed affectiveness	Emotion towards the other person.	"Thank you for helping me!" ";-)" , ":-(" , ":-P"

6 Discussion

The discussion is framed around the learning activity and the framework with its instruments. The reliability, validity, and generalizability of the framework is also discussed, and an agenda for implementation and further research is outlined.

Establishment of online coaching

The first research question of the thesis is: How can online coaching be conceptualized? Online coaching is in this thesis grounded in inquiry-based collaborative constructivism. It is suggested that a coachee engages in a conversation to complement their individual critical thinking with a collaborative discourse in order to construct personal meaning of an educational issue. It would be possible to ground the activity in other theories and paradigms. For example, an arrangement grounded in behaviorism with a stimuli and response approach to conversation could be of some value.

It is here argued that online one-to-one inquiry-oriented collaborative constructivism is an effective approach to learning. Since one-to-one tutoring is a very effective form of instruction (Bloom, 1984; Chi, Siler, Jeong, Yamauchi, & Hausmann, 2001) and inquiry is seen as a hallmark of education (Dewey, 1959; Lipman, 1991, 2003). Collaborative constructivism combines the individual's critical thinking in order to construct meaning of experience based on previous knowledge with engagement in a collaborative discourse (Jonassen, 1999; Lipman, 1991, 2003; Schunk, 2012). Online one-to-one inquiry-oriented collaborative constructivism is also consolidates the practical setting of the learning experience in the Math Coach program (Paper I). It is the integration of an individual's cognitive processes supported by an active conversation that outlines online coaching.

The adapted framework

The second research question of the thesis is: How can the Community of Inquiry framework be adapted for analysis of one-to-one online education? The Relationship of Inquiry framework is developed to offer a structure for the analysis of learning processes in one-to-one online coaching environments. This occurs by adapting the Community of Inquiry framework (Anderson et al., 2001; Garrison et al., 2000, 2001; Rourke et al., 2001, etc.). That framework has been revised and reshaped for implementation in a one-to-one setting.

The procedures of this thesis (in section 3 starting on on page 18) show that several existing frameworks have the potential to inform the learning activity, such as Dysthe's (2002) analysis of web-mediated discussions using dialogue theory and

Critical Discourse Analysis in Education (Rogers et al., 2005). The procedures also outline the five-point rationale for choosing the Community of Inquiry as the theoretical base and the motivation behind why the Community of Inquiry needs a review in order to be applicable in one-to-one settings.

The role of emotions

The third research question of the thesis is: What role do emotions play in inquiry-based one-to-one online education? The Community of Inquiry framework was introduced with the three elements of cognitive, social, and teaching presence. In recent research, the role of emotions and the role of the learner have gained special attention. Cleveland-Innes and Campbell (2012) have suggested the element of emotional presence to form a four-element construct where the new element outlines the emotions, affect, and feelings during the inquiry. This element was tested in Paper III. The findings confirm the earlier perceived central role that emotions play in one-to-one online education. Paper III suggests that emotional presence enhances the exploration of one-to-one online coaching settings. Emotional presence is therefore included in the Relationship of Inquiry framework.

The role of emotions in online coaching has also been further investigated in two conference proceedings. Stenbom, Cleveland-Innes, and Hrastinski (2012) identified positive and negative emotions during coaching, while Cleveland-Innes, Stenbom, and Hrastinski (2014) examined the interrelation between cognitive and emotional presence. The notion of emotional presence has been recognized by Garrison and Akyol (2013a) and was recently further refined by Rienties and Rivers (2014), who discussed emotions' impact on learners' motivation, self-regulation, and academic achievement.

Instruments

The two instruments used in this thesis are a survey study and a transcript coding procedure. These two instruments were chosen because they are validated and the two most used instruments in the Community of Inquiry. It would have been possible to develop new instruments for the Relationship of Inquiry. However, since validated methods were already in place for communities, the development of new instruments would demand a more extensive effort without gaining the same possibility for validation.

Research methods are often described as either qualitative or quantitative. Quantitative methods focus on measuring a phenomenon and often include statistical work, while qualitative methods focus on describing a phenomenon (Cohen et al., 2011). Both methods used in this thesis are quantitative since they involve the

systematic empirical investigation of a learning activity using numerical data and statistical analysis. By employing a quantitative approach, it was possible to conduct a comprehensive confirmatory assessment following the framework. However, the lack of a qualitative approach implies that fewer details about the learning experience were obtained, which could have been detected through, for example, interviewing coachees or coaches.

Reliability

Two important concepts in evaluating the research instruments are reliability and validity. In simple terms, reliability is the consistency of an instrument (Cohen et al., 2011). The reliability of the transcript coding procedure and the survey study are evaluated in each paper.

For the transcript procedure, reliability was measured as inter-rater reliability. A portion of the transcripts were coded by two persons, and then their codings were compared to evaluate to what level they align. If two persons assigned the same message in a transcript the same codes, it is assumed that the analysis of that message is consistent. In Paper IV, this was done with 10 of the 60 conversations. The total percent agreement was 0.74 on category and 0.89 on element level. However, percent agreement does not account for agreement by chance, which is done using Cohen's (1960) kappa. The study had a kappa of $\kappa = 0.71$ for categories and $\kappa = 0.85$ for elements, which supports a high level of reliability.

