# Adding eyebrows to CSCL : the combined use of synchronous and asynchronous communication and the role of motivation in computer-supported collaborative learning

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The combined use of synchronous and asynchronous communication, and the role of motivation in computer-supported collaborative learning

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Thank you!

Bas Giesbers
Rotterdam, June 2013

# Chapter 1

# General Introduction

Philipp is a German 20-year old prospective International Business student at the Maastricht University School of Business and Economics (MUSBE). Like many young Germans, he fulfilled a year of public service after graduating secondary education. He worked as an assistant in a non-profit organization that developed and implemented sustainable business models specifically for developing countries. During this year, his intentions to study International Business were further strengthened. He aims to make a difference in the world. So, when it was time to orient on further education, he visited the open days of several universities. MUSBE in The Netherlands had his preference because of its international orientation and its problem-based learning (PBL) approach. Though his excellent grades meet the university's application requirements, and he is certain of acceptance, Philipp feels both excited and insecure. What does it mean to go to university, especially a foreign one? Will his level of knowledge really be up to par with the requirements? After all, during the open days he learned that many prospective students had more hours of previous study in economics and business than he had. Although his year away from formal education made him more independent and experienced, it also caused his knowledge in economics and business to fade to the background. Furthermore, though Philipp deliberately chose MUSBE because of its PBL approach, his choice was based on theory and hearsay, and he wonders how PBL will actually work in practice. Philipp also has many practicalities to take care of, like arranging residential paperwork, finding a place to live, opening a bank account, etc. Despite all his questions and insecurities, Philipp feels confident in his abilities to cope with them, and he is highly motivated to work to the best of his abilities to attain his goals.

Laura is a 19-year old Dutch prospective MUSBE student who, unlike Philipp, enrols into university directly from secondary education. In the final year of secondary education, she was still unsure what to study next. After visiting a number of open door days she feels most attracted to studies in economics and business, as that in her view provides the best preparation for a

job with a decent income. She doesn't have a preference to study either International Business or Business Economics; both will do to reach her goal. Overall, her grades satisfy the entry levels of the universities she visited, but her results in economics could have been better. Laura predominantly chose for MUSBE because of two reasons: First, Maastricht seems a really nice city and it is distant enough from her hometown to finally move out of her parents' house and start living on her own. Second, the PBL approach appeals to her; she prefers to learn by discussing study materials in small groups instead of "absorbing" knowledge through mass lectures. But there also are a number of worries. Laura isn't completely sure if her assumption of what PBL entails is true and she wonders what it will actually be like. 'University' sounds so big, and, because none of her friends go to Maastricht, she feels a bit frightened to go alone. Laura already started to look for a student room, but there is a lot of competition and she did not have any success yet. Laura figures these questions and challenges can wait until after the two-week holiday with friends that she promised herself as a reward for her graduation.

# 1. Introduction

These two cases illustrate a number of the challenges regarding students´ transition to tertiary education that are just as real for universities as they are for individual students. Overall, for universities in general and Maastricht University School of Business and Economics in particular, the challenge is threefold.

First, there is a challenge concerning the heterogeneity in background that incoming students bring to university. Philipp and Laura bring different knowledge and skills to university and some of these may not exactly match a higher education program. For Laura, the transition to a Dutch university will be different from Philipp, as she is familiar with the Dutch education system, and Dutch culture. Laura enters university directly from a Dutch secondary school, meaning her readily available knowledge of economics and the match between her prior education and university will be different from Philipp's. However, Laura does not bring the practical experience Philipp gained during his year of public service. Both Laura and Philipp do not have any experience with PBL, the pedagogical model of MUSBE, which will also affect their

transition. Heterogeneity has been identified as a serious challenge for the transition to post-secondary education, and, due to increasing internationalization, can be expected to only grow in the future (Brants & Struyven, 2009; Rienties, Beausaert, Grohnert, Niemantsverdriet, & Kommers, 2012).

The second challenge is of a motivational nature: similar to bringing different prior knowledge and skills, students differ in the reasons to study and in the capacity to self-steer their learning process. Philipp has a clear and intrinsic drive to study business economics, and will most likely spend a lot of thought and effort on attaining his goals. Laura has an extrinsic drive (getting a job with a good income) and at this stage most likely has not spent much thought beyond the idea that this study will get her there.

The third challenge relates to instructional design, or, in other words, how to remediate a group of incoming students effectively, by taking into account the first two challenges? The development of remedial courses has increased in recent years, and because of the growing internationalisation, these often are in the form of online education (Brants & Struyven, 2009). Research has shown learning in online settings can be highly successful, especially in collaborative settings (e.g. Bromme, Hesse, & Spada, 2005; Jonassen & Kwon, 2001). Furthermore, online collaborative learning allows students to experience collaborative pedagogical approaches like PBL (e.g. Brodie, 2009; Nelson, 2010), it enhances the social aspect of learning, it allows to address other aspects of academic integration aside from learning content (Rienties, Beausaert, et al., 2012), regardless of geographical dispersion of participants (Brants & Struyven, 2009). However, a general finding regarding online collaborative learning is that there are large differences in students' activity levels, which have been found to largely depend on their motivation (Chen, 2010; Järvelä, Volet, & Järvenoja, 2010; Martens, Gulikers, & Bastiaens, 2004; Rienties, Tempelaar, Van den Bossche, Tempelaar, & Segers, 2009; Schellens & Valcke, 2005). The design of online collaborative courses that engage learners with all types of motivation is an on-going challenge, especially as the role of motivation in online learning behaviour of students is not well understood (Järvelä et al., 2010; Järvelä, Hurme, & Järvenoja, 2011; Martens et al., 2004; Rienties, 2010, Rienties, Tempelaar, Giesbers, Segers, & Gijselaers, 2012).

Aforementioned challenges have led to the development of a course in basic economics, to allow students like Laura and Philipp to facilitate their transition to MUSBE. The course was aimed to offer profound remediation of learning content, and to address other aspects of academic integration, like providing an introduction to PBL and studying in the Netherlands/Maastricht (see Rienties, Tempelaar, Waterval, Rehm, & Gijselaers, 2006). This made the course quite elaborate, and because we aimed to remediate students before their studies started (e.g. to not further overload students during their first semester), the summer prior to the start of the academic year was the most attractive period for it to be offered. Online collaborative learning was chosen, to allow participation of students who were not present in Maastricht during the summer and ensure flexibility to organize their studies next to other summer activities (see Rienties et al., 2006). The course required students and tutors to interact online, which, at the start of the course in 2005, was best facilitated by using asynchronous discussion forums.

Research of the communication process throughout the first years of the course showed students' activity levels differed a lot (Rienties, 2010). In accordance with previous research, this could be attributed to individual motivation. As the learning content of the course proved appropriate (Rienties et al., 2006), further development of the course was primarily aimed at improving the educational design to increase student engagement.

An initial redesign aimed at offering more autonomy support and structure (see Rienties, Giesbers, Tempelaar, Lygo-Baker, Segers, & Gijselaers, 2012) did not yield the desired effect in engaging all students with different motivational profiles to the same extent. However, recent research suggests that combining the existing asynchronous communication tools with synchronous communication tools has the potential to increase student engagement because the latter affords more direct interaction, and direct feedback and clarification (Hrastinski, 2008; Hrastinski, Keller, & Carlsson, 2010; Johnson, 2006). Current developments in online communication technology show an increase in the availability of synchronous online tools. For example, tools like Skype are freely available, easy to use and greatly increase the direct and personal nature of online interaction compared to discussion forums or e-mail. This development combined with the potentially positive effect of synchronous communication tools to increase student engagement

found in recent research (Hrastinski, 2008; Hrastinski et al., 2010; Johnson, 2006) make the addition of synchronous communication tools to the already existing asynchronous forums an interesting option for a second redesign of the course. Using synchronous communication tools, however, requires learners to become familiar with new technology, and may decrease the flexibility and freedom of time and place as participation requires students to be online at a certain time at a location that offers an internet connection with sufficient bandwidth. This faces students with additional choices to steer their learning process and thus adds to the complexity of the online collaborative learning process.

The recency of both the availability of rich synchronous communication tools as well as its suggested potential to enhance student engagement in online education leaves many educational design questions unanswered. For example, we don't know how students will actually use the combined communication modes, if the combination will actually enhance student engagement, what the effect of using both on student satisfaction and student learning will be, and of course what the influence of individual motivation will be on usage behaviour. Furthermore, no conceptual framework is available to address these issues and questions. Therefore, this dissertation will combine existing conceptual models on the social, technological, and motivational aspects of online collaborative learning. These will be addressed and related in this chapter. In the next section, we will first further elaborate the effect that a combination of both communication modes has on the online collaborative learning process. This will be followed by a description and interrelation of the different theoretical viewpoints that will be used to approach the context of study. In the last section we will make a translation into concrete research questions that form the basis for the separate studies in chapters two, three, four and five. This dissertation will be concluded by a sixth chapter, in which all aspects will be integrated into a general conclusion and discussion.

# 2. Combining asynchronous and synchronous communication in online learning

## 2.1 Asynchronous Communication in Online Collaborative Learning

Until recently, most online learning programs were designed with a strong focus on (linear and hierarchical) content-delivery, which were heavily structured and pre-defined by instructional designers and teachers (Bernard, Abrami, Borokhovski, Wade, Tamim, Surkes, & Bethel, 2009; Holden & Westfall, 2006), and required strong self-determination, self-regulation and persistence of participants (Rienties, Giesbers, et al., 2012). It is already known for some time that student interaction and collaboration can enhance the online learning process (e.g. Lou, Abrami, & D'Apollonia, 2001; Lou, Bernard, & Abrami, 2006), and the increasing possibilities of Information and Communication Technology (ICT) make it possible to facilitate collaborative learning in online settings (Bernard et al., 2009; Bromme et al., 2005).

Collaboration processes in online education around specific, structured tasks and assignments until now were generally facilitated by asynchronous communication, such as e-mail or discussion forums (Hrastinski, 2008; Hrastinski et al., 2010). Recent developments in Computer-Supported Collaborative Learning (CSCL) show increased opportunities to design more student-centred online learning environments, whereby authentic problems and complex tasks can be discussed in real-time, instigated by students rather than teachers (Holden & Westfall, 2006). For example, Figure 1.1 shows a screen capture of an asynchronous discussion forum that was used in our remedial economics course.

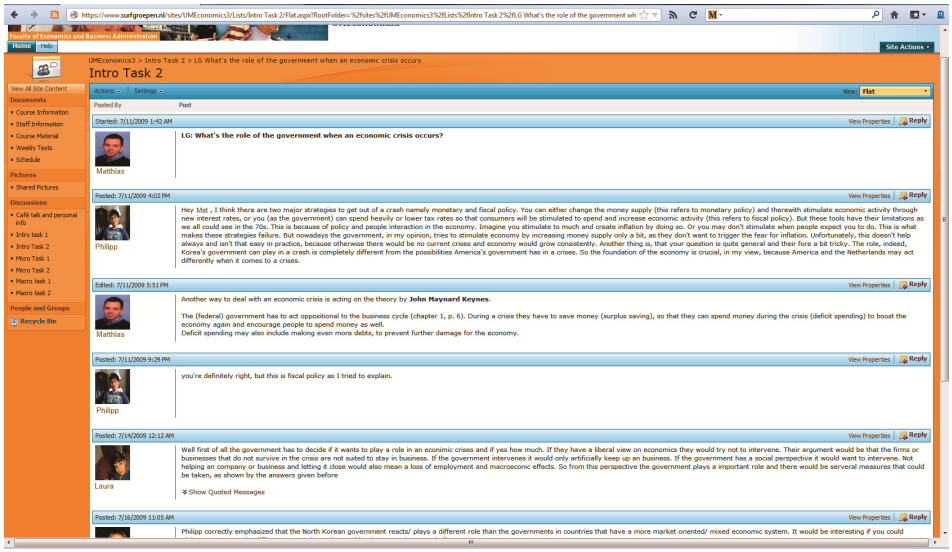



*Figure 1.1. Screen capture of an asynchronous discussion thread*

The example shown in Figure 1.1 is part of a discussion thread concerning the second introductory task of the course which is based on an article in The Economist discussing signs that indicate the end of the economic crisis (Buttonwood, 2009). This particular thread revolves around the learning goal "What's the role of the government when an economic crisis occurs?" As shown, all students could post their own contributions to the discussion.

A main advantage of asynchronous communication is that the delay between receiving a message and sending a response allows for time to reflect on the content before communicating it to others. For example, in Figure 1.1, Philipp can think about the content and formulation of his response to a post by Laura before sending it. However, afterwards Philipp has to wait for a response, which may cause him to experience the communication processes to be distant and impersonal, an experience that has been reported in several studies (Hrastinski, 2008; Hrastinski et al., 2010; Yang, Tsai, Kim, Cho, & Laffey, 2006).

Also, if Philipp chooses his words in such a way that others easily misunderstand them, it may take multiple postings (and thus time) to correct this. Though identifying learners' misconceptions and correcting these through peer discussion can be argued to be part of the learning process (Nicol & Boyle, 2003), CSCL research showed that asynchronous communication incorporates an increased risk of misconceptions to occur when only textual information is

used. Moreover, misconceptions take more time to be corrected through asynchronous communication because of the delay in response (Haythornthwaite, 2000; Rummel & Spada, 2005).

When looking at student behaviour in online discourse, often large differences between students in terms of participation are found (Schellens & Valcke, 2005). In the task shown in Figure 1.1, Philipp was very active and contributed 12 of the 62 messages posted, most of them with a profound length and quality. In comparison, Laura and Matthias only posted two messages each, which also seemed not to add much to the discussion. Similar differences in the amount and quality of students' e-learning activities are commonly found, and have been shown to strongly relate to the degree of students' intrinsic motivation or self-determination (Chen, 2010; Järvelä et al., 2010; Martens et al., 2004; Rienties et al., 2009). In addition, it is argued that some learners have to cross a substantial threshold before they start making contributions to asynchronous discourse (Garrison, 2007; Rienties et al., 2009, Rienties, Giesbers, et al., 2012).

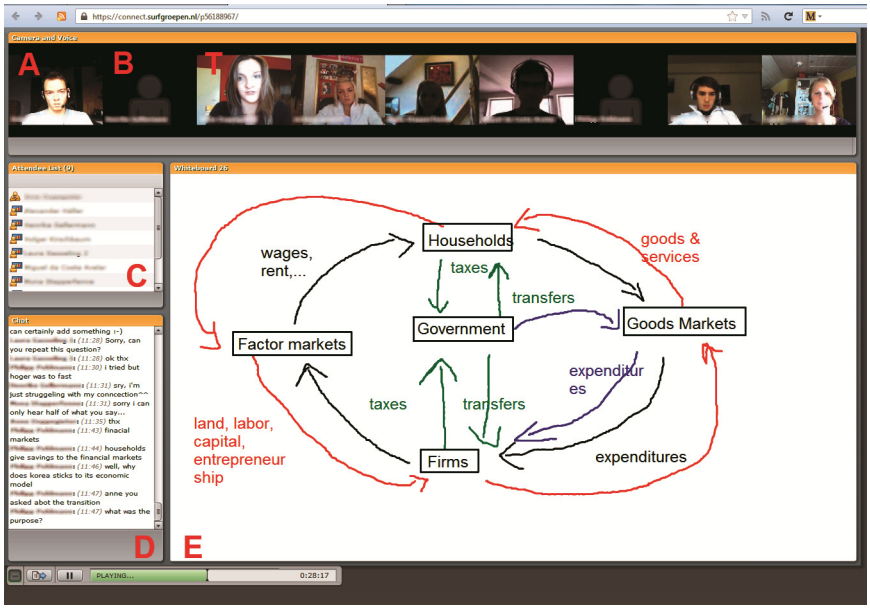
## 2.2 Synchronous Communication in Online Collaborative Learning

Technological developments have recently made it possible to support online learning processes by the use of rich synchronous communication tools, like Skype or web-videoconference, which are widely available nowadays and offer real-time communication that resembles face-to-face interaction through (a combination of) audio, video, and chat.

Findings in CSCL research provide some indications that synchronous communication is superior to asynchronous communication in establishing discourse, for example because it can overcome lack of bodily communication, delayed feedback, and barriers of meaning that occur in asynchronous communication (Beers, Boshuizen, Kirschner, & Gijselaers, 2007; Derks, Bos, & von Grumbkow, 2007; Haythornthwaite, 2000; Rummel & Spada, 2005; Tu, 2002). Synchronous tools can also add 'humanness' to online communication, which may especially be useful to engage less motivated students into the learning process (Hrastinski, 2008; Hrastinski et al., 2010).

Therefore, next to the asynchronous learning environment, we facilitated each group with access to an online web-videoconference environment in

which weekly videoconferences were organised for the first four weeks of the course. Figure 1.2 shows a screenshot of a web-videoconference meeting where direct communication between tutor and students was possible via (a combination of) video, audio, and chat. Except internet access, chat (D) and the shared whiteboard (E) required no further hardware and was available to all students. Using audio and video (A, B) required a webcam and/or a headset.




*A = webcam and audio; B = audio, no webcam; C = attendee list; D = chat; E = shared whiteboard; T = tutor*

*Figure 1.2. Screen capture of a synchronous web-videoconference*

Like in asynchronous communication, we see a number of differences between students in their use of synchronous communication in Figure 1.2. Philipp uses the full array of communication tools (A). He uses a webcam of which the image is shared with all participants, who can thus see his movements and facial expressions. He also uses audio that, like the webcam image, is shared with all participants. Thus, all participants can hear his voice when Philipp engages in the discussion. Because using a separate microphone and speakers sometimes causes echo or a feedback loop in the audio stream, a headset is recommended when using web-videoconferencing systems. In contrast, next to the possibility to use chat and whiteboard, Laura uses audio (the fact an anonymous image with a name appears next to the others'

webcam images (B) indicates that audio is used), but no shared webcam image. Finally, Matthias chose not to use audio or webcam and thus could communicate via text-based tools only.

Furthermore, over time students seem to change their engagement with the (range of) tools during the course. For example, Philipp participated in all four web-videoconferences by using the full array of communication tools. Laura started using more rich tools in every consecutive web-videoconference and participated in three out of four web-videoconferences. Matthias used only chat and stopped attending after the second web-videoconference.

Although there clearly are several advantages of synchronous communication, there are also potential barriers of which some are of practical, and others of technical nature. For example, Philipp and others are required to be present at a certain time, and at a place that facilitates internet with sufficient bandwidth. In addition, if they wish to use audio-visuals, they need a webcam and/or a headset. They may not be familiar with the hardware and software, which requires them to learn how to use these. Furthermore, using synchronous web-videoconference puts high demands on students' abilities to monitor multiple processes as following the discussion via all available communications (chat, audio, video, whiteboard) at the same time is a highly complex task. Finally, because of the direct nature of the communication process there is less time to reflect on answers than in the discussion forum.

In sum, both synchronous and asynchronous communication modes have their strengths and weaknesses and it has been suggested that a combination of both modes in accordance with their affordances would be preferable to enhance the quality of online collaborative learning and engage students in the learning process (Holden & Westfall, 2006; Hrastinski et al., 2010; Johnson, 2006). However, as the use of synchronous videoconferencing tools is relatively new and limited research is available how to effectively integrate synchronous with asynchronous communication in the instructional design of online collaborative learning, available literature lacks a clear, integrated conceptual framework. Therefore, this manuscript uses and integrates three different conceptual frameworks, which historically have been isolated from each other and used in (partially) different contexts and educational fields. That is, in this manuscript we will adopt the notions of Community of Inquiry

and social presence in particular (Garrison, 2007; Garrison, Anderson, & Archer, 2000), Self-Determination Theory (Deci & Ryan, 1985, 2002; Ryan & Deci, 2000), and the Technology Acceptance Model (Davis, 1989) to understand how learners engage with new synchronous and asynchronous technologies in a student-centred online learning environment.

# 3. Conceptual Frameworks

## 3.1 Community of Inquiry and Social Presence

The Community of Inquiry (CoI) framework is a well-researched model developed by Garrison et al. (2000) that helps to understand how meaningfull online learning occurs through the interaction of the three elements: social presence, teaching presence and cognitive presence. Cognitive presence is defined as "the extent to which the participants in any particular configuration of a community of inquiry are able to construct meaning through sustained communication." (Garrison et al., 2000, p. 89). In other words, the extent to which learners use and apply elements of critical inquiry to construct meaning in discussions is the key feature of cognitive presence.

The second component is teaching presence, whereby Anderson, Rourke, Garrison and Archer (2001) distinguish three key roles teachers have in CSCL environments: the organisation of the learning process and instructional design, facilitating discourse, and direct instruction.

The third component of CoI, social presence, addresses the need to create and establish a social learning space for learners to critically engage with discourse in CSCL settings and is defined as "the ability of participants […] to project their personal characteristics into the community, thereby presenting themselves to the other participants as 'real people'" (Garrison et al., 2000, p. 89). This definition extends the traditional approach of social presence, in which the medium of communication influences the perception of social presence (Short, Williams, & Christie, 1976). Garrison et al. (2000) have extended the traditional definition of social presence from the focus on the medium and the potential to communicate to the actual communication observed by focussing on the way learners can present themselves to the group. For example, asynchronous discussion forums bring about a perceived low degree of social presence as only text can be transmitted and there is a

delay in response (Tu & McIsaac, 2002). Web-videoconference, whereby participants not only can chat but also provide direct feedback based on the audio-visual information shared by other participants, brings about a medium to high degree of perceived social presence (e.g. see Wegge, Vogt, & Wecking, 2007).

By projecting one's own identity to a group, the perception of the identity of others and of the group also become important aspects in CSCL (Caspi & Blau, 2008). Thus, using synchronous communication primarily relates to social presence. Adding synchronous communication tools to asynchronous communication affords higher levels of social presence, which can be expected to remedy the previously mentioned challenges of asynchronous communication (e.g. delay in feedback, feelings of isolation) and foster higher learner engagement.

Though synchronicity and social presence have been shown to positively influence student satisfaction and student performance (Richardson & Swan, 2003; So & Brush, 2007), not much is known about this in contexts that offer a combination of asynchronous and synchronous communication tools.

## 3.2 Self-Determination Theory

A factor that has been found to have a large influence on learning behaviour in both offline and online educational settings is self-determination (Chen & Jang, 2010; Rienties et al., 2009). Self-determination refers to learners' perception of the extent to which they can steer their own learning process and is therefore strongly related to motivation as it "is specifically framed in terms of social and environmental factors that facilitate versus undermine intrinsic motivation" (Ryan & Deci, 2000, p. 58). In Self-Determination Theory (SDT, Deci & Ryan, 1985, 2002; Ryan & Deci, 2000), a distinction is made between three orientations. The first is autonomy-orientation, by which learners are indicated who typically are intrinsically motivated and engage in learning because it is perceived as an enjoyable or challenging activity. The second is control-orientation, which indicates learners who show a strong disposition for extrinsic motivation and feel they have limited control over their learning process. The third orientation is the impersonal orientation, which is held by learners who neither have an internal or external locus of control of their learning, and this orientation is therefore

associated with amotivation. The autonomous and control orientations are not seen as mutually exclusive categories: extrinsic motivation, for instance, is perceived as a continuum of types that differ in the degree of internalisation of the extrinsic motivation (Deci & Ryan, 2002). Amotivation, obviously, is seen as distinct from the other two.

SDT further states that learners' motivation and well-being are determined by the extent to which three basic needs are satisfied: the need for autonomy (i.e., learners' perception of the amount of control they have over the learning process), the need for relatedness (i.e., learners' perceived amount of social inclusion), and the need for competency (i.e., how learners perceive their ability to deal with learning activities). All three needs are affected by contextual factors, like the interaction between learners, teachers, and the learning materials (Deci & Ryan, 2000).

Several scholars have argued that the role of self-determination in the complex dynamics of online collaborative learning is not well understood (Järvelä et al., 2010, 2011; Martens et al., 2004; Rienties, Giesbers, et al., 2012). As already mentioned, online collaborative learning settings in general are open and flexible, and often offer a limited amount of external regulation and structure. Thereby, learners are allowed to be more autonomous in making choices regarding their learning behaviours (Chen & Jang, 2010; Chen, Jang, & Branch, 2010). At the same time this requires learners to be more self-determined, and not all learners are able to do this and learn efficiently in an online setting (Kirschner, Strijbos, Kreijns, & Beers, 2004; Liu, Horton, Olmanson, & Toprac, 2011; Rienties et al., 2009, Rienties, Tempelaar, et al., 2012).

Combining synchronous and asynchronous communication in an online collaborative course further enhances the choices learners can make to steer their learning behaviour. As limited research is available about the effect of synchronous communication opportunities on the engagement in asynchronous communication, it is an open question whether such opportunities would replace or enhance the use of asynchronous communication, and whether this effect depends on learners' motivation.

Translated in terms of SDT, synchronous communication may increase learners' sense of relatedness by affording more direct and personal social interactions and feedback. Furthermore, synchronous communication, via the

affordance to limit the delay in monitoring activity, may positively affect learners' sense of competency (e.g. by providing timely content related feedback by both learners and tutors), and the sense of autonomy (i.e. by providing timely process-related feedback).

Just as has been found with respect to asynchronous communication (e.g. Chen, 2010; Martens et al., 2004; Rienties et al., 2009), the differences in engagement and the use of synchronous communication tools may be explained from differences in their level of self-determination. However, this still remains a subject for further research.

## 3.3 Technology Acceptance Model

A third and final conceptual model is the Technology Acceptance Model (TAM, Davis, 1989). TAM is a commonly used model that originates from the domain of information systems research, and aims to predict the intention to use ICT. TAM is founded on the well-established Theory of Planned Behaviour (Ajzen, 1991), which explains human behaviour by stating that it is directly preceded by the intention to perform this behaviour. Intention, in turn, is influenced by three factors: personal beliefs about one's own behaviour, one's norms, and the amount of behavioural control one has. Building on this theory, TAM states that the intention to use ICT is influenced by two main factors: the perceived usefulness (the extent to which a person believes the use of ICT will, for example, enhance his or her performance in a course) and the perceived ease of use (the perceived effort it would take to use a particular communication tool like a webcam).

TAM research has shown motivation to be a key mediator for behavioural intention to use ICT (Davis, Bagozzi, & Warshaw, 1992; Venkatesh, Morris, Davis, & Davis, 2003). This model thus provides a third lens that may help us to understand how learners engage with new technology in a student-centred online collaborative learning environment.

# 4. Overview of this Dissertation and Research Questions

This dissertation is focused on the relationship between the use of e-tools for synchronous communication, (asynchronous) communication in discussion forums, and the role of students' motivation. This dissertation is divided in two parts: The first part (chapters two and three) revolves around the question: *Does a combination of synchronous and asynchronous communication modes in online collaborative learning lead to different learner perceptions and learner satisfaction of the course compared to using asynchronous communication alone?* The question is approached from the framework of the CoI model and social presence (Garrison et al., 2000).

Chapter 2 presents an initial study comparing self-reported satisfaction scores of a cohort of learners using a combination of both communication modes to similar satisfaction scores of a cohort of learners using asynchronous discussion forums only. We expect students who used the combined communication modes to report higher satisfaction on all categories, as indicated in Figure 1.3.

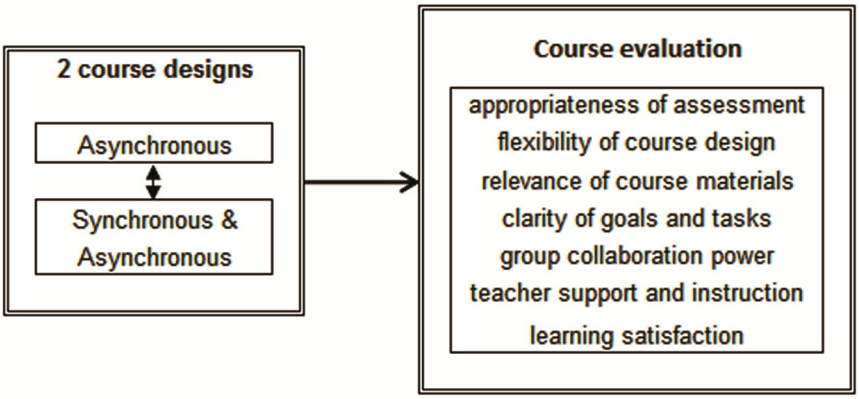



*Figure 1.3. Schematic overview of the relations researched in chapters 2 and 3*

The follow-up study that is presented in Chapter 3 was initiated because of two main reasons. First, the population of web-videoconference users in Chapter 2 consisted of a relatively small sample. Second, as it was the first

summer that web-videoconference was used, minor technical issues and a substantial learning curve for students and tutors to use synchronous communication tools may have influenced its results. Therefore, participants from three subsequent implementations were included in chapter 3.

The recently advocated combination of TAM (Davis, 1989) and SDT offers an appropriate framework (see Roca & Gagné, 2008; Sørebø et al., 2009) as it relates motivation to the use of information technology. However, available research largely rests on the assumption that the intention to use communication tools equals actual usage. As Bagozzi (2007) indicated this does not have to be the case, but to the best of our knowledge the study reported in Chapter 3 is among the first to investigate the actual use of synchronous communication tools. Also, most CSCL studies do not take an intertemporal point of view. Yet, as argued by Luppicini (2007), CSCL should be regarded as a complex combination of factors in time. Therefore, the second part of this dissertation (Chapters 4 and 5) takes an intertemporal point of view of investigating the usage behaviour of synchronous communication tools, the mutual effect (on usage behaviour in both communication modes) when combined with asynchronous communication tools, and the influence of individual self-determination thereon. A measure of learner performance was incorporated in the form of a final exam score.

The fourth chapter revolves around the questions: *Can participation and actual usage behaviour in synchronous web-videoconferences over time be explained from learners' self-determination, and to what extent is learner performance determined by actual usage behaviour of communication tools in the web-videoconferences and self-determination measures?*

Usage behaviour of synchronous communication tools was observed and scored for every individual taking part in the subsequent web-videoconferences. A schematic overview of the relations that are investigated in this chapter is provided in Figure 1.4.

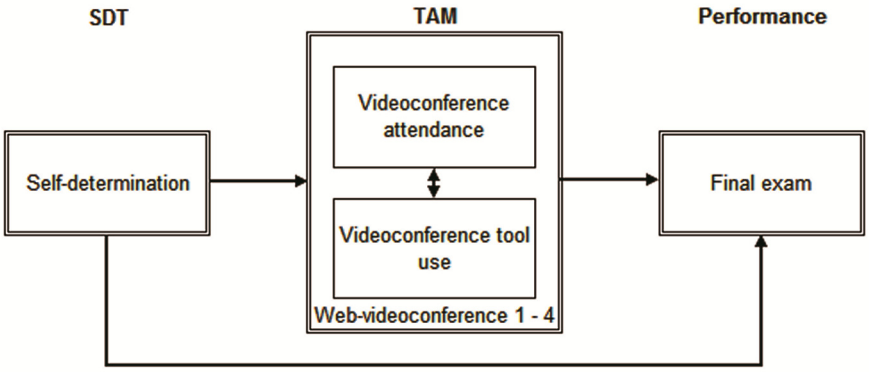



*Figure 1.4. Schematic overview of the relations researched in Chapter 4*

The fifth chapter logically follows the fourth as it broadens the shift to both communication modes and addresses the questions: *How does, in a dynamic setting, the quantity and richness of synchronous communication relate to the quantity and quality of asynchronous communication, to what extent are these influenced by a learners' level of self-determination, and to what extent does using combined communication modes influence learner performance?* The quality of contributions to asynchronous discourse is measured via Content Analysis (CA), which is a commonly used method in CSCL research to assess discourse (see De Wever, Schellens, Valcke, & Van Keer, 2006). By using a validated coding scheme, posted messages are categorised not only in quantity but also in quality to reveal evidence of knowledge transfer and learning. CA results can for example be used to determine if the quantity and quality of discourse are related to the amount of web-videoconferences they participated in and/or to the richness of communication tools they used within the web-videoconferences. Figure 1.5 provides a schematic overview of the relations that are investigated in this chapter.

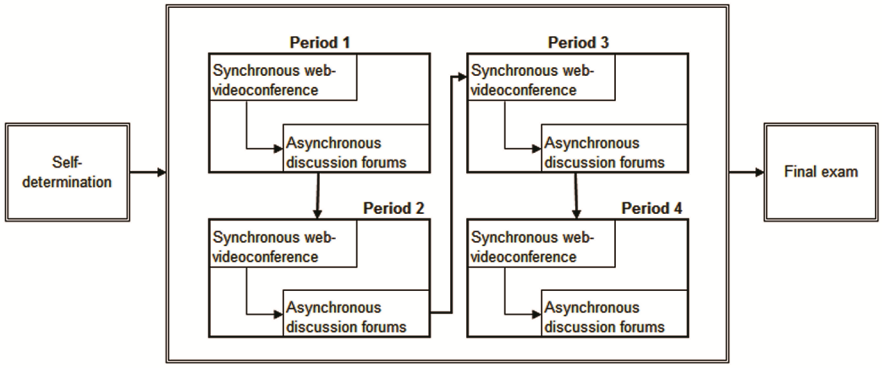



*Figure 1.5. Schematic overview of the relations researched in Chapter 5*

In the sixth and final chapter of this dissertation, the four studies and their results will be reflected upon, and implications for educational practice and future research will be discussed.

Each of the forthcoming four chapters is based on an individual journal article. Because these are written to be read as independent contributions to the scientific literature, repetitions and overlap in content are inevitable.

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# PART I

# The Effect of Combined Asynchronous and Synchronous Communication on Student Satisfaction and Student Learning

# Chapter 2

# Social Presence, Web videoconferencing and Learning in Virtual Teams*

The potential of information technology to facilitate collaboration in education has grown considerably in recent years. The use of Web videoconferencing, whereby learners in an online classroom can simultaneously collaborate using audiovisual communication tools, increases the learner's ability in social and emotional expression, thus improving communication which may enhance learning satisfaction. This paper compares two cohorts of students who attended the same online course in economics. Both could communicate via a discussion board and one cohort had the additional opportunity to participate in Web conferences. Contrary to expectations, learning satisfaction did not seem to increase with the introduction of Web videoconferencing. This finding leads to several questions for future research.