For the survey study, reliability was measured with Cronbach's (1951) alpha. This is a test of internal consistency of scales (in this case a Likert scale) that measures how related a set of items are as a group. In the calculations of Paper II, the reliability of the original elements was tested. Teaching presence had ($\alpha = 0.85$) a high level of reliability, while social presence ($\alpha = 0.68$) and cognitive presence ($\alpha = 0.71$) were measured at an acceptable level (Nunally & Bernstein, 1978). In Paper III, emotional presence was measured at an acceptable level of reliability: $\alpha = 0.74$.

Validity

In simple terms, validity is the accuracy of a construction in relation to the real world (Cohen et al., 2011). Following this, the instruments' validates depend on their ability to accurately measure online coaching. A standard way of validating surveys is through factor analysis. This was, however, not possible in this case since the total number of respondents compared with the number of items and elements (factors) were too few for factor analysis. For transcript coding, the validity builds

upon the preciseness of the framework, coding scheme, and the unit of analysis to cover the learning experience.

The validity of the Relationship of Inquiry rests in its relation to the Community of Inquiry. Arguments for the validity of the Community of Inquiry are "its genesis in mature educational literature; the fact that it appears to have some value based upon its adoption to frame online education research; and the fact that there have not been any significant critiques of the framework itself" (Garrison et al., 2006, pp. 3–4). The critical difference between the community and relationship is the one-to-one setting. This difference has been described through a review of the literature. All three papers (Paper II, Paper III, and Paper IV) have concluded that the framework and the instruments used led to insights into the educational communication in the learning activity as well as the participants' perception of it. Therefore, it is argued that the studies have some validity. That said, since only two empirical investigations (one per instrument) have been conducted so far for the Relationship of Inquiry, no high level of validity can be claimed at this point.

Generalizability

The selection of the Math Coach program as the case for this research was reasonable since the thesis was initiated by exploring the learning that occurs in the Math Coach program. The learning activity of online coaching that has been defined and explained was formed as a description of the coaching sessions in the Math Coach program. By using only one case, a more in-depth description of the activity was possible. Using two instruments (survey and transcripts) on the same material, it was possible to re-test the framework in the same context. The Relationship of Inquiry framework has been constructed for analysis of online math coaching. No other cases of equal or similar learning activities have informed the work for the thesis. Other cases of online coaching activities have been identified, such as the Danish Lektier online and the Pearson-owned company Smartthinking. The author has also been involved in starting a Swedish Coach program that focuses on Swedish as second language for youths. There are also activities that are related to online coaching, such as tutoring in online courses, which are often online and one-to-one, but rarely near-synchronous or inquiry-based.

Since this thesis tests only one case, the Relationship of Inquiry framework is only claimed for the online coaching activity of the Math Coach program. No applicability can be concluded beyond the case at this stage. That said, all conceptualizations in this introduction and the papers have been made using general approaches to learning in settings that are (i) online, (ii) one-to-one, (iii) and inquiry-based. Therefore, it is hypothesized that the Relationship of Inquiry applies for similar

cases given the three conditions about the learning setting. This hypothesis needs to be tested in further research.

Comparison of the two instruments

Although the purpose of this thesis is to establish the Relationship of Inquiry framework, the framework has also been used to gain information about the Math Coach program. The findings are presented in each paper and reviewed in the overview of papers (see section 4 starting on page 25). A comparison of the findings is discussed here.

Each of the papers focused on either the survey (Paper II), the transcript procedure (Paper IV), or the emotional element (Paper III). Both instruments were found to be reliable, but when comparing them, there are differences in the measured values. On the element level, the survey rated emotional presence lower than the others, while the transcript procedure rated cognitive and teaching presence higher than social and emotional presence (with no pairwise internal differences). For cognitive presence, there were no significant differences found in the survey, while the transcript procedure rated exploration higher than the other categories. In teaching presence, design and organization was rated lower than the other categories in the survey. In the transcript procedure, direct instruction was rated higher than all the others. For social presence, open communication was higher in the survey, and the transcript procedure had a mixed result where the coachee focused on open communication and the coach on relationship cohesion. For emotional presence, no categories were employed in the survey. The transcript procedure had a high rating for activity emotion compared to directed affectiveness. Outcome emotion was almost absent.

The variation in the results of the two instruments can be explained either by an issue in the validity of the instruments or by comparing what the instruments measure. The survey consists of a set of items where a respondent evaluates their learning experience, and the transcript coding procedure results in a numerical description of the actual conversation. The variation relates to the difference between the individual and the social component of the inquiry. When respondents value the items in the survey, it is assumed that the respondent involve both the individual's critical thinking and the outspoken social interaction in the conversation. The transcript procedure, however, values only the conversation and not an individual's critical thinking. In contrast, the survey contains only the participant's perceived experience, while the transcript consists of the actual dialogue. An example of the difference between the individual and social components can be found in cognitive presence. In cognitive presence, the categories are rated as equal in the survey, while exploration dominates the transcript. This can be interpreted that the individual

gave equal attention to all phases (triggering event, exploration, integration, and resolution) in cognitive presence but has a larger need to discuss during exploration than during the others. An example of differences in the perceived experience and the actual dialogue is teaching presence. In the survey, design and organization are rated lower than the other categories, presumably due to the pre-decided structure of the conversations. No difference between the two other categories, facilitation and direct instruction, was found in the survey. In the transcripts, however, direct instruction is much more common than facilitation. This can be interpreted as the coaches perceive that they evenly facilitate and give instructions, but they actually give instructions more.