## 1. Introduction

A large body of literature in computer-supported collaborative learning (CSCL) has highlighted the fact that synchronous communication is superior to asynchronous communication in establishing discourse. It does this by overcoming the lack of bodily communication, delayed feedback and barriers of meaning in asynchronous tools such as discussion forums (Beers, Boshuijzen, Kirschner, & Gijselaers, 2007; Derks, Bos, & von Grumbkow, 2007; Haythornthwaite, 2000; Mehrabi, Gluckstein, Benner, Hashemi, & Herfarth, 2000; Rummel & Spada, 2005; Tu, 2002). Tu (2002), for example, found that discussion forums had the lowest level of conveying feelings and emotion. Haythornthwaite (2000) noted that people with frequent and strong ties to others used more synchronous communication tools, or asynchronous tools as if they were synchronous. Beers et al. (2007) argued that, for online teams to share and construct knowledge effectively, they had to be able to understand one another, which is more difficult in asynchronous communication. Often, a lack of shared context, body language or writing style leads to an

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interpretation of written text (such as a post on a discussion board) not intended by the writer (Bromme, Hesse, & Spada, 2005). Due to miscommunication, a learner's connectivity and sense of belonging (relatedness) may be reduced, as may perceived competences and this in turn can reduce social interaction. A recent development in collaborative working and learning has been the use of synchronous tools such as Web videoconferences, whereby learners meet online at a fixed time (synchronous) in an online classroom. While Web videoconferencing is not a new phenomenon, tools like Skype, MSN Web Messenger and Acrobat Connect allow learners to communicate efficiently using free or low-cost technology, such as a simple desktop computer. Until recently, such basic technology would allow only for asynchronous communication, as in discussion groups. The differences in these two formats of communication are substantial, from both the functional and motivational perspectives, as the look-and-feel differences visible in Figures 2.1 and 2.2 demonstrate.

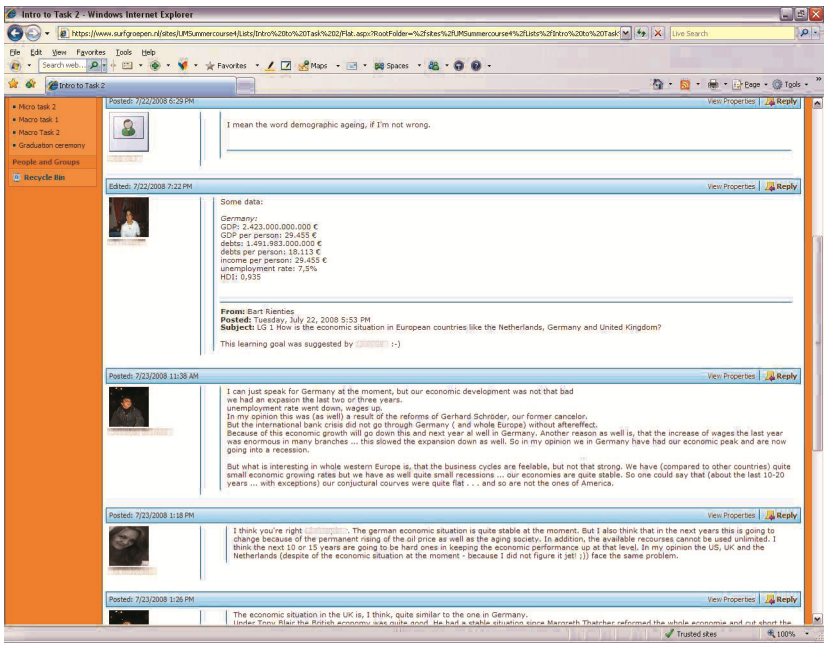


*Figure 2.1. An example of asynchronous communication using a discussion board*

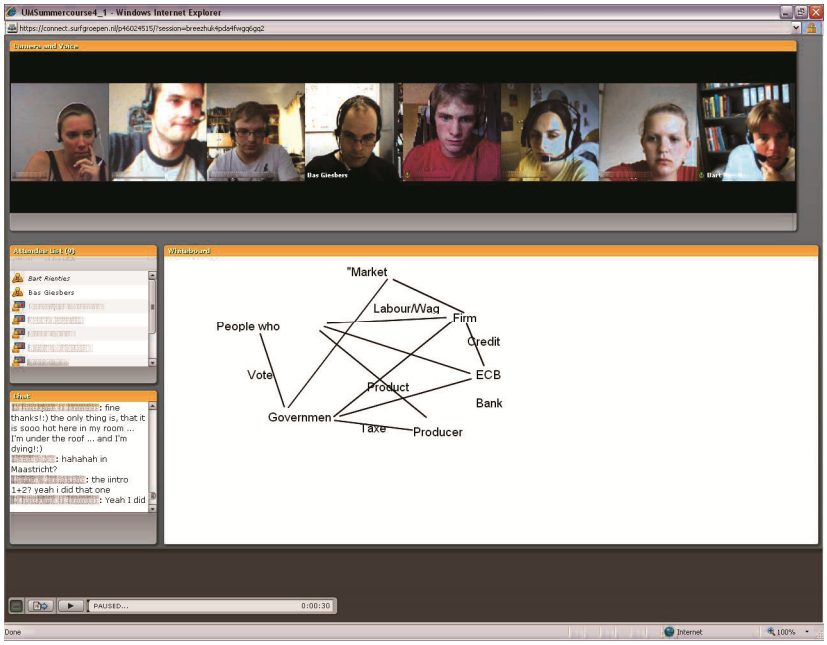

*Figure 2.2. An example of synchronous communication using Web videoconferencing*

Figure 2.1 shows a discussion board supporting asynchronous communication and Figure 2.2 shows a Web videoconference tool that allows for synchronous communication. (Both examples are from a collaborative environment called Surfgroepen (www.surfgroepen.nl) offered by SURFnet, which allows Dutch universities and research institutes to collaborate nationally and internationally by using innovative Internet communication facilities.) As Figure 2.2 shows, Web videoconferencing enriches the learning environment by including audiovisual information such as face expressions, the collaborative use of a whiteboard and chat.

Garrison, Anderson, & Archer (2000) present a model in which the interaction of social presence, teaching presence and cognitive presence is crucial for meaningful learning to occur. The use of Web videoconferencing is likely to have a positive effect on social presence since it is defined as 'the ability of participants [. . .] to project their personal characteristics into the community, thereby presenting themselves to the other participants as ''real people''' (Garrison et al., 2000, p 89). Social presence has been found to determine learners' experience and perception of social interaction (Yang, Tsai, Kim, Cho, & Laffey, 2006). If learners are able to be seen and heard

simultaneously and use a shared workspace through Web videoconferencing while being physically separated, social presence is increased since the participants are more able to express themselves socially and emotionally in a group. Of course, cognitive presence (meaning construction through communication) and teaching presence (the facilitation of social and cognitive presence) are also affected by using Web videconferencing, but not as directly as social presence.

Several researchers have argued that clear design in an online course and adequate instruction are essential prerequisites for effective collaborative learning in virtual teams (Anderson, Rourke, Garrison, & Archer, 2001; Arts, Gijselaers, & Segers, 2006; Beers, Boshuijzen, Kirschner, & Gijselaers, 2005; Kirschner, Strijbos, Kreijns, & Beers, 2004). This can be established through the support of teaching presence which, in online settings, can also be achieved by Web videoconferences. Because the facilitator is present during synchronous communication and both coursedesign and course material can be presented in a more direct way, teaching presence is enlarged.

Furthermore, recent research (Caspi & Blau, 2008; Rogers & Lea, 2005) has suggested that an increase in social presence is important, not only because of its impact on the quality of collaboration. The development of a shared group identity is considered a more important factor and, when achieved, may help even the leanest form of communication to become a successful tool of collaborative learning. Moreover, Rogers and Lea (2005) have argued that the visual cues of some may even distract the attention of others.

To investigate the potential of Web videoconferencing, we compared two cohorts of students participating in the same course. One cohort could communicate only asynchronously by using a discussion board, while the other was facilitated with regular Web videoconferences in addition to the discussion board. The use of Web videoconferences led to a direct increase of social presence in the second group and provided an additional functionality by which a shared group identity could be formed or restricted.

Based on the increase in social presence and the availability of a richer set of learning tools (such asa collaborative whiteboard) when using Web videoconferences, we expected a positive impact on course design and the achievement of learning goals and tasks. In addition, as it should be easier to

establish communication and express emotion with Web videoconferencing than with discussion forums (Derks et al., 2007; Jonassen & Kwon, 2001; Rourke, Anderson, Garrison, & Archer, 1999; Tu & McIsaac, 2002), we expected improved collaboration. As it is also easier for the teacher to provide timely feedback and instruction in synchronous communication (De Laat, Lally, Lipponen, & Simons, 2007; Vonderwell, 2003), we expected students' rating of teacher instruction in the second cohort to be higher. Finally, we expected the hypothesized increase in social presence and teaching presence to have a positive impact on cognitive presence, which in turn was expected to increase learners' satisfaction. As the course material and assessments were the same in both phases, we expected no change in perceived usefulness.

Given the increased use of Web-based synchronous communication tools in professional business environments (online meetings, corporate training etc), the findings of this study are relevant for many fields outside business education.

# 2. Method

## 2.1 Setting

The present study took place during an online summer course for students intending to study for a Bachelor's degree in International Business in the Netherlands. The aim of the summer course was to bridge the gap in the students' prior knowledge of economics before they began their degree studies (Rienties, Tempelaar, Waterval, Rehm, & Gijselaers, 2006). The online course was delivered over six weeks, during which students were expected to work for 10–15 hours per week. The participants never met face-to-face before or during the course and had to learn to use the virtual learning environment 'on the fly'. The course applied the principles of problem-based learning (PBL), which focuses student learning on complex situations and a variety of realistic information (Dochy, Segers, Van den Bossche, & Gijbels, 2003; Van den Bossche, Gijselaers, Segers, & Kirschner, 2006). A key issue in PBL is that students actively construct knowledge in collaborative groups (Hmelo-Silver, 2004). To assess the influence of Web videoconferencing on social presence and learning in virtual teams, two experimental conditions were applied in separate cohorts.

To investigate whether increasing social presence by adding Web videoconferencing led to an increase in students' perceived usefulness of the course, we compared two cohorts of students. Both participated in the same course, with cohort 1 applying an asynchronous environment offering communication via a discussion board, and cohort 2 having the additional functionality of Web videoconferencing. As participation in the online bridging course is optional, as is participation in an entry test that provides students with feedback on their prior level of mastery, selection effects might be present. Individual differences in learning motivation, ranging from being intrinsically motivated to being extrinsically motivated to not being motivated to learn, were expected to be a potential source of selection bias (Rienties, Tempelaar, Van den Bossche, Gijselaers, & Segers, 2009). Measurements of learning motivation were therefore included, so that checks could be made that the cohorts were comparable with regard to the relevant individual characteristics.

In both cohorts, students had to collaborate to solve six tasks. An e-book was available and they could use additional resources. The tutorial group, together with their tutor, could decide on the pace within a maximum runtime of six weeks. At the end of each week, the tutor suggested how to proceed with the next task, thus focusing on process rather than on content. The results of three intermediate tests and a final summative test combined with graded participation in the discussion forums were used to make a pass–fail decision. A non-recognized certificateand a drink at a graduation ceremony were the only external rewards.

In cohort 1, students had access to a collaborative learning environment equipped with discussion forums and announcement boards. No obligatory meetings were scheduled. In cohort 2, students could also attend four Web videoconferences. A novelty of the Web videoconference system was the simultaneous use of video/audio communication, chat and an integrated whiteboard. At the start of the course, the students spent a lot of time on becoming acquainted with each other during the first videoconference. In addition, the course design, goals and the first task were discussed within the group so that the students would be familiarized with PBL. Afterwards, the students discussed the tasks in the discussion forums. At the start of each new

week, a videoconference was organized to discuss assignments, after which the students continued working in the discussion forum.

## 2.2 Participants

In cohort 1, 100 participants were randomly assigned to six groups. Data were analysed for those participants who actually posted at least once in the discussion forum. This resulted in a total of 82 participants selected for analysis. The six groups had an average of 13.66 members (SD=2.16, range=11–17) per group. The average age was 19 and 50% of the learners were female.

In cohort 2, 69 participants were randomly assigned to five groups, of which 62 actually posted at least once in the discussion forum or attended a Web videoconference. The five groups had an average of 13.80 members (SD=2.59, range 11–18) per group. The average age was 19 and 39% of the learners were female. As the numbers of participants in the two phases was unequal, we removed one rather atypical group from cohort 1: it differed from the other groups in its type of learning motivation and underperformed in discourse. This left 71 participants in cohort 1 and 62 in cohort 2.

## 2.3 Instruments

### 2.3.1 Expectations before the start of the course

Before the course started, participants' perceptions of the online course were measured by an instrument developed at Maastricht University. The questionnaire comprised 18 questions on a seven-point Likert scale, ranging from 1 (totally disagree) to 7 (totally agree). The questionnaire was divided into four categories: (a) the usefulness of the prior knowledge test (four items); (b) reasons for joining the course (five items); (c) group collaboration (four items); and (d) the appropriateness of the course design (five items). Aside from these categories, participants could indicate their level of ICT expertise, whether 'beginning' (26.3%), 'experienced' (62.6%) or 'expert' (11.1%). Fewer than 10% of the students had taken an online course before. The response rates for cohort 1 and cohort 2 were 93% and 73%, respectively.

### 2.3.2 Academic motivation

Previous research on virtual teams has shown that type of academic motivation can have a strong influence on learning processes and outcomes (Rienties et al., 2009). Individual contextual motivation for education was measured by the Academic Motivation Scale (AMS) (Vallerand, Pelletier, Blais, Brière, Senécal, & Vallières, 1992), which consists of 28 items based on the question stem 'Why are you going to college?' There are seven sub-scales in the AMS, of which three belong to the intrinsic motivation scale, three to the extrinsic motivation scale and one to no motivation. 'Intrinsic' motivation includes motivation to know, to accomplish and to experience stimulation. The 'extrinsic' motivation sub-scales constitute a motivational continuum reflecting the degree of self-determined behaviour, ranging from identified regulation as the component most adjacent to intrinsic motivation, to externally regulated learning, where learning is steered through external means such as rewards. The 'no motivation' scale constitutes the extreme of the continuum: the absence of regulation, either externally or internally directed. The AMS questionnaire was completed before the course started. The response rates for cohorts 1 and 2 were 93% and 73%, respectively, and the Cronbach alpha of the seven sub-scales ranged from 0.760 to 0.856, which is in line with previous studies.

### 2.3.3 Perceived usefulness of the course

The perceived usefulness of the course was measured by an instrument developed specifically for online remedial education (Rienties et al., 2006). This measure has been used in a variety of online courses for prospective Bachelor's and Master's students in The Netherlands as well as for international professionals working together in virtual teams (Rehm, 2009). The questionnaire consists of 33 questions on a five-point Likert scale ranging from 1 (totally disagree) to 5 (totally agree), and spans seven categories: assessment (four items); course design (six items); course materials (three items); goals and tasks (four items); group collaboration (five items); instruction by teacher (five items); and learning satisfaction (five items). For cohort 2, a further category was added to measure the perceived usefulness of videoconferencing relative to the discussion forum (five items). Finally, the participants' age and the number of hours worked were measured and a

textbox for open comments was included. Contrary to the above instruments, this questionnaire was completed at the end of the course. The response rates for cohorts 1 and 2 were 83% and 77%, respectively.

### 2.4 Analysis

The metric used to estimate and describe perceived usefulness of the two online course designs was the standardized difference of two means (Cohen's d effect size). This metric is appropriate when the means of two groups are compared. Cohen's d expresses the distance between two group means in terms of their pooled standard deviation (Cohen, 1998). Cohen recommended that d=0.20 (small effect), d=0.50 (moderate effect) and d=0.80 (large effect) should serve as a general guideline across disciplines.

## 3. Results

The cohorts showed no significant differences with respect to age, gender, ICT skills and prior experiences with online education. With respect to students' expectations before the start of the course, no significant differences were found in the four categories using an independent sample t-test, with the outcome for group collaboration being somewhat indecisive. Before the start of the online course, cohort 1 users were on average more positive about the usefulness of group collaboration than cohort 2 users (F=14.978, t 1.972, p=0.051, d=0.36). Although the difference is almost statistically significant, the effect size (Cohen's d value) is small. No significant differences were found among participants with respect to intrinsic motivation. However, participants in cohort 1 had a higher level of identified regulation (F=0.728, t=2.157, p =0.033, d=0.42) and external regulation (F=5.633, t=2.409, p=0.018, d=0.45), indicating that cohort 1 participants were slightly more extrinsically motivated. Nonetheless, the size effects were small and Rienties et al. (2009) showed that extrinsically motivated students did not differ significantly from average students in virtual teams with respect to their contribution to discourse.