Implications for education

The implications of this thesis on education rest on the prescriptive use of the framework. In the Community of Inquiry, the framework has been used not only as a tool for the analysis of learning experiences but also as a guide when designing new activities. The motivation for this use is the argument that the framework reflects a very efficient process of learning (Anderson & Dron, 2011; Archer, 2010; Garrison, 2013; Garrison & Anderson, 2003; Garrison et al., 2000, 2001; Gašević et al., 2015; Ke, 2010; Swan et al., 2009; Szeto, 2015; Vaughan et al., 2013).

The Math Coach program has an introductory course for all coaches. The course includes theory and practice in online coaching and is mandatory in order to work as a math coach. Starting in 2014, the Relationship of Inquiry framework was introduced in the course content. This introduction was made after the collection of the empirical data for the thesis. In the course, the notion of online coaching viewed as a one-to-one inquiry-oriented collaborative constructivist learning activity is used. The activity is guided by the elements of cognitive, teaching, social, and emotional presence with their categories. The framework is used in order to explain the process that a coachee undergoes in a coaching session (cognitive presence), how to support and direct that process (teaching presence), and the human aspect of learning (social and emotional presence). An assignment in the course is for the coach to code a transcript from a conversation they have had.

Further research

In further research about this framework, other online one-to-one educational settings would be of value for investigation. It is vital in order to make more general claims about the framework that research about online coaching in several subjects is conducted. This thesis includes an empirical case of math; however, no subject-specific analysis has been done. Moving beyond online coaching is the learning

activity of one-to-one online tutoring, which is central in the design of many distance education courses and an area of interest for further investigation.

A difference between the setting of a distance education course and the online coaching in Math Coach is the length of the interaction. A Math Coach conversation on average lasts 44 minutes, while a course could run for a semester. This difference was not addressed in the papers since it is assumed that it does not affect the conceptualization, but it needs to be examined as it might reflect the dialogue. This could be done with, for example, a study where the time factor is included in transcript analysis. Through this, the elements and categories transformation could be evaluated over time.

Another area for further research is the connection between the Relationship of Inquiry framework and the Community of Inquiry framework. A connection between the frameworks is that a community of learners can be seen as consisting of several one-to-one relationships. Figure 5 (on page 21) can be used to illustrate this. In social network analysis, groups or collections are investigated by examining the connections (relationships) that a node (person) has with other nodes in the network (Dron & Anderson, 2014; Wasserman & Faust, 1994). A hypothesis is that the examination of a community of inquiry would be more detailed if the community was tested not only as one community but by evaluating all relationships between participants. Important insights about the effect of different levels of relationships between persons might provide new insights for learning communities.

In the case of Math Coach, further research could be enhanced by a new survey study. By conducting a survey with coachees as respondents, the volume (number of respondents) that the study in Paper II is lacking would be addressed. Following that a validation through factor analysis would be feasible and the coachee's perception more observable. The reasons why this was not done in Paper II are that the items in the survey are too many and too complex to be practical for use with young people. A new survey construct with fewer items that are easier to answer would probably be of great value for both the Relationship of Inquiry and the Community of Inquiry.

Additional new instruments would also be valuable. The inclusion of qualitative components would probably increase the value of both the Relationship of Inquiry and the Community of Inquiry. Examples of potential qualitative research methods grounded in the theoretical framework are interviews and observations. For interviews, a validated interview guide grounded in the framework could provide a structure for questions and interview analyses. Kanuka and Garrison (2004) have made an initial study using a focus group interview. For observations, a validated scheme grounded in the framework could be employed. In transcript analysis, text-mining learning analytics software that can on a large scale highlight elements

and categories would be valuable. A promising attempt to automatically detect cognitive presence has been done by Kovanović, Joksimović, Gašević, and Hatala (2014). Another area of interest is the development of an instrument that addresses the learning experience that is not written in a conversation or easily reported in a survey. This would be especially interesting for emotional presence since it is possible that a multitude of emotions exist that are not seen in the transcripts or that can be explained by responding to a confirmatory survey.

7 Conclusion

The purpose of this thesis is to explore inquiry-based one-to-one online education. First, online coaching is defined as an inquiry-based learning activity where a person gets support on a specific subject matter from a more knowledgeable person using the Internet. The activity is argued to be grounded in collaborative constructivism, which is an effective approach to learning. Secondly, the Community of Inquiry framework is adapted to the Relationship of Inquiry framework for the purpose of analyzing online coaching. The elements of cognitive, teaching, social, and emotional presence are reviewed for the purpose of analyzing the process of teaching and learning using a survey and a transcript coding procedure. Emotional presence was especially investigated and confirmed for the Relationship of Inquiry framework. The empirical data were collected from the Math Coach program.

The importance of this thesis can be motivated by a general call for improved computer-based methods and tools to support learning. In discussions about educational development for the next century, much faith is put into the use of computers to enhance learning and teaching. This thesis provides theoretical insights into the establishment and analysis of one-to-one learning, which is a very efficient learning environment using modern technology. By doing so, it addresses Bloom's 2 sigma problem by arguing that online coaching is an alternative way to realize high order one-to-one education under practical and realistic conditions.

The theoretical contribution of the thesis is to establish the Relationship of Inquiry framework for the analysis of online one-to-one learning environments. The Relationship of Inquiry is an adaptation of the Community of Inquiry. Since the Community of Inquiry is one of the most commonly used theoretical framework in the research field of online education, it is probable that the extension of the model to a one-to-one setting is of value for online learning researchers. The instruments give valuable information regarding an online coaching environment. The framework can also be of value in designing online coaching environments and in the education of coaches. However, since only one case has informed the exploration, no generalizability can be claimed at this stage.

This thesis is, using four papers and this introduction, proposing the Relationship of Inquiry framework as a structure by which to frame the analysis of an inquiry-based learning activity where a person gets support on a specific subject from a more knowledgeable person using the Internet. Researchers are encouraged to criticize, refine, and extend this framework.

8 References

Ackland, R. (1991). A Review of the Peer Coaching Literature. *Journal of Staff Development*, *12*(1), 22–27.

Akyol, Z., Arbaugh, J. B., Cleveland-Innes, M., Garrison, D. R., Ice, P., Richardson, J. C., et al. (2009). A Response to the Review of the Community of Inquiry Framework. *The Journal of Distance Education/Revue de l'Éducation à Distance*, *23*(2), 123–136.

Akyol, Z., & Garrison, D. R. (2011a). Assessing metacognition in an online community of inquiry. *The Internet and Higher Education*, *14*(3), 183–190.

Akyol, Z., & Garrison, D. R. (2011b). Understanding cognitive presence in an online and blended community of inquiry: Assessing outcomes and processes for deep approaches to learning. *British Journal of Educational Technology*, *42*(2), 233–250.

Anderson, T. (2008). *The theory and practice of online learning* (2nd ed.). Edmonton: Athabasca University Press.

Anderson, T., & Dron, J. (2011). Three Generations of Distance Education Pedagogy. *International Review of Research in Open and Distance Learning*, *12*(3), 80–97.

Anderson, T., Rourke, L., Garrison, D. R., & Archer, W. (2001). Assessing teaching presence in a computer conferencing environment. *Journal of Asynchronous Learning Networks*, *5*(2), 1–17.

Annand, D. (2011). Social presence within the community of inquiry framework. *International Review of Research in Open and Distance Learning*, *12*(5), 40–56.

Arbaugh, J., & Hwang, A. (2006). Does "teaching presence" exist in online MBA courses? *The Internet and Higher Education*, *9*(1), 9–21.

Arbaugh, J. B., Cleveland-Innes, M., Diaz, S. R., Garrison, D. R., Ice, P., Richardson, J. C., et al. (2008). Developing a community of inquiry instrument: Testing a measure of the community of inquiry framework using a multi-institutional sample. *The Internet and Higher Education*, *11*(3), 133–136.

Archer, W. (2010). Beyond online discussions: Extending the community of inquiry framework to entire courses. *The Internet and Higher Education*, *13*(1–2), 69.

Artino, A. R. (2012). Emotions in online learning environments: Introduction to the special issue. *The Internet and Higher Education*, *15*(3), 137–140.

Bagley, E., & Shaffer, D. (2015). Stop talking and type: comparing virtual and face-to-face mentoring in an epistemic game. *Journal of Computer Assisted Learning*.

Bakhtin, M. M. (1981). *The Dialogical Imagination: Four Essays* (M. Holquist, Ed.). Austin: University of Texas Press. (Translated by Caryl Emerson and Michael Holquist)

Barth, R. (1988). School as a community of learners. In A. Liberman (Ed.), *Building a Professional Culture in Schools.* New York: Teachers College Press.

Bloom, B. S. (1984). The 2 Sigma Problem: The Search for Methods of Group Instruction as Effective as One-to-One Tutoring. *Educational Researcher*, *13*(6), 4–16.

Borup, J., Graham, C. R., & Drysdale, J. S. (2014). The nature of teacher engagement at an online high school. *British Journal of Educational Technology*, *45*(5), 793–806.

Brown, J. S., Collins, A., & Duguid, P. (1989). Situated Cognition and the Culture of Learning. *Educational Researcher*, *18*(1), 32–42.

Chi, M. T., Siler, S. A., Jeong, H., Yamauchi, T., & Hausmann, R. G. (2001). Learning from human tutoring. *Cognitive Science*, *25*(4), 471–533.

Cleveland-Innes, M., & Campbell, P. (2012). Emotional presence, learning, and the online learning environment. *The International Review of Research in Open and Distance Learning*, *13*(4), 269–292.