### 3.1 Effects of the Redesign

Table 2.1 displays the scores for each of the 37 questions referring to the perceived usefulness of the course. Cohort 1 students were in general very pleased with the online course. Most scores for the five-point Likert scale

questions average around 4.0, while the overall course score and the score for teacher support surpasses eight on a ten-point scale.

*Table 2.1. Comparison of course usefulness per item*

| | Discussion Forum | | Videoconference | | t-test |
|---|---|---|---|---|---|
| | M | SD | M | SD | difference |
| This Summer/Wintercourse offered me a lot | 4,27 | 0,64 | 4,02 | 0,53 | 0.031* |
| The contents of the Summer/Wintercourse were inspiring | 4,15 | 0,61 | 3,94 | 0,56 | 0.063† |
| The format of the Summer/Wintercourse was good | 4,15 | 0,69 | 4,04 | 0,77 | |
| The Summer/Wintercourse was well organized | 4,10 | 0,64 | 4,17 | 0,72 | |
| The quality of the digital material was good | 4,44 | 0,60 | 3,96 | 0,85 | 0.01** |
| The digital material motivated me to keep up with the subject matter | 3,63 | 0,81 | 3,54 | 0,90 | |
| Learning with an E-book is not different from learning from a hard-copy book | 2,78 | 0,89 | 2,85 | 0,99 | |
| It was fun that I could attend this Summer/Wintercourse via the internet | 4,22 | 0,74 | 4,06 | 0,81 | |
| The goals of the Summer/Wintercourse were clear to me | 4,00 | 0,72 | 4,17 | 0,63 | |
| It was clear to me what was expected of me this Summer/Wintercourse | 3,85 | 0,87 | 4,04 | 0,71 | |
| The assigments/tasks stimulated me to collaborate with the other group | 3,53 | 0,86 | 3,50 | 0,92 | |
| The assignments/tasks stimulated me to study | 3,78 | 0,85 | 3,69 | 0,80 | |
| I am satisfied with what I learned in terms of knowledge, skills and insight | 3,81 | 0,78 | 3,69 | 0,88 | |
| I gained enough knowledge and skills in economics to start with my study in Maastricht | 3,68 | 0,71 | 3,73 | 0,79 | |
| I think that by attending this Summer/Wintercourse I will get better results in my future study in | 3,85 | 0,71 | 3,77 | 0,93 | |
| The group in which I participated functioned well | 3,86 | 0,86 | 3,56 | 0,90 | 0.079† |
| It was fun to collaborate with others in this Summer/Wintercourse | 4,07 | 0,85 | 3,71 | 0,94 | 0.041* |
| Collaborating with others facilitated my understanding of the subject matter | 3,78 | 0,72 | 3,65 | 0,79 | |
| I think I learned more in this Summer/Wintercourse through collaboration with others than I would have learned if I had to work individually | 3,34 | 0,96 | 3,25 | 1,12 | |
| I think I was motivated to finish this Summer/Wintercourse because I could work in my own | 3,68 | 0,94 | 3,83 | 0,86 | |
| It is good that I could attend this Summer/Wintercourse independently (without interference | 4,37 | 0,61 | 3,92 | 0,87 | 0.02* |
| The use of the webvideoconference system (Breeze) was useful | . | . | 3,79 | 0,87 | |
| I learned a lot from the discussions in the web videoconferences (Breeze) | . | . | 3,48 | 0,92 | |
| The use of the discussion forums (SURF-groepen) was useful | . | . | 3,90 | 0,93 | |
| I learned a lot from the discussions in the discussion forums | . | . | 3,27 | 1,01 | |
| There were too many webvideoconferences in this summer/winter course | . | . | 2,67 | 0,86 | |
| I was given the support that I needed | 4,03 | 0,69 | 4,23 | 0,66 | |
| The Online Summercourse-team was enthousiastic in coaching our group | 4,22 | 0,72 | 4,54 | 0,58 | 0.014* |
| The Online Summercourse team stimulated participation of all group members in the online | 3,54 | 0,86 | 3,88 | 0,70 | 0.033* |
| The Online Summercourse team helped us to apply what we had learned on other situations than those mentioned in the assignments/tasks | 3,63 | 0,61 | 3,94 | 0,91 | 0.038* |
| Give an overall grade for the functioning of the Summer/Wintercourse team (1 = very bad - 10 | 8,20 | 0,94 | 7,98 | 1,42 | |
| The instructions for making the final test were clear | 4,05 | 0,75 | 3,79 | 0,71 | 0.073† |
| The Weekly tests (intermediate tests) in this Summer/Wintercourse gave me a good picture of what I still had to study | 3,78 | 0,79 | 3,96 | 0,62 | |
| The internet application used for the tests was easy to work with | 4,15 | 0,83 | 3,88 | 0,94 | |
| Give an overall grade for the quality of the Summer/Wintercourse (1 = very bad - 10 = very | 8,46 | 1,02 | 7,73 | 1,33 | 0.01** |
| I participated actively in the online group discussions | 3,19 | 1,15 | 3,25 | 1,10 | |
| I have made ..... Weekly (intermediate) tests | 2,81 | 0,97 | 2,60 | 1,35 | |
| Weekly I have spent .... hours on this course | 13,43 | 6,76 | 11,12 | 5,54 | 0.069† |

Independent sample T-test (2-sided) of Discussion forum (n=59) vs. Videoconference and Discussion forum (n=49).

**Coefficient is significant at the 0.01 level (2-tailed).

*Coefficient is significant at the 0.05 level (2-tailed).

† Coefficient is significant at the 0.10 level (2-tailed).

Quite surprisingly, cohort 2 students seemed to be less positive. Eight questions have statistically significant lower scores in cohort 2 than in cohort 1 on the basis of an independent sample t-test. In particular, the overall grade for the online course for cohort 2 is 0.7 points lower, which is statistically significant at 1%. In contrast, cohort 2 shows significantly higher scores for the three questions concerning the role of the instructor.

With respect to the redesign, five questions were put to students of cohort 2 in order to measure the usefulness of Web videoconferencing and discussion forums. Students in cohort 2 were positive about both the use of the Web videoconference system (average score=3.8) and the use of discussion forums (average score=3.9). However, the slightly higher value in cohort 2 for learning in videoconference sessions (average score=3.5) than for the discussion forums (average score=3.3) is insignificant in a paired sample t-test. Finally, students in cohort 2 worked fewer hours per week than students in cohort 1, which is significant at a 10% significance level.

*Table 2.2 Perceived course usefulness per scale*

| | Discussion Forum | | Videoconference | | t-test | Cohen |
|---|---|---|---|---|---|---|
| | M | SD | M | SD | difference | d-value |
| Assessment | 14,80 | 2,41 | 14,23 | 2,60 | | |
| Course Materials | 11,29 | 1,66 | 10,65 | 1,80 | 0,058† | 0,37 |
| Course Design | 24,69 | 2,59 | 23,76 | 2,48 | 0,064† | 0,36 |
| Goals and Tasks | 15,15 | 2,51 | 15,40 | 1,82 | | |
| Group Collaboration | 18,24 | 3,34 | 17,42 | 3,28 | | |
| Instruction | 19,53 | 2,13 | 20,57 | 2,09 | 0,012* | -0,50 |
| Learning Satisfaction | 19,83 | 2,50 | 19,27 | 2,73 | | |

Independent sample T-test (2-sided) of Discussion forum (n=59) vs. Videoconference and Discussion forum (n=49).
*Coefficient is significant at the 0.05 level (2-tailed).
† Coefficient is significant at the 0.10 level (2-tailed).

Table 2.2 lists the effects of the redesign on the perceived usefulness of the course per category. In contrast to our expectations, students in cohort 2 were less satisfied with the course materials. With respect to the course design, cohort 2 students differ from cohort 1 students, but the effect is in the opposite direction to what we expected. In other words, cohort 1 students were more satisfied with the course design than cohort 2 students. No effect was found with respect to goals and tasks and group collaboration. We found an improved satisfaction of the role of the teacher in cohort 2 at a 5% significance level with a moderate size effect (F=0.057, t=2.549, p=0.012, d=0.50). However, we did not find any difference among the cohorts with respect to learning satisfaction. Overall, we have to conclude that students who used Web videoconferencing in addition to discussion forums were not

more positive about the online course than students who used only the discussion forums.

# 4. Discussion

Based on the idea that better opportunities to establish communication and express emotion contribute to social presence, we expected that the use of Web videoconferences would positively influence perceptions of the course design, goals and tasks, group collaboration, instruction and finally learning satisfaction among learners. In other words, we expected that groups working together using synchronous Web videoconferences in combination with asynchronous discussion forums would be more positive about the course's usefulness than groups who worked together using only discussion forums. However, the results indicate that students using videoconferencing were in general not more positive about the online course, with the exception of their perception of teacher instruction.

The fact that students in cohort 2 (Web videoconferencing) were less positive about the course materials may be explained by other factors. In cohort 2 a new version of the e book system was used, which seemed to be less compatible with Apple machines. In fact, six students complained about compatibility (for example, 'exercises cannot be made with a Mac'; 'that it works better with Mac computers') in response to the 'open' question, while there were no remarks about compatibility in cohort 1, which might explain the lower rating for course materials. Secondly, as the course materials were the same in both cohorts, the lower score from cohort 2 students may be directly attributable to the use of the richer learning environment. As Rogers and Lea (2005) suggest, richer learning environments can lead to distraction from learning rather than being a constructive addition.

The lower evaluation of the course design for cohort 2 raises several questions. Although discussion forums have obvious disadvantages with respect to the speed of interaction, feedback and the ability to express emotion, they have the important advantage that students can learn whenever they want. Flexibility may be important for online remedial education when prospective students are preparing themselves for university at home or at their holiday location (Rienties et al., 2006). In addition, several authors have argued that, by using discussion forums, participants have more time to think

and are therefore more able to build effective arguments (Schellens & Valcke, 2006; Weinberger & Fischer, 2006). Even though the second cohort also used discussion boards, the use of Web videoconferences may have put additional pressure on participants leading to a decrease in perceived usefulness.

Explaining the fact that no difference was found in the perception of goals and tasks, group collaboration and learning satisfaction between the two cohorts is challenging. It may be that the goals and tasks of the course were sufficiently clear when communicated via a course manual and communication by the instructors in the discussion forum, as cohort 1 students indicated that they knew what was expected of them. This would indicate that Web videoconferencing was perceived as an unnecessary extra, which, as Rogers and Lea (2005) have suggested, could be a distraction. Given that it is easier to establish communication and social presence using Web videoconferencing, we at least expected that cohort 2 students would be more positive about the merits of group collaboration. Again, the merits of synchronous communication might be offset by the flexibility of asynchronous communication or might act as a distraction. In addition, not all participants had an adequate broadband connection, which may have hampered their ability to contribute to the videoconference discussions and hence their perception about group collaboration.

As group collaboration and the course design were not improved in the redesign, the overall learning satisfaction did not increase despite the fact that the role of the instructor was perceived more positively. A possible explanation as to why the role of the instructor (for example, in helping students to apply the content to other contexts or stimulating the participation of more passive students) received a higher rating is that the delay in feedback in asynchronous communication could have been counteracted by the weekly videoconferences. Beyond that, a rough comparison of the roles of the instructor in the videoconference and in the discussion forum indicates that the instructor was more active in the videoconference, which in distance learning is highly appreciated by students (Vonderwell, 2003).

## 4.1 Limitations and Future Research

The results of this study are based on self-reported student perceptions in one particular setting. This can be viewed as a potential limitation, as in other

settings Web conferencing may lead to superior results to the use of discussion forums only. In addition, the measurement of participants' perceptions of learning characteristics and learning processes is difficult. However, given the reliability figures of the seven categories, high response rates and the fact that we controlled for differences in motivation and prior expectations, we deem that the results remain valid.

Second, the formation and perception of group identity were not measured in this study. As the perceived usefulness of group collaboration at the start of the online courses was different in the two cohorts, this may have affected the formation and perception of group identity. If we want to assess whether this factor is improving performance, it should be measured. Content analysis of the posts in the discussion boards may provide further indications in this respect.

Third, neither content analysis nor social network analysis was conducted on the discourse. These analyses may reveal evidence about learning and knowledgeconstruction from online discussions and interaction patterns among individuals within groups. Research for cohort 1 showed large differences in participation, type of discourse and position within the social network (Rienties et al., 2009), which we would expect to be smaller in cohort 2 given to the increased opportunities for interaction.

Fourth, future research should investigate whether groups using Web videoconferences are more balanced with respect to type of discourse and participation. In addition, to what extent are students overwhelmed by a variety of ICT tools? To what extent does the requirement to be present during videoconferences hinder the flexibility of learners to decide when and where to learn? Finally, how much does the behaviour of participants (students and teachers) differ when using Web videoconferences and discussion forums?

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# Chapter 3

# Why Increased Social Presence through Web-videoconferencing does not Automatically Lead to Improved Learning*

The Community of Inquiry (CoI) model provides a well-researched theoretical framework to understand how learners and teachers interact and learn together in Computer-supported collaborative learning (CSCL). Most CoI research focusses on asynchronous learning. However, with the arrival of easy-to-use synchronous communication tools the relevance of the CoI model needs verification for these new environments. Synchronous communication is (assumed to be) superior in establishing discourse due to the ability to express immediate feedback, intonation, body language, and thus the affordance to increase social presence. In a quasi-experimental design, we analysed whether increased social presence led to (perceived) improved learning satisfaction and an increased pass rate. That is, the learning experiences of 147 students using discussion forums (2005-2007) and 256 students using web-videoconferencing in addition (2008-2011) over seven consecutive summers were contrasted using the self-developed Students Evaluation of Online Remedial Education Experience questionnaire. Results indicate that students in the web-videoconference design were not more satisfied about their learning experiences, except for the clarity of goals and tasks. Furthermore, in the four years of using the web-videoconference design, a lower pass rate was found compared to the discussion forum-only designs in the years before. Although web-videoconferencing provides an experience that seems more conducive to social presence, more research is needed how to effectively use synchronous communication in e-learning.

## 1. Introduction

Media richness theory (Daft & Lengel, 1986) makes a distinction between rich communication media that resemble face-to-face communication, and lean media ranging from a collection of documents to asynchronous communication via discussion forums (also see Hrastinski, 2010). Current developments in Computer-supported collaborative learning (CSCL) show that communication tools are becoming increasingly rich, and offer more opportunities for synchronous communication resembling face-to-face

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situations. For instance, synchronous communication tools like Skype or Adobe Connect facilitate real-time communication through audio, video, chat, shared whiteboard facilities, or a combination of those. Recent research in CSCL has proposed that synchronous communication, such as videoconferencing (like Skype, Elluminate or Adobe Connect), fosters more direct social interaction and feedback amongst learners and teachers than asynchronous communication (Hrastinski, Keller, & Carlsson, 2010; Strømsø, Grøttum, & Lycke, 2007). For example, Beers, Boshuizen, Kirschner, & Gijselaers (2007) argue that in order for online teams to effectively share and construct knowledge they need to be able to understand each other. Often, a lack of shared context, body language or writing style leads to an interpretation of written text (e.g. a post on a discussion board) not intended by the writer (Bromme, Hesse, & Spada, 2005). However, the delay that often occurs in asynchronous communication allows for more reflection time on the task at hand and the learning process, which leads several researchers to advocate that a combination between asynchronous and synchronous communication is preferable (Hrastinski et al., 2010; Haythornwaite, 2001; Johnson, 2006).

In terms of the well researched Community of Inquiry framework (Garrison, 2007; Garrison, Anderson, & Archer, 2000), it can be argued that synchronous communication in online learning fosters social presence ("the ability of participants […] to project their personal characteristics into the community, thereby presenting themselves to the other participants as 'real people" (Garrison et al., 2000, p. 89) stronger than it fosters cognitive presence (meaning construction through communication), or teaching presence (the facilitation of social and cognitive presence). Indeed, synchronous communication fosters more direct interaction and has been found to increase the sense of community (Dawson, 2006) and to be experienced as more social (Chou, 2002). However, some studies suggested that an increase in social presence not necessarily leads to an increase in the quality of collaboration (Caspi & Blau, 2008; Rogers & Lea, 2005). As a result, using rich synchronous tools with more social presence may not automatically equate to a better learning experience. Therefore, this study compares learner satisfaction and pass rates on an e-learning course between cohorts of learners using lean asynchronous communication tools and cohorts using both asynchronous in combination with rich synchronous communication tools.

## 1.1 Social Presence and Communication in CSCL

In CSCL, learners have to construct meaning and co-construct knowledge in a blended or entirely online setting. The Community of Inquiry framework (Garrison, 2007; Garrison et al., 2000) provides a theoretical model that helps to understand how learners and teachers interact and learn together in CSCL, by making a distinction between cognitive presence, teaching presence, and social presence. Cognitive presence is defined as "the extent to which the participants in any particular configuration of a community of inquiry are able to construct meaning through sustained communication." (Garrison et al., 2000, p. 89). In other words, the extent to which learners use and apply elements of critical inquiry to construct meaning in discussions is the key feature of cognitive presence. The second component is teaching presence, whereby Anderson, Rourke, Garrison and Archer (2001) distinguish three key roles teachers have that impact upon teaching presence in CSCL environments, namely instructional design and organisation, facilitating discourse, and direct instruction. The third component of CoI and the key focus of this study, social presence, addresses the need to create and establish a social learning space for learners to critically engage with discourse in CSCL settings (Giesbers, Rienties, Gijselaers, Segers, & Tempelaar, 2009; Rusman, van Bruggen, Cörvers, Sloep, & Koper, 2009; Van den Bossche, Gijselaers, Segers, & Kirschner, 2006), as by projecting one's own identity to a group (the definition of social presence), also the perception of the identity of others and of a group identity become important aspects in CSCL (Caspi & Blau, 2008).

In the traditional approach of social presence, the medium of communication influences the perception of social presence (Short, Williams, & Christie, 1976). That is, based on richness, listening to a podcast would probably be perceived by students to be of a lower social presence as engaging in a discussion forum, or even a synchronous web-videoconference. Garrison et al. (2000) have extended the traditional definition of social presence from the focus of the medium and the potential to communicate to the actual communication observed by focussing on the way learners can present themselves onto the group. For example, asynchronous discussion forums have a perceived low degree of social presence as only text can be transmitted and there is a delay in response (Tu & McIsaac, 2002). Using web-

videoconference whereby participants not only can chat but also provide direct feedback based on the audiovisual information shared by other participants have a medium to high degree of social presence (Giesbers et al., 2009; Wegge, 2007).

It has been argued that when using asynchronous communication like discussion forums, learners have to cross a substantial threshold before they start making contributions (Garrison, 2007; Rienties, Giesbers, Tempelaar, & Lygo-Baker, 2012; Rienties, Tempelaar, Van den Bossche, Gijselaers, & Segers, 2009). This may, for example, be due to the fact that learners often find it difficult to integrate various points of argumentation in order to provide resolutions to a learning task (Caspi & Blau, 2008; Rogers & Lea, 2005). By affording higher social presence, enhancing the sense of community (Dawson, 2006) and increasing the information flow (Carr, Cox, Eden, & Hanslo, 2004), theories of communication suggest that synchronous media in general may remedy these issues and foster higher learner engagement. Still, asynchronous communication does allow for more time to reflect and thus for more refined contributions to the discourse at hand (Davidson-Shivers, Muilenburg, & Tanner, 2001; Hrastinski et al., 2010). A combination of synchronous and asynchronous communication in CSCL in line with their affordances has been suggested to be beneficial for the sense of community, to enhance the learning process, and as a result to enhance learners' satisfaction (Hrastinski et al., 2010; Johnson, 2006).

It has been argued that, besides social presence, several other factors may have an influence on the quality of group collaboration. For example, Rogers and Lea (2005) suggest that the development of a shared group identity is an important factor, which, when achieved, may help even the leanest form of communication to be a successful tool of collaborative learning. Moreover, Rogers and Lea (2005) argued that visual cues of others might even distract a learners' attention. As a result, using rich synchronous tools affording more social presence does not automatically equate to a better learning experience. For example, in an explorative study comparing perceived learning satisfaction of an online distance course in economics amongst 82 participants using discussion forums versus 69 participants using web-videoconferencing, Giesbers et al. (2009) found that participants using web-videoconferencing reported lower satisfaction about their learning than participants using

discussion forums only, except for their perception of instructional support. In fact, participants in the web-videoconference condition were less satisfied about the course design.

Because the population of web-videoconference users in the initial study were participating the first summer that web-videoconference was used, minor technical issues and an additional learning curve for students and teachers to use synchronous communication tools may have troubled its results. Therefore, in this article, we aim to build on the initial findings by extending the population with groups of students who participated by using web-videoconferencing in follow-up implementations of the same course. By including students who (we assume, for example because of the widespread use of tools like Skype) have been more familiar with synchronous communication tools, and who have been tutored by teachers with more web-videoconference experience, we expect to find that enhanced social presence will lead to improved (perceived) learning and pass rates.

## 1.2 Research Questions

Based on previous research where synchronous communication has been shown to enhance the sense of community and thereby student satisfaction (Dawson, 2006; McInnerney & Roberts, 2004), we expect learners using solely (asynchronous) discussion forums to be less satisfied about their (perceived) learning than learners using (synchronous) web-videoconferences in addition to discussion forums (H1).

Similar to face-to-face settings, where the complexity of group dynamics that has been widely acknowledged (Decuyper, Dochy, & Van den Bossche, 2010; Järvelä, Järvenoja, & Veermans, 2008; Rienties et al., 2009; Rusman et al., 2009), group dynamics in online settings are constituted by social interaction processes, as well as combinations of - and interactions between - different personal characteristics within a group (Järvelä et al., 2008; Järvelä, Volet, & Järvenoja, 2010; Rusman et al., 2009). However, several researchers have found that online teams need to spend more time and effort to develop an effective group collaboration processes (Giesbers et al., 2009; Hrastinski et al., 2010). Because of the decrease in delay compared to asynchronous communication, synchronous communication allows for more direct and straightforward interpersonal interaction (Hrastinski et al., 2010) , and because

it has been shown to enhance the sense of community (Dawson, 2006; McInnerney & Roberts, 2004), we expect the development of group strategies to be supported more strongly by synchronous communication. We therefore hypothesise that learners using discussion forums only will be less satisfied about the group collaboration than learners using web-videoconferences in addition to discussion forums (H2).

In line with the CoI framework, we expect that teachers will find it easier to establish netiquette, and facilitate discourse and direct instruction in a synchronous learning environment (Anderson et al., 2001; Rienties, Giesbers, Tempelaar, Lygo-Baker, Segers, & Gijselaers, 2012). That is, the direct nature of synchronous communication allows teachers and learners to provide feedback about each others' needs and concerns more quickly, which may lead to less miscommunication to occur. Thus, we expect learners using asynchronous discussion forums only to be less satisfied about the teacher presence than learners using web-videoconferences in addition to discussion forums (H3).

Related to the previous hypothesis, in the CoI framework it is argued that it is important that the instructional design of an online course, and in particular its goals and tasks, are clear and well-understood by the learners (Chen & Jang, 2010). Given that synchronous communication allows for more direct feedback between teachers and learners, teachers can gauge whether learners have internalised the goals and tasks of a course and adjust their teaching accordingly. Therefore, we expect learners using discussion forums only to be less satisfied about the clarity of goals and tasks than learners using web-videoconference in addition to discussion forums (H4).

The affordance of offering more direct feedback by using web-videoconferencing may help to limit the delay in monitoring activities and may positively affect three elements that have been found (Deci & Ryan, 2000; Chen & Jang, 2010) to be pivotal in a learners' ability to steer or self-determine their own learning process, namely the sense of competency (e.g. by providing timely content related feedback by both learners and tutors), sense of relatedness (e.g. by making contact moments and feedback more direct and personal), and sense of autonomy (i.e. by providing timely process-related feedback). We therefore expect that learners using discussion forums only will be less satisfied about the opportunity to self-determine their learning

compared to learners using web-videoconferences in addition to discussion forums (H5).

Research has shown that appropriate assessment and feedback methods are crucial for learning, whether in face-to-face or in online contexts (Rienties, Tempelaar, Waterval, Rehm, & Gijselaers, 2006). Assuming that synchronous communication supports direct clarification of goals and tasks and enhances social presence and teacher presence, we expect that learners using web-videoconferencing will be able to critically engage with the various tasks, receive appropriate feedback and as a result also perceive the assessment methods as more appropriate. Thus, we hypothesise that learners using solely discussion forums are less satisfied about the appropriate assessment methods than learners using web-videoconference in addition to discussion forums (H6).

Finally, in line with the findings of Johnson (2006), who suggests a combination of synchronous and asynchronous communication in online learning fosters both higher levels of student satisfaction as well as performance in a course, we expect that successful completion rates of the online module will be lower for learners using discussion forums only compared to learners using web-videoconferencing in addition (H7).

# 2. Method

## 2.1 Setting

The present study took place in the context of an online summer course economics for prospective bachelor students of an International Business degree program at an Institute for Higher Education in the Netherlands. This summer course is part of a wider summer course program that has been offered since 2004 to over a thousand participants and has been integrated in the admission and application processes of the respective business school (Rienties et al., 2006). The primary aim of this course was to bridge potential gaps in economics knowledge prior to study on a degree program (Rienties, Tempelaar, Dijkstra, Rehm, & Gijselaers, 2008; Tempelaar, Rienties, Giesbers, & Schim van der Loeff, 2012). The online course was delivered over a period of six weeks within which learners were assumed to work for 10-15 hours per week. Participants never met face-to-face before or during the course and

therefore had to learn economics using the CSCL environment exclusively. The CSCL environment included all course background information, literature, and communication tools.

Research shows that participants who successfully completed the summer course were more likely to complete the business schools' first year curriculum (Rienties et al., 2008; Tempelaar et al., 2012).

### 2.1.1 Tasks and discussion themes

The course design was based on principles of Problem-based learning (PBL; Loyens, Kirschner, & Paas, 2011) by letting groups of students collaboratively solve six realistic problems. These problems were constructed to simulate real-world settings but in a semi-structured manner, using a simple-to-complex sequence (Loyens, Kirschner, & Paas, 2011; Segers, van den Bossche, & Teunissen, 2003), whereby the learners themselves could decide their learning actions and future directions. The learning process within PBL is commonly scaffolded according to the so-called 'seven-jump method' (Schmidt, 1983; Segers et al., 2003). That is, the problems serve as the context for new learning, whereby learners' co-construction of knowledge and problem-solving skills is guided by requiring learners to: 1) identify difficult terms; 2) identify the main problem and brainstorm to formulate learning goals; 3) start to solve the learning goals by referring to personal experience, course literature and/or additional literature; 4) elaborate on the findings in the previous step; 5) reach agreement on the answers through discussion, 6) check if all learning goals are answered and; 7) summarize the main points of the entire discussion.

Learners participated in a collaborative learning environment using seven discussion forums. There was one café-forum where learners could get to know each other and share non-task related information. The remaining six forums were task-related, each dedicated to one task. The first two tasks were introductory and addressed basic terminology of economics to get a feel for the domain. For example, the first task focussed on an international student from North-Korea coming to the institute and realising that the way markets function in Western Europe are different, while the second task focussed on explaining a graph of longitudinal Gross Domestic Product growth differences between Europe and the U.S. The following four tasks addressed current

realistic problems within micro-economics (tasks 3-4) and macro-economics (tasks 5-6) which became increasingly complex. The CSCL environment, tasks, course materials, and assessments were identical in all three settings (see below), although the themes of the tasks were updated to reflect the then current debates in economics.

## 2.2 Three Cohorts of Learners

The population in this study was drawn from three design settings of learners in the same course but in different settings. The three design settings that form the context of this study all originated from the principles of ePBL designed with the first implementation of the summer course economics in 2005. That is, the course design was based on the principles of Problem-based learning (PBL; for a recent review of PBL, see Loyens et al., 2011), but in an online setting. Within PBL, the context for new learning is formed by real-world or authentic problems, using a simple-to-complex sequence (Schmidt et al., 2009; Segers et al., 2003). Six problems formed the basis of the course which are collaboratively solved by groups of students, whereby the learners themselves can decide their learning actions and future directions.

### 2.2.1 ePBL design using discussion forums (2005-2006)

This is the initial design of the course where participants discussed task-related and non-task related subjects using the seven discussion forums. An eighth discussion forum entitled 'How does PBL work?' provided an example of a typical discussion process in the form of a replication that was made by tutors.

The discussions were structured using separate threads for each difficult term, learning goal, and summary, which also promoted easy retrieval of information. When writing a post, students could indicate if the post was the start of a new discussion, if it was a question, or an answer. The system allowed the learners to give a 'thumbs up' for a post or indicate they disagreed with its content. When viewing a forum, the aforementioned indicators were depicted as icons behind each post as was the number of ´thumbs up´.

In comparison to a typical application of PBL in face-to-face classroom settings, in ePBL the phases of the traditional seven jump might be less

obvious as learners interacted with the materials and discourse with peers at various times during a week. In other words, in ePBL learners had a large degree of autonomy in the way how, what and when to contribute. (see Rienties, Giesbers, Tempelaar, Lygo-Baker, Segers, & Gijselaers, 2012 for a more elaborate description of the ePBL design).

### 2.2.2 Optima design using discussion forums and additional scaffolding (2007)

The second implementation of the course was a redesign of the first, offering more explicit scaffolding of the various learning process phases, as well as a more explicit articulation and reflection of activities within the various PBL jumps aimed at supporting higher levels of knowledge construction (see Rienties, Giesbers, Tempelaar, Lygo-Baker, Segers, & Gijselaers, 2012) for an elaborate description of the Optima model). For example, specific scaffolds were given by providing a simple schematic overview (Optima card) that showed which part of the discussion and learning process was represented by each of the seven jumps. The process of going through the seven jumps was further scaffolded by additional rules. For example, learners could only proceed to answering a particular learning goal (the third jump) when at least three (25% of group members) learners gave a 'thumbs up' to agree with the formulation and relevance of that learning goal.

### 2.2.3 VC design using web-videoconference and discussion forums (2008-2011)

In the third design, participants used a discussion forum and some of the scaffolds (like the Optima card) that were offered in the previous design. The restrictive rules to follow through the seven-jump process, however, had been abandoned because these were found to have a negative impact on student engagement (Rienties, Giesbers, Tempelaar, Lygo-Baker, Segers, & Gijselaers, 2012). In addition, four web-based web-videoconferences were organised, separately for each group. The first web-videoconference started with a personal introduction by all participants, followed by an explanation of the content and procedures of the course. Afterward, a pre-discussion of the introductory tasks took place. In the second meeting the introductory tasks were post-discussed, and the next tasks were pre-discussed, etc.

During the web-videoconferences, participants could decide which (combination) of the available tools (chat, audio, camera) they would use. No special hardware was needed to hear and see the audio and video from others and to participate in chat, though a headset and/or webcam were needed to share their own audio and/or image. Most recent findings show that the participants in the videoconferences primarily used all tools of audio, video and chat together to communicate with each other (Giesbers, Rienties, Tempelaar, & Gijselaers, 2013). The time between the web-videoconferences was dedicated to self-study. For each task, if learners came up with new learning goals during self-study, they could post and discuss this in the designated discussion forum.

## 2.3 Participants

Participants were selected for the course based on their scores on an entry assessment in economics (see Rienties et al. (2006) for more detail), where students also had to indicate a number of demographics like gender, age, ICT skills and previous e-learning experience. Table 3.1 summarizes the main characteristics for each design setting.

*Table 3.1. Descriptives per design setting*

| | Design Setting | | |
|---|---|---|---|
| | *ePBL* | *Optima* | *Videoconference* |
| Year | 2005 - 2006 | 2007 | 2008 - 2011 |
| *n* Students | 82 | 61 | 274 |
| *n Teams* | 6 | 5 | 23 |
| *M* members | 13.66 | 12.20 | 12.45 |
| Member *range* | 11 - 17 | 10 - 17 | 6 - 23 |
| *M* Age | 19 | 19 | 20 |
| % Female | 45 | 45 | 45 |
| *Mode* ICT skills | Intermediate | Intermediate | Intermediate |
| *n* Previous e-learning experience | 3 | 3 | 14 |

In total, the 34 teams had an average of 12.29 members (SD= 3.47, range = 6-23). The average age was 19.33 (SD = 1.26) years and 45% of the learners were female. The difference in team member range for the VC design was due to two groups: one being smaller after a number of learners dropped out in the beginning of the course, and one being larger after (by exception) a

number of learners was added to the final group in 2011. There were no significant differences in gender, age, ICT skills and previous e-learning experience within and between the design settings.

## 2.4 Instruments

### 2.4.1 Evaluation questionnaire

The Students' Evaluation of Online Remedial Educational Experience (SEOREE) of the summer course economics was used to measure the learning experience of the students (Rienties et al., 2006). This measure has been used in a variety of online courses for prospective Bachelor's and Master's students in The Netherlands. The original questionnaire developed in 2005 consisted of 34 questions on a five-point Likert scale ranging from 1 (totally disagree) to 5 (totally agree). In the initial design of the questionnaire, based upon a literature review and initial pilot of remedial education in 2004, seven key concepts of online learning in a collaborative remedial setting (Rienties, Giesbers, Tempelaar, Lygo-Baker, Segers, & Gijselaers, 2012; Rienties et al., 2009) were identified: appropriateness of assessment; flexibility of course design; relevance of course materials; clarity of goals and tasks; the power of group collaboration; support and instruction by the teacher; and finally, learning satisfaction. For each of these concepts at least two items were constructed. Furthermore, the number of hours spent on the course were measured and a textbox for open comments was included. For both the ePBL cohort and the Optima cohort, the same questionnaire has been implemented. For VC cohort, two items about the entry-test (e.g. "The entry test on the UM website was a good test to show me what I did know and what I did not know") were removed as most participants reacted similarly to this question. The response rates for the ePBL, Optima and VC cohorts were 83%, 77%, and 56%, respectively, leading to (for social sciences and educational science in particular) high average response rate of 64%.