Cleveland-Innes, M., Stenbom, S., & Hrastinski, S. (2014). The Influence of Emotion on Cognitive Presence in a Case of Online Math Coaching. In *Proceedings of the 8th European Distance and E-Learning Network Research Workshop.*

Cobb, P. (1994). Where Is the Mind? Constructivist and Sociocultural Perspectives on Mathematical Development. *Educational Researcher*, *23*(7), 13–20.

Cohen, J. (1960). A Coefficient of Agreement for Nominal Scales. *Educational and Psychological Measurement*, *20*(1), 37–46.

Cohen, L., Manion, L., & Morrison, K. (2011). *Research Methods in Education* (7th ed.). London: Routledge.

Contreras-Castillo, J., Pérez-Fragoso, C., & Favela, J. (2006). Assessing the use of instant messaging in online learning environments. *Interactive Learning Environments*, *14*(3), 205–218.

Cronbach, L. J. (1951). Coefficient alpha and the internal structure of tests. *Psychometrika*, *16*(3), 297–334.

Denis, B., Watland, P., Pirotte, S., & Verday, N. (2004). Roles and Competencies of the e-Tutor. In *Proceedings of the Networked Learning Conference: Lancaster University.*

Derks, D., Fischer, A. H., & Bos, A. E. (2008). The role of emotion in computer-mediated communication: A review. *Computers in Human Behavior*, *24*(3), 766–785.

De Wever, B., Schellens, T., Valcke, M., & Van Keer, H. (2006). Content analysis schemes to analyze transcripts of online asynchronous discussion groups: A review. *Computers & Education*, *46*(1), 6–28.

Dewey, J. (1933). *How We Think*. Mineola: Dover publications.

Dewey, J. (1959). My Pedagogic Creed. In J. Dewey (Ed.), *Dewey on education* (pp. 19–32). New York: Teachers College, Columbia University. (Original work published 1897)

Dirkx, J. M. (2008). The meaning and role of emotions in adult learning. *New Directions for Adult and Continuing Education*, *2008*(120), 7–18.

Dron, J., & Anderson, T. (2014). *Teaching crowds: Learning and social media*. Edmonton: Athabasca University Press.

Duncan, H. E., & Barnett, J. (2009). Learning to Teach Online: What Works for Pre-Service Teachers. *Journal of Educational Computing Research*, *40*(3), 357–376.

Dysthe, O. (2002). The Learning Potential of a Web-mediated Discussion in a University Course. *Studies in Higher Education*, *27*(3), 339–352.

Fahy, P. J., Crawford, G., & Ally, M. (2001). Patterns of Interaction in a Computer Conference Transcript. *The International Review of Research in Open and Distance Learning*, *2*(1).

Gašević, D., Adesope, O., Joksimović, S., & Kovanović, V. (2015). Externally-facilitated regulation scaffolding and role assignment to develop cognitive presence in asynchronous online discussions. *The Internet and Higher Education*, *24*, 53–65.

Garrison, D. R. (2009). Communities of inquiry in online learning. In P. L. Rogers, G. A. Berg, J. V. Boettcher, C. Howard, L. Justice, & K. D. Schenk (Eds.), *Encyclopedia of Distance Learning* (2nd ed., pp. 352–355). Hershey: IGI Global.

Garrison, D. R. (2013). Theoretical Foundations and Epistemological Insights of the Community of Inquiry. In Z. Akyol & D. R. Garrison (Eds.), *Educational Communities of Inquiry: Theoretical Framework, Research and Practice* (pp. 1–11). Hershey: IGI Global.

Garrison, D. R., & Akyol, Z. (2013a). The Community of Inquiry Theoretical Framework. In M. G. Moore (Ed.), *Handbook of Distance Education* (3rd ed., pp. 104–119). New York: Routledge.

Garrison, D. R., & Akyol, Z. (2013b). Toward the development of a metacognition construct for communities of inquiry. *The Internet and Higher Education*, *17*, 84–89.

Garrison, D. R., & Akyol, Z. (2015). Toward the development of a metacognition construct for communities of inquiry. *The Internet and Higher Education*, *24*, 66–71.

Garrison, D. R., & Anderson, T. (2003). *E-learning in the 21st century : A framework for research and practice* (1st ed.). London: Routledge/Falmer.

Garrison, D. R., Anderson, T., & Archer, W. (2000). Critical Inquiry in a Text-Based Environment: Computer Conferencing in Higher Education. *The Internet and Higher Education*, *2*(2–3), 87–105.

Garrison, D. R., Anderson, T., & Archer, W. (2001). Critical thinking, cognitive presence, and computer conferencing in distance education. *American Journal of Distance Education*, *15*(1), 7–23.

Garrison, D. R., & Arbaugh, J. B. (2007). Researching the community of inquiry framework: Review, issues, and future directions. *The Internet and Higher Education*, *10*(3), 157–172.

Garrison, D. R., & Cleveland-Innes, M. (2005). Facilitating Cognitive Presence in Online Learning: Interaction Is Not Enough. *The American Journal of Distance Education*, *19*(3), 133–148.