In order to verify the construct validity of the instrument, we first performed an exploratory factor analysis (principal component analysis) with direct oblimin rotation. Kaiser-Meyer-Olkin Measure of sampling adequacy was .869, indicating a stable factor solution, and a significant result on Bartlett's test of Sphericity, $\chi^2(465)= 2933.46$, $p < .001$, indicated that the variables in the

model correlated well with each other. Based upon screeplots and separate factor analyses with 3-7 factors, the best fit both in terms of statistical and theoretical relevance was for a six factor model, explaining a total of 53% of variance.

*Table 3.2. Factor loadings of the SEOREE questionnaire*

| Item | Oblimin rotated factor loadings | | | | | |
|---|---|---|---|---|---|---|
| | 1 | 2 | 3 | 4 | 5 | 6 |
| The contents of the Summer course were inspiring | 0.70 | | | | | |
| The assignments/tasks stimulated me to study | 0.63 | | | | | |
| I am satisfied with what I learned in terms of knowledge, skills and insight | 0.58 | | | | | |
| The digital material motivated me to keep up with the subject matter | 0.57 | | | | | |
| This Summer course offered me a lot | 0.55 | | | | | |
| I think that by attending this Summer course I will get better results in my future study in Maastricht | 0.53 | | | | | |
| Give an overall grade for the quality of the Summer course (1 = very bad - 10 = very good) | 0.44 | | | | | |
| I gained enough knowledge and skills in economics to start with my study in Maastricht | 0.41 | | | | | |
| Collaborating with others facilitated my understanding of the subject matter | | -0.83 | | | | |
| It was fun to collaborate with others in this Summer course | | -0.80 | | | | |
| The assignments/tasks stimulated me to collaborate with the other group | | -0.68 | | | | |
| I think I learned more in this Summer course through collaboration with others than I would have learned if I had to work individually | | -0.67 | | | | |
| The group in which I participated functioned well | | -0.56 | | | | |
| I participated actively in the online group discussions | | -0.40 | | | | 0.45 |
| The Online Summer course team stimulated participation of all group members in the online group discussions | | | 0.68 | | | |
| The Online Summer course-team was enthusiastic in coaching our group | | | 0.63 | | | |
| The Online Summer course team helped us to apply what we had learned on other situations than those mentioned in the assignments/tasks | | | 0.56 | | | |
| I was given the support that I needed | | | 0.54 | | | |
| The Summer course was well organized | | | 0.47 | | | |
| Give an overall grade for the functioning of the Summer course team (1 = very bad - 10 = very good) | | | 0.46 | | | |
| It was clear to me what was expected of me this Summer course | | | | 0.78 | | |
| The goals of the Summer course were clear to me | | | | 0.76 | | |
| It is good that I could attend this Summer course independently (without interference from others) | | | | | 0.71 | |
| I think I was motivated to finish this Summer course because I could work in my own pace | | | | | 0.61 | |
| Learning with an E-book is not different from learning from a hard-copy book | | | | | 0.46 | |
| The Weekly tests (intermediate tests) in this Summer course gave me a good picture of what I still had to study | | | | | | 0.73 |
| The instructions for making the final test were clear | | | | | | 0.59 |
| The internet application used for the tests was easy to work with | | | | | | 0.55 |
| Eigen Value | 8.18 | 2.42 | 1.75 | 1.48 | 1.35 | 1.23 |
| Explained Variance | 26% | 8% | 5% | 5% | 4% | 4% |

As illustrated in Table 3.2, the first eight items all loaded on the first factor, which we label as “Learning experience”. For second factor, which we label as “Group collaboration”, five out of six items tapping the study support scale loaded on the second factor, while the item “I participated actively in the online group discussions” also loaded on factor 6. However, conceptually this item fits better with “Group collaboration”. As was reported by Rienties et al. (2009) and Rienties, Giesbers, Tempelaar, Lygo-Baker, Segers, & Gijselaers, (2012), participants in the ePBL design and Optima design differed significantly in the amount of discourse contribution in terms of messages posted, therefore potentially causing a relatively lower loading of this respective item on “Group collaboration”. Although conceptually CoI researchers might consider relating the six “Group collaboration” items to both cognitive presence and social presence, we opted for keeping the term Group collaboration, as the items address more the learning processes in groups. The third factor can be labelled as “Teacher presence”, as the six items loading on this all referred to the role of the summercourse team (e.g. “The Online Summer course team helped us to apply what we had learned on other situations than those mentioned in the assignments / tasks”). We labelled the fourth factor, which consisted of two items, as “Goals and tasks”. Given the focus on independent learning in the fifth component, and given that our own (Giesbers et al., 2013) and other (Chen & Jang, 2010) research showed that self-determination is a key characteristic of effective online learners, we labelled the fifth factor as “Self-determined learning”. Finally, the last factor, on which three items loaded, was labelled as “Assessment”.

Next, a reliability analysis of the factor analysis solutions was conducted. Cronbach alpha values were .83 for the Learning experience scale (factor 1); .80 for the Group collaboration scale (factor 2); .73 for the Teacher presence scale (factor 3); .72 for the Goals and tasks scale (factor 4); .45 for the Self-determined learning scale (factor 5), and finally .63 for the Assessment scale (factor 6), indicating appropriate reliability, except for self-determined learning. The item “Learning with an E-book is not different from learning from a hard-copy book” loaded highest on this scale, but with a relatively low factor loading (0.46). Conceptually, it doesn’t quite fit this scale nor any of the other scales and it was therefore removed which improved the alpha score for Self-determined learning to .61.

# 3. Results

## 3.1 Descriptive Statistics

Figure 3.1 shows the average scores on the six subscales for the seven years of implementation of the online summer course economics. First of all, most participants in all three design settings indicated to be satisfied about the overall learning experience. That is, taking a cut-off value of 3.5 as representing a good learning experience, 86% of the participants were positive about the teacher presence, 79% had a positive learning experience, 74% were positive about the difficulty of the assessment, 71% were positive about the clarity of goals and tasks, 61% were positive about the opportunity to self-determine their learning, and finally 48% of the participants were positive about group collaboration. These results in general give the impression that most participants were overall satisfied about the course, although only half of the participants were satisfied about the functioning of their group. With the exception for the scores on group collaboration in the Optima design, and both the 2008 and 2010 implementations of the VC design, all average values are above 3.5 in Figure 3.1.

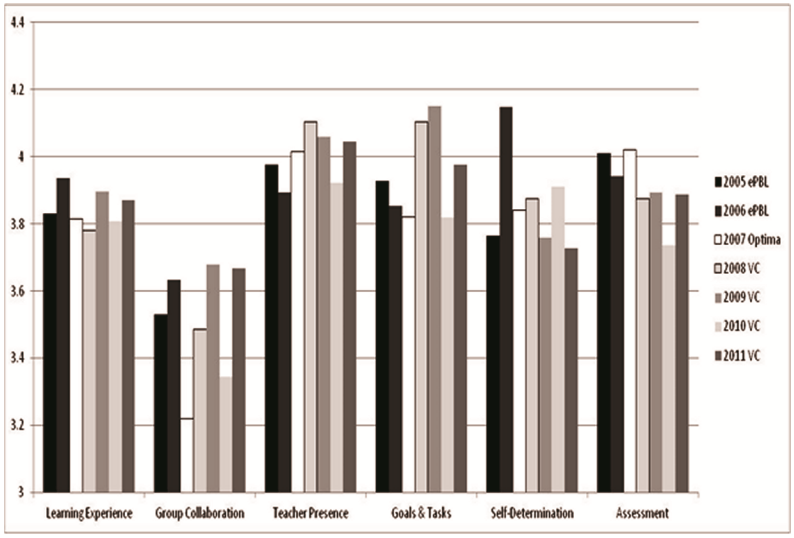


*Figure 3.1. Average SEOREE scores across the seven years of summer course implementation*

In order to be able to aggregate the SEOREE scores per design condition, we first verified whether the scores within each design condition were similar. With respect to the ePBL design setting, an independent sample t-test showed a significant difference for the self-determination scale only, $t(66) = -2.324$, $p < .05$, which was higher for participants participating in 2006 ($M = 4.15$, $SD = .58$) compared to 2005 ($M = 3.76$, $SD = .76$). All other scores on the five factors were similar in both years. With respect to the four years of the VC design setting, no significant differences were found using ANOVA at a 5% confidence level. At a more liberal confidence interval of 10%, group collaboration, $F(3, 152) = 2.26$, $p < .10$, and goals and tasks, $F(3, 152) = 2.28$, $p < .10$, showed a marginally significant difference across the four years of VC implementation. This seemed to be primarily due to a relatively lower score in 2010, which was confirmed by post-hoc tests showing a significant difference between VC design 2009 and 2010 for group collaboration and between VC design 2010 and 2008 and VC design 2010 and 2009 for goals and tasks. Overall, we think that for both the ePBL and the VC condition there are no overwhelming arguments not to aggregate the data for their respective cohort.

## 3.2 Comparison of ePBL Design vs. VC Design

In Table 3.3 the scores of the SEOREE across the three designs are illustrated. An ANOVA showed no significant differences across the three designs, with the exception of the group collaboration scale, $F(2, 267) = 5.28$, $p < .05$, of which post-hoc tests showed it was significantly lower in the Optima condition. Given that the number of participants in the VC design was substantially higher than the other two conditions, we checked whether it was possible to aggregate the data of the ePBL design with the data of the Optima design as in both only discussion forums were used. Except for lower group collaboration scores for the Optima design ($n = 47$, $M = 3.23$, $SD = .64$) compared to ePBL design ($n = 68$, $M = 3.58$, $SD = .66$), $t(113) = 2.92$, $p < .05$, an independent sample t-test showed no differences in the SEOREE scores between both designs. Therefore, we merged the two discussion forum scores together in order to create two cohorts (i.e. of discussion forums only and of videoconferencing combined with discussion forums) that were more comparable in size. Independent samples t-test results are shown in Table 3.4. In contrast to our expectations, we did not find any significant difference in

SEOREE scores between the designs using discussion forums and the VC design on learning experience, group collaboration, teacher presence, and self-determination. A notable exception is that participants in discussion forums condition were less positive about the clarity of goals and tasks of the module, $t(266) = -2.15$, $p < .05$, thereby providing support for our fourth hypothesis (learners using discussion forums only are expected to be less satisfied about the clarity of goals and tasks than learners using web-videoconference in addition). In other words, participants using tools with a low social presence, that is, discussion forums, indicated to be equally satisfied about their learning experience as participants who used web-videoconferencing. Thereby, we did not find confirmation for our first, second, third, fifth, and sixth hypothesis.

*Table 3.3. Comparison of SEOREE scores between ePBL design, Optima design and VC design*

| | Design | | | | | | |
|---|---|---|---|---|---|---|---|
| | ePBL | | Optima | | VC | | |
| | *M* | *SD* | *M* | *SD* | *M* | *SD* | *F value* |
| Learning Experience | 3.88 | 0.49 | 3.81 | 0.56 | 3.84 | 0.53 | 0.28 |
| Group Collaboration | 3.58 | 0.66 | 3.22 | 0.64 | 3.54 | 0.64 | 5.29** |
| Teacher Presence | 3.94 | 0.43 | 4.01 | 0.49 | 4.04 | 0.49 | 1.18 |
| Goals & Tasks | 3.89 | 0.71 | 3.82 | 0.79 | 4.04 | 0.61 | 2.46† |
| Self-Determination | 3.96 | 0.70 | 3.84 | 0.79 | 3.82 | 0.79 | 0.72 |
| Assessment | 3.98 | 0.59 | 4.02 | 0.57 | 3.85 | 0.67 | 1.70 |

ANOVA F-Test for participants in the ePBL (n=68), Optima (n=47), and VC condition (n=152).
**Coefficient is significant at the 0.01 level (2-tailed).
†Coefficient is significant at 0.10 level (2-tailed).

*Table 3.4. Comparison of SEOREE scores between discussion forums design and VC design*

| | Design | | | | |
|---|---|---|---|---|---|
| | Forums | | VC | | |
| | *M* | *SD* | *M* | *SD* | *t value* |
| Learning Experience | 3.85 | 0.52 | 3.84 | 0.53 | 0.27 |
| Group Collaboration | 3.43 | 0.67 | 3.54 | 0.64 | -1.38 |
| Teacher Presence | 3.97 | 0.46 | 4.04 | 0.49 | -1.26 |
| Goals & Tasks | 3.86 | 0.74 | 4.04 | 0.61 | -2.15* |
| Self-Determination | 3.91 | 0.74 | 3.82 | 0.79 | 0.90 |
| Assessment | 3.99 | 0.58 | 3.85 | 0.67 | 1.80† |

Independent sample T- test of participants in discussion forum (n=115) and VC condition (n=152).
*Coefficient is significant at the 0.05 level (2-tailed).
†Coefficient is significant at 0.10 level (2-tailed).

### 3.3 Student Pass Rate

Finally, the pass rate of students participating in the discussion forums design was 55%, while the pass rate of students participating in the VC design was 41%, which was significantly lower, $\chi^2(1) = 6.86$, $p < .05$. Thus, as this result is opposite to our expectations, we have to reject our seventh hypothesis (successful completion rates of the online module are expected to be lower for learners using discussion forums only compared to learners using web-videoconferencing in addition). Participants who failed the summer course reported significantly lower on all the six factors of SEOREE (all $p < .05$), irrespective whether they participated in the discussion forums or VC design (not illustrated). A follow-up independent samples t-test of students who failed the course showed that students in the discussion forums condition scored almost identical as students in the VC condition, although students in the discussion forum condition scored marginally lower on the group collaboration scale, $t(92)= -1.74$, $p < .10$. Similarly, students who passed the course in the discussion forums design had similar SEOREE scores to students in the VC design, except for higher scores on the self-determined learning scale, $t(172) = 2.06$, $p < .05$, and marginally higher scores on the assessment scale, $t(172) = 1.68$, $p < .10$.

## 4. Discussion

In this quasi-experimental study of 418 students across seven years of implementation of an online distance program in economics, we found that using technologies that some research associates with a higher level of social presence in a Community of Inquiry was not consistent with more favourable student reports on their learning experience, and improved student performance (i.e. pass rates). This finding is in contrast to our initial expectations and argumentations that enhancing the abilities of learners to project their personal characteristics in an online community would lead to more engagement and interaction, which in turn was expected to positively influence learning. Furthermore, the significantly lower pass rate in the VC design, which was 14 percentage points lower than in the discussion forum condition, is further evidence that not all learners were able to effectively learn in a setting that (in theory) affords the development of social presence,

which in turn is thought to lead to improved student performance (include if you can establish this above as a possible causal linkage). In all four summers where web-videoconferencing was implemented, the pass rates were significantly lower than the initial (ePBL) discussion forum condition, thereby strengthening our findings that fewer students were able to complete (and thus pass for) the course when collaborating with web-videoconferencing tools in addition to asynchronous discussion forums.

These two findings are surprising, as many researchers in CSCL would argue that the affordances of synchronous tools to establish social presence (Hrastinski et al., 2010; Rummel & Spada, 2005; Strømsø et al., 2007) would lead to an improved and more authentic learning experience. One possible explanation for the similar learning experiences and lower learning outcomes in the VC design may be that the degree to which students actually used ICT tools was (in part) determined by the interaction amongst participants. For example, the fact that most people in a group choose to use webcam and audio may have influenced others to do the same. As argued by Rogers and Lea (2005), even in settings using only asynchronous communication tools affording low social presence, when learners are able to develop a shared group identity, they can establish and build a powerful learning experience. The similarity between the ePBL design and the VC design on the group collaboration scale points in the direction that a shared group identity was not facilitated by offering web-videoconferences.

A second explanation may be that the success of using a technology is strongly related to the learners' acceptance of technology. For example, in the Technology Acceptance Model (Davis, 1989) the use of a tool is directly preceded by the intention to perform this behaviour. In turn, the ease of use and the perceived usefulness determine the intention to use technology. Most likely, the majority of the 418 students were familiar with discussion forums and other asynchronous online communication means, as for example the Facebook 'wall'. However, most students indicated in the intake survey to have limited e-learning experience, and to perceive themselves as having intermediate ICT skills. Perhaps the perceived ease of using audiovisual technology (i.e. a headset and/or webcam) and the perceived usefulness of meeting fellow-participants in the web-videoconferences might have

discouraged some participants who were less confident about their technological expertise, their ability to engage actively to synchronous cognitive discourse or the purpose of the web-videoconferences in general. Preliminary findings of the usage of specific web-videoconferencing tools (chat, audio, video) used during the first two years of the VC design point in this direction as a sharp drop in participation after the first web-videoconference was found (Giesbers et al., 2013), in particular for students who were not using the full range of available tools. Offering an extra amount of rich communication tools may have drawn students' attention away from the content toward the workings of the technology. However, experiences from the tutors show technical distraction was minimal and technology related comments from students in the discussion forums showed the same.

Third, another factor that may have had an influence is brought forward by the work of Wegge (2006), who found that seeing one's own image in videoconferencing relates to individual emotional dispositions and can decrease performance. As there is no quantitative nor qualitative data available on this issue, we can only speculate that such mechanism has had an influence on the participation and pass rate in our setting. Yet, it remains an interesting angle that should be addressed in future research on the use of web-videoconferencing.

A fourth possible explanation may be related to the degree to which a learning environment provides an appropriate balance between autonomy and structure (Rienties et al., 2009). Students in the VC design who successfully passed the module were less satisfied about their ability to self-determine their own learning. That is, a strong advantage of discussion forums is that learners can interact at a time and place of their convenience (Chen & Jang, 2010; Järvelä et al., 2008; Rienties et al., 2009), while participants in the VC design were expected to be present online at a particular time for four times. Although this time was determined and agreed upon by all participants in the group (rather than by a teacher setting a time), participants who were unable to join the next web-videoconference may have felt less involved in the learning process.

## 4.1 Limitations

The results of this study are based on a seven year consecutive implementation of an online summer course in economics, using quasi-experimental research methods. A limitation of this study is that we did not measure the interactions between individual and mutual conceptions, emotions and shared regulation among participants (Giesbers et al., 2013), or explored how the actual learning processes and contributions to cognitive presence and social presence in the various discussion forums and web-videoconferences developed over time. However, a particular merit of this research is that we were able to consecutively implement the three designs over a total of seven years. As our findings were consistently replicated in all designs across the years of implementation, and we did not find any differences amongst participants in the three designs in terms of demographic characteristics, ICT and e-learning experience, we feel that there is a clear indication that in our context increasing social presence in the form of web-videoconference does not automatically lead to more satisfied students.

## 4.2 Future Research

Future research should investigate how web-videoconferencing can be better integrated into the design of distance education in general and online forms of PBL in particular. At the same time, we recommend researchers to analyse how learners mutually influence each other in synchronous collaborative e-learning. More specifically, the influence of using synchronous and asynchronous communication on team identity should be taken into account as well as how individual characteristics like the type of motivation and the degree of self-determination and technology-acceptance of a learner influences the behaviour of other learners.

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# Part II

# A Dynamic View of Students' Usage Behaviour of Synchronous and Asynchronous Communication Tools in CSCL, and the Influence of Motivation thereon

# Chapter 4

# Investigating the Relations between Motivation, Tool Use, Participation, and Performance in an E-learning Course Using Web-videoconferencing*

Web-videoconference systems offer several tools (like chat, audio, and webcam) that vary in the amount and type of information learners can share with each other and the teacher. It has been proposed that tools fostering more direct social interaction and feedback amongst learners and teachers would foster higher levels of engagement. If so, one would expect that the richer the tools used, the higher the levels of learner engagement. However, the actual use of tools and contributions to interactions in the learning situation may relate to students' motivation. Therefore, we investigated the relationship between available tools used, student motivation, participation, and performance on a final exam in an online course in economics (N = 110). In line with our assumptions, we found some support for the expected association between autonomous motivation and participation in web-videoconferences as well as between autonomous motivation and the grade on the final exam. Students' tool use and participation were significantly correlated with each other and with exam scores, but participation appeared to be a stronger predictor of the final exam score than tool use. This study adds to the knowledge base needed to develop guidelines on how synchronous communication in e-learning can be used.

## 1. Introduction

E-learning tools become increasingly rich, and offer more opportunities for synchronous communication resembling face-to-face situations. For instance, web-videoconference tools like Skype or Adobe Connect facilitate real-time communication through audio, video, chat. A particular feature of web-videoconferencing is that users can actively determine and decide whether to use audio, voice, chat, and video tools (Garcia, Uria, Granda, & Suarez, 2007), which is substantially different from earlier tools like discussion forums, where users were restricted to a single (text-based) functionality. It

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has further been proposed that tools that foster more direct social interaction and feedback amongst learners and teachers would foster higher levels of learner engagement (Carr, Cox, Eden, & Hanslo, 2004; Hrastinski, Keller, & Carlsson, 2010; Strømsø, Grøttum, & Lycke, 2007). An elaborate meta-analysis of interaction types in distance education (Bernard et al., 2009) showed that increasing either one of three interaction types (i.e. student– student, student–content, or student–teacher) increases learner engagement (see also Anderson, 2003). So, if tools foster interaction and interaction fosters engagement, one would expect that the richer the available tools are, the higher the levels of learner engagement. However, research has also suggested that it is the actual use of tools and the resulting interactions in the learning situation which are related to students' motivation (Roca & Gagné, 2008; Sørebø, Halvari, Gulli, & Kristiansen, 2009). Therefore, we investigated the relationship between available tools used, student motivation, participation, and performance on a final exam, in the context of a distance education program in economics for prospective university students. Because participation was voluntary, this context offers a unique possibility for studying the role of student motivation and student engagement (defined here as the extent of tool use and participation). This may foster our understanding of how different types of learners engage and interact with available tools, and may ultimately contribute to guidelines for optimizing synchronous e-learning.

## 1.1 Technology Acceptance and Motivation

One factor that is considered pivotal in the degree to which studentswill use ICT tools is their acceptance of technology. The Technology Acceptance Model (Davis, 1989) is a commonly used model, and aims to predict the intention to use ICT. TAM is founded on the well-established Theory of Planned Behaviour (Ajzen, 1991), which explains human behaviour by stating that it is directly preceded by the *intention* to perform this behaviour. Intention, in turn, is influenced by three factors: personal beliefs about one's own behaviour, ones norms, and the amount of behavioural control one has. Building on this theory, TAM states that the intention to use ICT is influenced by two main factors: the perceived usefulness (the extent to which a person believes the use of ICT will, for example, enhance his or her performance on a course) and the perceived ease of use (the perceived effort it would take to use a particular

communication tool like a webcam). Furthermore, research has shown motivation to be a key mediator for behavioural intention to use ICT (Davis, Bagozzi, & Warshaw, 1992; Venkatesh, Morris, Davis, & Davis, 2003).

Only recently has the link between technology acceptance and motivation been made in the domain of e-learning, more specifically in computer-supported collaborative learning (CSCL; Roca & Gagné, 2008; Sørebø et al., 2009), by linking TAM with selfdetermination theory (SDT; Deci & Ryan, 1985, 2002). Selfdetermination, which is understood as the extent to which learning is perceived to be self-steered and autonomous, has been found to be a dominant factor that influences learning behaviour in various settings, including in e learning settings (Chen & Jang, 2010; Rienties, Tempelaar, Van den Bossche, Gijselaers, & Segers, 2009). Self-determination is strongly related to motivation (Vallerand, 1997), or in terms of SDT ''is specifically framed in terms of social and environmental factors that facilitate versus undermine intrinsic motivation'' (Ryan & Deci, 2000, p. 58). Intrinsically motivated learners are also referred to as 'autonomous', as they typically engage in learning because they find it enjoyable or challenging and they have an internally focused locus of causality (Black & Deci, 2000). Extrinsically motivated learners are referred to as 'control oriented', as they feel they have limited control over their learning process.

According to SDT, motivation is not a dichotomous construct where students either have an intrinsically or extrinsically directed drive (Deci & Ryan, 1985). Instead, extrinsic motivation is perceived as a continuum of types differing in how close they are to intrinsic motivation and vice versa. Self-determination has been shown to explain differences in amount and quality of students' e-learning activities (Chen, 2010; Martens, Gulikers, & Bastiaens, 2004; Rienties et al., 2009). For example, Martens et al. (2004) showed higher activity levels in online tasks when students were more intrinsically motivated. In addition, the quality of contributions to discussion forums in online courses have been found to be higher for more intrinsically motivated students (e.g. Rienties et al., 2009).

SDT states that motivation and well-being are determined by the extent to which three basic needs are satisfied: the need for autonomy (i.e. the extent to which a learner feels in control), the need for relatedness (i.e. the extent to

which a learner feels included), and the need for competency (i.e. the extent to which a learner feels competent with respect to tasks and learning activities). All three needs are affected by contextual factors, like the interaction between learners, teachers, and the learning material (Deci & Ryan, 2000). Because of the nature of e-learning, processes such as monitoring classroom activity, providing timely feedback, and fostering students' sense of competence, autonomy, and relatedness are different from face-to-face education (Chen & Jang, 2010). However, research in face-to-face education showed that offering autonomy support and structure profoundly influence student engagement (Guay, Ratelle, & Chanal, 2008; Jang & Deci, 2010), and similar results have been found in e-learning (Chen & Jang, 2010; Rienties et al., 2012).

Using synchronous communication in e-learning, especially with more advanced tools such as videoconferencing, may help to limit delays in monitoring activity and may positively affect the sense of competency (e.g. by providing timely content related feedback by both students and tutors), the sense of relatedness (e.g. by making contact moments and feedback more direct and personal), and the sense of autonomy (i.e. by providing timely process related feedback). Indeed, combining SDT and TAM in research on e-learning, Roca and Gagné (2008) found that an increase in perceived autonomy support, perceived competence, and relatedness positively influenced users' motivation to use ICT. Furthermore, findings by Sørebø et al. (2009) suggest that the use of e-learning tools is a reciprocal process between learner and technology, which can fortify both intrinsic and extrinsic motivation, leading to a repeated refinement of learners' motivation to continue their engagement. In sum, combining SDT and TAM in CSCL research has been shown to offer a better framework for understanding the use of technology in e-learning compared to each of the theories separately.

A(nother) critical gap that has been identified in research on technology acceptance is that most studies are based on the assumption that intention to use ICT tools is directly linked to actual usage behaviour (Bagozzi, 2007). For example, according to TAM, if students in an e-learning course that incorporates a combination of discussion forums and web videoconferences would find the web-videoconference system easy to use and the web-videoconferences useful, they will be more inclined to participate in the web-videoconference meetings. Bagozzi (2007) stated, however, that there is not

necessarily a one-to-one relationship between intention and actual use, and therefore more research is desired on actual usage behaviour and how that is related to motivation. Especially in facultative settings, students may find a webvideoconference useful, but they may still choose against participating due to competing activities, such as work, family or leisure (see Bernard et al., 2004; Marks, Sibley, & Arbaugh, 2005). So the question is what role motivation plays in actual participation and actual tool use during participation. Therefore, the present study investigated the link between observed student behaviour (i.e. how often students participate and what tools they use), motivation, and performance on a final exam in the context of a facultative course.

## 1.2 The Present Study

Previous research has already shown that the combination of the theoretical frameworks of SDT and TAM was useful for explaining the relation between motivation and the intention to continue e-learning usage, but without specifying if the e-learning context used synchronous or asynchronous communication (e.g. Roca & Gagné, 2008; Sørebø et al., 2009). The present study uses the combination of those theories as a starting point to address the actual usage of synchronous tools. The model depicted in Fig. 4.1 shows the variables in this study and their assumed relations.

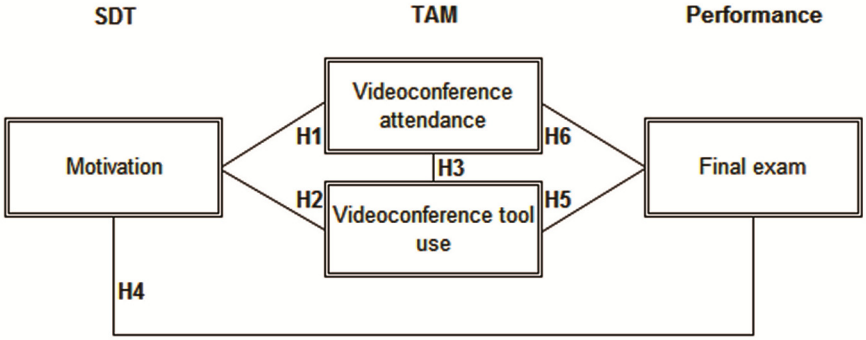


*Figure 4.1. Research model*

Regarding the relation between the level of motivation and the actual use of web-videoconference, two hypotheses can be stated building on the findings by Davis et al. (1992), and Roca and Gagné (2008) about the

relationship between motivation (SDT) and the intention to use ICT (TAM): first, it can be hypothesized that higher levels of autonomous motivation would be associated with higher participation in web-videoconferences (H1), and secondly, that higher levels of autonomous motivation would be associated with the use of richer communication tools when taking part in a webvideoconference (H2).

Regarding the relationship between the two technology related variables, based on the findings that successful experiences using ICT lead to a higher intention to continue the use of ICT (Roca & Gagné, 2008) it can be hypothesized that taking part in more web-videoconferences would be associated with the use of richer communication tools (H3).

Research on motivation has shown a strong relation between intrinsic motivation, enhanced learning, and performance (Benware & Deci, 1984; Deci & Ryan, 2000; Grolnick & Ryan, 1987), which has been confirmed in online settings (Guay et al., 2008; Keller & Suzuki, 2004). Thus, it can be hypothesized that higher levels of autonomous motivation would be associated with higher scores on the final exam (H4).

As mentioned above, synchronous communication with rich tools may offer a powerful way to provide autonomy support and structure and it may help to increase the sense of perceived autonomy, perceived competence, and perceived relatedness (e.g. when using text in a chat tool in combination with audio-visual information such as voice intonation and facial expression, information is transferred in a way that is more supportive for understanding compared to using chat only; Hrastinski et al., 2010). Therefore, it is hypothesized that the use of richer communication tools would be associated with higher scores on the final exam (H5), and that participation in more web-videoconferences would be associated with higher scores on the final exam (H6).

# 2. Method

## 2.1 Participants and Design

Participants were students in a facultative summer course in economics for prospective Bachelor students of an International Business degree programme at a Dutch business school, which was offered entirely online and

aimed to bridge potential gaps in prior knowledge of economics. This summer course is part of a wider summer course program that has been offered since 2004 to over a thousand students and has been fully integrated in the admission and application processes of the respective business school (see Rienties, Tempelaar, Waterval, Rehm, & Gijselaers, 2006; Rienties et al., 2009, 2012). Participants who successfully completed the summer course have been found to be more likely to successfully complete the first year of the Bachelor program (Rienties, Tempelaar, Dijkstra, & Gijselaers, 2008; Tempelaar et al., 2012). All students who subscribed to the Bachelor program were informed of the possibility to participate in this course via a letter with information about the course and a link to a prior knowledge test. Based on their score on the prior knowledge test, students could decide to voluntarily enrol. Students with a low prior knowledge score who did not enrol received a follow-up e-mail recommending enrolment. The prior knowledge test was used for enrolment purposes only, and as the majority of students in the course had a low level of prior knowledge, it was not taken into account in the remainder of this study.

After enrolment, students were assigned to a small group and could communicate online via discussion forums and via four web-videoconferences (more information about the course is provided in Section 2.2). Participants in this study came from two consecutive years of the course (N = 155). Based on the score on a demographic entry questionnaire, we could ascertain there were no significant differences in gender, age, ICT skills and previous e-learning experience between participants in each year. The total number of groups was 11 (M group size = 10; range = 6–16). Forty-five students who did enrol failed to fill out the motivation questionnaire or had too many missing data on that questionnaire; as a consequence, only 110 students were included in this study (M age = 19.5; SD = 1.28; 39% female).

## 2.2 Materials and Procedure

### 2.2.1 Online preparatory course

The course design was based on principles of Problem-Based Learning (PBL, for a recent review of PBL, see Loyens, Kirschner, & Paas, 2011) by letting groups of students collaboratively solve six authentic problems: two introduction tasks addressing basic economic concepts, two tasks about micro-

economics, and two tasks about macro-economics. The web-videoconference process was structured in a manner similar to the face-to-face courses in the Business degree programme, according to the PBL Seven-Jump model (see Schmidt & Moust, 2000; Segers, Van den Bossche, & Teunissen, 2003). The original model was adapted slightly to accommodate the online setting (Rienties et al., 2009, 2012), and required students to: (1) identify difficult terms; (2) identify the main problem(s) and brainstorm to formulate learning goals; (3) start to solve the learning goals by referring to personal experience, course literature and/or additional literature; (4) elaborate on the findings in the previous step; (5) reach agreement on the answers through discussion, (6) check if all learning goals are answered and; (7) summarize the main points of the entire discussion. This process is guided by a tutor. The course ran for a maximum of 6 weeks and had an estimated study load of 10–15 h per week. In the first 4 weeks, there were weekly web-videoconferences, in which participation was voluntary but encouraged by asking the tutor for a rating of each student's contributions which counted as 10% of that student's final grade for the course (not to be confused with their final test score used in this study).

At least 5 days before the first web-videoconference, students received a personal e-mail with instructions on how to set up their account and a request to test the web-videoconference facilities. They were instructed to contact the tutor if they experienced problems with this so s/he could assist in setting them up properly prior to the start of the course. Finally, they were instructed to be online on the day and time of the first web-videoconference.