Garrison, D. R., Cleveland-Innes, M., & Fung, T. S. (2010). Exploring causal relationships among teaching, cognitive and social presence: Student perceptions of the community of inquiry framework. *The Internet and Higher Education*, *13*(1–2), 31–36.

Garrison, D. R., Cleveland-Innes, M., Koole, M., & Kappelman, J. (2006). Revisiting methodological issues in transcript analysis: Negotiated coding and reliability. *The Internet and Higher Education*, *9*(1), 1–8.

Graesser, A. C., Person, N. K., & Magliano, J. P. (1995). Collaborative dialogue patterns in naturalistic one-to-one tutoring. *Applied Cognitive Psychology*, *9*(6), 495–522.

Gunawardena, C. N., Lowe, C. A., & Anderson, T. (1997). Analysis of a global online debate and the development of an interaction analysis model for examining social construction of knowledge in computer conferencing. *Journal of Educational Computing Research*, *17*(4), 397–431.

Gunawardena, C. N., & Zittle, F. J. (1997). Social presence as a predictor of satisfaction within a computer-mediated conferencing environment. *American Journal of Distance Education*, *11*(3), 8–26.

Haythornthwaite, C., & Kazmer, M. M. (2002). Bringing the Internet Home: Adult Distance Learners and Their Internet, Home, and Work Worlds. In B. Wellman & C. Haythornthwaite (Eds.), *The Internet in Everyday Life* (pp. 431–464). Oxford: Blackwell Publishing.

Herring, S. (1999). Interactional Coherence in CMC. *Journal of Computer Mediated Communication*, *4*(4).

Hmelo, C., & Ferrari, M. (1997). The problem-based learning tutorial: Cultivating higher order thinking skills. *Journal for the Education of the Gifted*, *20*(4), 401–422.

Hrastinski, S. (2006). Introducing an informal synchronous medium in a distance learning course: How is participation affected? *The Internet and Higher Education*, *9*(2), 117–131.

Hrastinski, S. (2008). The potential of synchronous communication to enhance participation in online discussions: A case study of two e-learning courses. *Information & Management*, *45*(7), 499–506.

Hrastinski, S., Edman, A., Andersson, F., Kawnine, T., & Soames, C.-A. (2014). Informal math coaching by instant messaging: Two case studies of how university students coach K–12 students. *Interactive Learning Environments*, *22*(1), 84–96.

Hrastinski, S., & Stenbom, S. (2013). Student–student online coaching: Conceptualizing an emerging learning activity. *The Internet and Higher Education*, *16*, 66–69. (This paper is cited as Paper I)

Hulkko, A., & Jansson, M. (2013). *Education through instant messaging: A content analysis in an online coaching project.* Unpublished master's thesis, KTH, School of Education and Communication in Engineering Science (ECE).

Hwang, W.-Y., Huang, Y.-M., & Wu, S.-Y. (2011). The effect of an MSN agent on learning community and achievement. *Interactive Learning Environments*, *19*(4), 413–432.

Ice, P., Curtis, R., Phillips, P., & Wells, J. (2007). Using Asynchronous Audio Feedback to Enhance Teaching Presence and Students' Sense of Community. *Journal of Asynchronous Learning Networks*, *11*(2), 3–25.

Jézégou, A. (2010). Community of Inquiry in E-learning: A Critical Analysis of the Garrison and Anderson Model. *Journal of Distance Education/Revue De L'Éducation à Distance*, *24*(3).

Jonassen, D. (1999). Designing Constructivist Learning Environments. In C. M. Reigeluth (Ed.), *Instructional design theories and models: A new paradigm of instructional theory* (Vol. 2, pp. 215–239). New York: Routledge.

Jonassen, D. (2000). Toward a design theory of problem solving. *Educational Technology Research and Development*, *48*(4), 63–85.

Kaiser, H. F. (1974). An index of factorial simplicity. *Psychometrika*, *39*(1), 31–36.

Kanuka, H., & Garrison, D. (2004). Cognitive Presence in Online Learning. *Journal of Computing in Higher Education*, *15*(2), 21–39.

Ke, F. (2010). Examining online teaching, cognitive, and social presence for adult students. *Computers & Education*, *55*(2), 808–820.

Kirschner, P. A., Sweller, J., & Clark, R. E. (2006). Why Minimal Guidance During Instruction Does Not Work: An Analysis of the Failure of Constructivist, Discovery, Problem-Based, Experiential, and Inquiry-Based Teaching. *Educational Psychologist*, *41*(2), 75–86.

Kohler, F. W., Crilley, K. M., Shearer, D. D., & Good, G. (1997). Effects of Peer Coaching on Teacher and Student Outcomes. *The Journal of Educational Research*, *90*(4), 240–250.

Kopp, B., Matteucci, M. C., & Tomasetto, C. (2012). E-tutorial support for collaborative online learning: An explorative study on experienced and inexperienced e-tutors. *Computers & Education*, *58*(1), 12–20.

Kovanović, V., Joksimović, S., Gašević, D., & Hatala, M. (2014). Automated Cognitive Presence Detection in Online Discussion Transcripts. In *Proceedings of the 4th International Conference on Learning Analytics and Knowledge.*

Kozan, K., & Richardson, J. C. (2014). Interrelationships between and among social, teaching, and cognitive presence. *The Internet and Higher Education*, *21*, 68–73.

Krippendorff, K. (2013). *Content Analysis: An Introduction to Its Methodology* (3rd ed.). Thousand Oaks: SAGE.

Leidner, D. E., & Järvenpää, S. L. (1995). The Use of Information Technology to Enhance Management School Education: A Theoretical View. *MIS Quarterly*, *19*(3), 265–291.

Lipman, M. (1991). *Thinking in Education* (1st ed.). New York: Cambridge University Press.

Lipman, M. (2003). *Thinking in Education* (2nd ed.). New York: Cambridge University Press.

Mayes, T., & De Freitas, S. (2004). *Review of e-learning theories, frameworks and models.* London: Joint Information Systems Committee.

Moore, M. G. (1989). Three types of interaction. *The American Journal of Distance Education*, *3*(2), 1–7.

Nardi, B. A., Whittaker, S., & Bradner, E. (2000). Interaction and outeraction: instant messaging in action. In *Proceeding CSCW '00 Proceedings of the ACM conference on Computer supported cooperative work* (pp. 79–88).

Neuendorf, K. A. (2002). *The Content Analysis Guidebook.* Thousand Oaks: SAGE.

Nicholson, S. (2002). Socialization in the "virtual hallway": Instant messaging in the asynchronous Web-based distance education classroom. *The Internet and Higher Education*, *5*(4), 363–372.

Nunally, J. C., & Bernstein, I. H. (1978). *Psychometric theory* (2nd ed.). New York: McGraw-Hill.

Peirce, C. S. (1955). The Fixation of Belief. In C. S. Peirce & J. Buchler (Eds.), *Philosophical writings of Peirce.* Mineola: Courier Dover Publications.

Pekrun, R. (2006). The Control-Value Theory of Achievement Emotions: Assumptions, Corollaries, and Implications for Educational Research and Practice. *Educational Psychology Review*, *18*(4), 315–341.

Pekrun, R., Goetz, T., Titz, W., & Perry, R. P. (2002). Academic Emotions in Students' Self-Regulated Learning and Achievement: A Program of Qualitative and Quantitative Research. *Educational Psychologist*, *37*(2), 91–105.

Phan, K. L., Wager, T. D., Taylor, S. F., & Liberzon, I. (2004). Functional neuroimaging studies of human emotions. *CNS spectrums*, *9*(4), 258–266.

Piaget, J. (1977). *The Essential Piaget* (H. E. Gruber & J. J. Vonèche, Eds.). London: Routledge & Kegan Paul.

Plutchik, R. (2003). *Emotions and Life: Perspectives from Psychology, Biology, and Evolution.* Washington, DC: American Psychological Association.

Prince, M., & Felder, R. (2006). Inductive Teaching and Learning Methods: Definitions, Comparisons, and Research Bases. *Journal of Engineering Education*, *95*(2), 123–138.

Rainie, L., & Wellman, B. (2012). *Networked: The New Social Operating System.* Cambridge: MIT Press.

Richardson, J., & Swan, K. (2003). Examining social presence in online courses in relation to students' perceived learning and satisfaction. *Journal of Asynchronous Learning Network*, *7*(1), 68–88.

Rienties, B., & Rivers, B. A. (2014). *Measuring and Understanding Learner Emotions: Evidence and Prospects.* Learning Analytics Community Exchange.

Rogers, R., Malancharuvil-Berkes, E., Mosley, M., Hui, D., & Joseph, G. O. (2005). Critical Discourse Analysis in Education: A Review of the Literature. *Review of Educational Research*, *75*(3), 365–416.

Rourke, L., Anderson, T., Garrison, D. R., & Archer, W. (2001). Assessing Social Presence In Asynchronous Text-based Computer Conferencing. *Journal of Distance Education / Revue De L'Éducation à Distance*, *14*(2).

Rourke, L., & Kanuka, H. (2009). Learning in Communities of Inquiry: A Review of the Literature. *Journal of Distance Education / Revue De L'Éducation à Distance*, *23*(1), 19–48.

Rovai, A. (2002). Building Sense of Community at a Distance. *The International Review of Research in Open and Distance Learning*, *3*(1), 74–85.

Schunk, D. H. (2012). *Learning Theories: An Educational Perspective* (6th ed.). Boston: Pearson.

Schutz, P. A., & Lanehart, S. L. (2002). Introduction: Emotions in Education. *Educational Psychologist*, *37*(2), 67–68.

Segerstad, Y. H. A., & Ljungstrand, P. (2002). Instant messaging with WebWho. *International Journal of Human-Computer Studies*, *56*, 147–171.

Shea, P., & Bidjerano, T. (2009). Community of inquiry as a theoretical framework to foster "epistemic engagement" and "cognitive presence" in online education. *Computers & Education*, *52*(3), 543–553.

Shea, P., & Bidjerano, T. (2010). Learning presence: Towards a theory of self-efficacy, self-regulation, and the development of a communities of inquiry in online and blended learning environments. *Computers & Education*, *55*(4), 1721–1731.

Shea, P., Hayes, S., Uzuner-Smith, S., Gozza-Cohen, M., Vickers, J., & Bidjerano, T. (2014). Reconceptualizing the community of inquiry framework: An exploratory analysis. *The Internet and Higher Education*, *23*, 9–17.

Showers, B., & Joyce, B. (1996). The Evolution of Peer Coaching. *Educational Leadership*, *53*(6), 12–16.

Spronken-Smith, R., & Walker, R. (2010). Can inquiry-based learning strengthen the links between teaching and disciplinary research? *Studies in Higher Education*, *35*(6), 723–740.

Stenbom, S., Cleveland-Innes, M., & Hrastinski, S. (n.d.). Emotional presence in a relationship of inquiry: The case of one-to-one online math coaching. *Manuscript submitted for publication.* (This paper is cited as Paper III)

Stenbom, S., Cleveland-Innes, M., & Hrastinski, S. (2012). Examining a learning-driven relationship of inquiry: discerning emotional presence in online math coaching. In *Proceedings of the 7th European Distance and E-Learning Network Research Workshop.*

Stenbom, S., Hrastinski, S., & Cleveland-Innes, M. (2012). Student–Student Online Coaching as a Relationship of Inquiry: An Exploratory Study from the Coach Perspective. *Journal of Asynchronous Learning Networks*, *16*(5), 37–48. (This paper is cited as Paper II)

Stenbom, S., Jansson, M., & Hulkko, A. (in press). Revising the Community of Inquiry framework for the analysis of one-to-one online learning relationships. *The International Review of Research in Open and Distributed Learning.* (This paper is cited as Paper IV)

Sutton, R. E. (2004). Emotional regulation goals and strategies of teachers. *Social Psychology of Education*, *7*(4), 379–398.

Sutton, R. E., & Wheatley, K. F. (2003). Teachers' Emotions and Teaching: A Review of the Literature and Directions for Future Research. *Educational Psychology Review*, *15*(4), 327–358.

Swan, K., Garrison, D. R., & Richardson, J. C. (2009). A Constructivist Approach to Online Learning: The Community of Inquiry Framework. In C. R. Payne (Ed.), *Information Technology and Constructivism in Higher Education: Progressive Learning Frameworks* (pp. 43–57). Hershey: IGI Global.

Swan, K., & Ice, P. (2010). The community of inquiry framework ten years later: Introduction to the special issue. *The Internet and Higher Education*, *13*(1–2), 1–4.

Swan, K., Richardson, J. C., Ice, P., Garrison, D. R., Cleveland-Innes, M., & Arbaugh, J. B. (2008). Validating a Measurement Tool of Presence in Online Communities of Inquiry. *E-mentor*, *2*(24), 1–12.

Szeto, E. (2015). Community of Inquiry as an instructional approach: What effects of teaching, social and cognitive presences are there in blended synchronous learning and teaching? *Computers & Education*, *81*, 191–201.

Värlander, S. (2008). The role of student's emotions in formal feedback situations. *Teaching in Higher Education*, *13*(2), 145–156.

Varnhagen, C. K., McFall, G. P., Pugh, N., Routledge, L., Sumida-MacDonald, H., & Kwong, T. E. (2010). lol: new language and spelling in instant messaging. *Reading and Writing*, *23*(6), 719–733.

Vaughan, N., Cleveland-Innes, M., & Garrison, D. (2013). *Teaching in Blended Learning Environments: Creating and Sustaining Communities of Inquiry*. Edmonton: Athabasca University Press.

Vygotsky, L. L. S. (1978). *Mind in society: The development of higher psychological processes*. Cambridge: Harvard university press. (Edited by Michael Cole, Vera John-Steiner, Sylvia Scribner and Ellen Souberman)

Walther, J. B., & D'Addario, K. P. (2001). The Impacts of Emoticons on Message Interpretation in Computer-Mediated Communication. *Social Science Computer Review*, *19*(3), 324–347.

Wasserman, S., & Faust, K. (1994). *Social Network Analysis: Methods and Applications*. New York: Cambridge University Press.

Wells, G. (1999). *Dialogic Inquiry: Towards a Socio-cultural Practice and Theory of Education*. New York: Cambridge University Press.

Werry, C. C. (1996). Linguistic and interactional features of Internet Relay Chat. In S. C. Herring (Ed.), *Computer- Mediated Communication: Linguistic, social, and cross-cultural perspectives* (pp. 47–64). Amsterdam: John Benjamins Publishing.

Wood, D., Bruner, J. S., & Ross, G. (1976). The role of tutoring in problem solving. *Journal of Child Psychology and Psychiatry*, *17*(2), 89–100.

Zimmerman, B. J. (1990). A social cognitive view of self-regulated academic learning. *Educational Psychology Review*, *2*(2), 173–201.

PAPERS:

The papers are not included in this electronic version of the thesis. The papers can be found either in the printed version of the thesis or via http://stefanstenbom.se.

ISBN 978-91-7595-526-1
TRITA-ECE 2015:04