The first web-videoconference started with a personal introduction by all participants, followed by an explanation of the content and procedures of the course. The second part consisted of a prediscussion (Seven-Jump steps 1–3) of the introductory tasks. In the second meeting the introductory tasks were post-discussed (Seven-Jump steps 4–7), followed by a pre-discussion of the micro- economics tasks; in the third meeting the post-discussion of those tasks took place, with a pre-discussion of the macro-economics tasks; and in the fourth meeting those were post-discussed. Some groups deviated a little from this schedule when they did not keep up with the study pace.

The time between the web-videoconferences was dedicated to self-study. For each task, if learners came up with new learning goals during self-study, a

dedicated discussion forum was available where they could post and discuss their learning goals. Also, after the videoconference, students could continue their postdiscussions of the task in the respective discussion forum. For the present study only participation and tool use during the videoconference was of interest (note though, that when students did not participate in the web-videoconferences, they tended not to use the discussion forum either). During the videoconferences, students could decide which (combination) of the available tools they would use (chat, audio, camera). No special hardware was needed to hear and see the audio and video from others and to participate in chat. Students could use a headset and/or webcam to share their own audio and image. With permission from the students, all web-videoconferences were recorded. These recordings could be watched by group members, which allowed students who had been unable to attend a particular videoconference to catch up with the key discussion points, but this option was only seldom used. More importantly, based on these recordings, students' tool use could be established.

The course environment further provided an e-book and articles, and students were encouraged to search for and use additional information sources (see also Giesbers, Rienties, Gijselaers, Segers, & Tempelaar, 2009).

### 2.2.2 Final exam

After the fourth week, a final exam that addressed all topics encountered in the course was made available online. It consisted of 20 multiple choice items and one open item and could be taken on a voluntary basis (which 50 participants, 45.5%, did).

### 2.2.3 Academic motivation scale

Students' motivation was measured at the start of the course using the Academic Motivation Scale (AMS; Vallerand & Bisonnette, 1992), which is based on SDT (Deci & Ryan, 1985, 2002). The AMS consists of 28 items on a 7-point Likert scale divided into seven subscales. Three subscales concern intrinsic motivation: (1) motivation to know (IMTK, learning driven by the need to understand something new, Cronbach $\alpha = .82$); (2) motivation to accomplish (IMTA, learning driven by the need to accomplish something, Cronbach $\alpha = .77$); (3) motivation to experience stimulation (IMES, learning driven by the

need to experience stimulations, Cronbach α = .81). Three subscales concern extrinsic motivation and display a range on the continuum of selfdetermined behaviour from (1) identified regulation (EMID, which is closest to intrinsic motivation, Cronbach α = .60), (2) introjected regulation (EMIN, Cronbach α = .83) to (3) externally regulated learning (EMER, where learning is steered through external means such as rewards, Cronbach α = .85). The final scale concerns amotivation (AMOT, Cronbach α = .81) or the absence of regulation that can be directed either external or internal. The reliability as reflected by Cronbach α scores is in line with previous studies (Fairchild, Horst, Finney, & Barron, 2005; Vallerand & Bisonnette, 1992; Vallerand & Pelletier, 1993).

## 2.3 Data Scoring

On the final exam, students could obtain a score ranging from 0 (lowest) to 10 (highest). Based on the recordings of the videoconferences, two variables were created to measure the extent of tool use and participation in the videoconferences. The number of videoconferences a student participated in was scored (range: 0–4) to obtain a 'participation' score.

To the best of our knowledge, there are no studies available that offer a categorization of tool use in online synchronous communication. We therefore based the categorization of tool usage on the generally accepted distinction in communication medium richness between visual, verbal (spoken, auditive), and symbolic (written) information (Daft & Lengel, 1986; Dennis, Fuller, & Valacich, 2008). Each student's tool use in a videoconference was scored as: 1 (chat only); 2 (audio and chat); 3 (webcam and chat), or 4 (webcam, audio, and chat). The tool use scores were then summed over the four web-videoconferences, which creates a 'total tool use' score; however, that score is confounded with participation. To get a score that did not depend on participation, the sum was divided by the number of times a student participated to obtain an 'average tool use' score (i.e. if a student participated only once, with all tools, s/he would have a score of 4, and if a student participated all four times with all tools, s/he would also have a score of 4). So, the higher this average tool use score, the more complete set of tools a student used during participation regardless of the number of times s/he participated.

# 3. Results

We will first provide some relevant descriptive data before testing the hypotheses. Fig. 4.2 shows the amount of participation and use of communication tools during the four web videoconferences. From the total of 110 participants, 18 never attended a web-videoconference; 27 attended once; 27 attended twice; 16 attended three times and 22 students attended all four videoconferences. Because there is a limited amount of groups and because each group was relatively small, effects nearing significance (i.e. a significance level of $p < .1$) will also be mentioned.

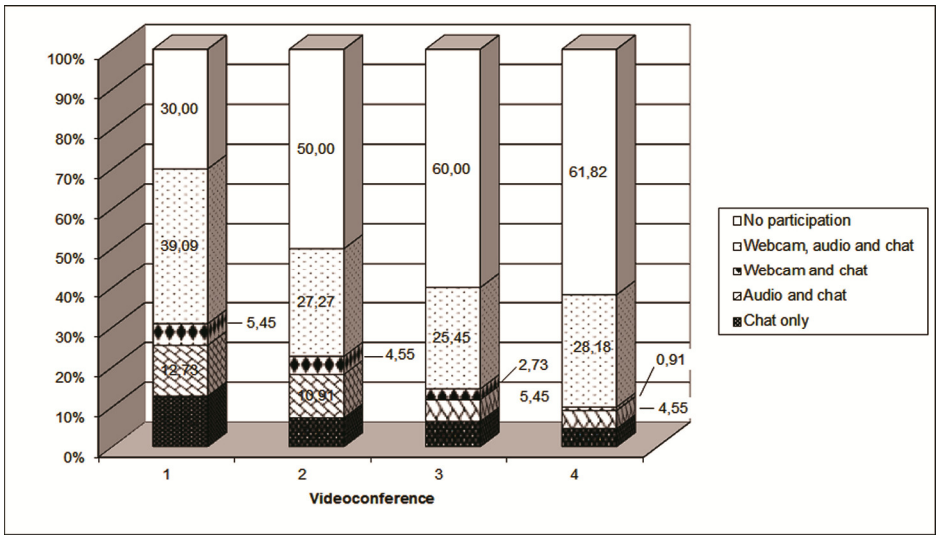


*Figure 4.2. Tool use as percentage of total participation per web-videoconference*

The first web-videoconference was attended by 70% (n = 87) participants. Most participants present used all communication tools; a little over 12% chose not to share visual information with the rest of the group but did use audio and chat; the same amount of participants chose to use chat only, and a minority of 5% combined the use of webcam with chat but did not participate by using audio. Over time, participation rates decreased, but interestingly, the percentage of participants using webcam, audio, and chat remained almost the same. An additional look at the continuity of tool use shows that from the students who participated all four times, 30% consistently used webcam, audio, and chat and 60% used it three out of four times. In all web-

videoconferences, all participating students communicated; only one student consistently used chat and one used chat only in three web-videoconferences plus chat in combination with webcam once.

Table 4.1 shows the correlations between the variables in our research model (displaying Spearman correlation coefficients because of the use of both continuous and categorical variables). Two subscales of the AMS related to intrinsic motivation (IMTK and IMTA) show significant positive correlations with number of webvideoconferences participated, as well as with the final test score. This suggests that intrinsic motivation was positively related to the choice to participate in a web-videoconference. The average tool use, however, did not correlate significantly with any of the independent motivation subscales. In addition, there was a high significant correlation between the number of web videoconferences participated in and the final exam score. Also, the average tool use correlated significantly with the final exam score.

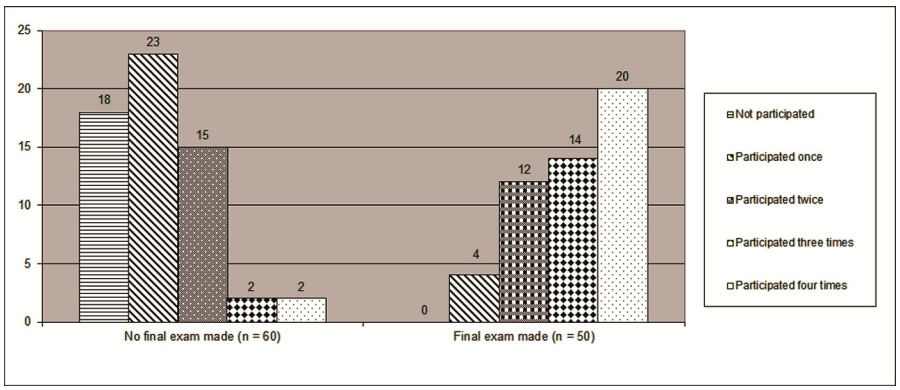


*Figure 4.3. Number of participation compared for dropout versus non-dropout*

Finally, 55% of the participants (n = 60) did not take the final exam. This group contains both students who did not participate in any of the videoconferences and students who did participate once or more (see Figure 4.3). An independent samples t-test shows a significant difference at the .1 level of significance only on the scores of the AMS intrinsic motivation to accomplish (IMTA) subscale between students who did not take the final exam ($M = 4.77$, $SD = .99$) and students who did ($M = 5.11$, $SD = 1.07$), $t(108) = 1.71$, $p < .1$).

*Table 4.1. Spearman intercorrelations between the variables in the research model*

| | Mean | SD | IMTK | IMTA | IMES | EMID | EMIN | EMER | AMOT | NumPart | Tool Average | Final test grade |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Intrinsic Motivation To Know | 5.65 | 0.95 | – | | | | | | | | | |
| Intrinsic Motivation To Accomplish | 4.92 | 1.04 | 0.60** | – | | | | | | | | |
| Intrinsic Motivation to Experience Stimulation | 4.35 | 1.16 | 0.66** | 0.56** | – | | | | | | | |
| Extrinsic Motivation IDentified | 5.95 | 0.80 | 0.30** | 0.35** | 0.29** | – | | | | | | |
| Extrinsic Motivation INtrojection | 4.61 | 1.36 | -0.33 | 0.39** | 0.03 | 0.11 | – | | | | | |
| Extrinsic Motivation External Regulation | 5.60 | 1.09 | -0.10 | 0.20* | -0.17 | 0.35** | 0.42** | – | | | | |
| AMOTivation | 1.29 | 0.57 | -0.24* | -0.17 | -0.11 | -0.23* | 0.00 | -0.07 | – | | | |
| Number of web-videoconference participated | 1.97 | 1.36 | 0.27** | 0.31** | 0.14 | 0.08 | 0.07 | 0.09 | -0.07 | – | | |
| Average tooluse | 2.53 | 1.47 | 0.07 | 0.14 | 0.02 | 0.04 | 0.10 | 0.17 | -0.12 | 0.53** | – | |
| Final exam grade | 3.41 | 3.84 | 0.19* | 0.26** | 0.09 | -0.01 | -0.02 | 0.03 | 0.04 | 0.67** | 0.31** | – |

N=110, * $p < 0.05$; ** $p < 0.01$

*Table 4.2. Mean and SD scores for AMS scales and Final exam grade per number of times participated in a web-videoconference*

| | Number of times participated | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | 0 (n=18) | | 1 (n=27) | | 2 (n=27) | | 3 (n=16) | | 4 (n=22) | | |
| | M | SD | M | SD | M | SD | M | SD | M | SD | F |
| *AMS subscale* | | | | | | | | | | | |
| IMTK | 5.40 | 0.94 | 5.53 | 0.57 | 5.56 | 1.36 | 5.83 | 0.92 | 5.98 | 0.65 | 1.28 |
| IMTA | 4.69 | 1.02 | 4.60 | 0.94 | 4.82 | 1.31 | 5.20 | 0.81 | 5.40 | 0.77 | 2.55* |
| IMES | 4.25 | 1.23 | 4.14 | 0.98 | 4.37 | 1.34 | 4.16 | 1.17 | 4.78 | 1.05 | 1.14 |
| EMID | 5.58 | 1.29 | 6.08 | 0.58 | 5.95 | 0.75 | 5.89 | 0.61 | 6.13 | 0.64 | 1.45 |
| EMIN | 4.58 | 1.50 | 4.63 | 1.37 | 4.20 | 1.47 | 4.83 | 0.89 | 4.94 | 1.36 | 1.04 |
| EMER | 5.18 | 1.56 | 5.69 | 0.95 | 5.69 | 0.84 | 5.48 | 1.17 | 5.78 | 0.98 | 0.97 |
| AMOT | 1.36 | 0.61 | 1.36 | 0.61 | 1.19 | 0.33 | 1.39 | 0.63 | 1.16 | 0.38 | 0.79 |
| Final exam grade | 0.00 | 0.00 | 1.14 | 2.80 | 3.20 | 3.74 | 6.47 | 2.80 | 7.01 | 2.52 | 25.15** |

*p<.05, **p<.001

## 3.1 Motivation, Participation, and Tool use

Table 4.2 presents the means and standard deviations of motivation, participation and tool use. To test our first hypothesis that higher levels of autonomous motivation would be associated with higher participation in web-videoconferences, an ANOVA on AMS subscales with number of times participated as the independent variable was conducted. It showed a significant difference on the IMTA subscale, $F(4,105) = 2.55$, $p < .05$. Post-hoc tests showed that students participating in four web-videoconferences had significantly higher scores on the IMTA subscale than students who did not participate ($p < .05$), or who participated once ($p < .01$) or twice ($p < .05$). Differences on all other subscales were non significant.

To test our second hypothesis that higher levels of autonomous motivation would be associated with the use of richer communication tools when taking part in a web videoconference, multinomial regression analysis was used with average tool use as dependent variable and the AMS scales as covariates (linear regression could not be used because average tool use is a categorical variable for which distances between observations do not have the same meaning). As was to be expected based on the correlation presented in Table 4.1, results indicate that none of the AMS scales was a significant predictor of the average tool use score.

## 3.2 Tool use and Participation

The third hypothesis stated that higher participation in the webvideoconferences would be associated with the use of richer tools. The descriptive data presented above already showed that students who took part in more web-videoconferences used richer communication tools. Because average tool use is a categorical variable, the Jonckheere–Terpstra test (also see Bridge, Jackson, & Robinson, 2009) was used, which tests if a move along a grouping variable (i.e. the number of web-videoconference participation) from a lower group to a higher group leads to an in- or decrease of a test variable (i.e. average tool use). Results indicate a significant trend at the .1 level in the expected direction, $J = 1814$, $z = 1.78$, $p = .07$.

## 3.3 Motivation and Final Exam Performance

The fourth hypothesis stated that higher levels of autonomous motivation would be associated with higher scores on the final exam. A backward multiple regression analysis was performed with the AMS scales as independent variables. Again, IMTA was the only predictor nearing significance in predicting the final exam score, R2 = .032, B(SE) = .66 (.35), b = .18, F (1,105) = 3.54, p < .1.

## 3.4 Tool use, Participation, and Final Exam Performance

The fifth hypothesis stated that the use of richer communication tools would be associated with higher scores on the final exam, and the sixth hypothesis was that participation in more web-videoconferences would be associated with higher scores on the final exam. Because the correlation between average tool use and number of times participated was high, we first performed a multiple regression analysis to investigate the influence of both on the final exam grade. Results indicated that the number of times participated showed a significantly stronger relation with the final exam grade ($R^2$ = 0.48, B(SE) = 2.09 (0.25), b = 0.74, p < .001) than the average tool use (B(SE) = - 0.24 (0.23), b = - 0.09).

An ANOVA on final exam score with number of times participated as independent variable (see also Table 4.2) showed, in line with our expectation and the regression analysis, that students who took part in more web-videoconferences had higher scores on the final exam, F(4,105) = 25.15, p < .001. Post-hoc tests showed significant differences between all groups except between students who participated once and twice and between students who participated three and four times (all p < .01).

# 4. Discussion

This study explored the relationship between available tools used, student motivation, participation, and performance on a final exam in the context of a facultative summer course in economics. Our first hypotheses concerned the relationship between academic motivation and participation, and stated that higher levels of autonomous motivation are associated with more participation

in web-videoconferences (H1) and with the use of richer communication tools when taking part in a web-videoconference (H2).

We found partial support for the first hypothesis: the AMS IMTA subscale was significantly associated with the number of times participated. These results are in line with previous findings of Roca and Gagné (2008) and Sørebø et al. (2009), but in contrast to those studies, we did not find a significant effect of all three subscales related to autonomous motivation. Potentially, this difference could be related to the facultative nature of the course.

We did not find any support for the second hypothesis; there was no relation between autonomous motivation and tool use. A possible explanation for this finding might be that students who participated with chat could still see and hear the other participants (who did have a webcam) as well as the tutor. This might have weakened a potential link between autonomous motivation and tool use, by giving those participants experiences that could also have some beneficial effects on the sense of competency, relatedness, and autonomy (e.g. despite the fact that others could not see or hear them, participants using only chat could have felt a quite high degree of direct and personal contact because they could see and hear others). An alternative reason might be that (even highly autonomously motivated) students may not have had access to sufficient quality of broadband and technical facilities (e.g. when participating from a holiday or summer job location), which would also weaken a potential link between autonomous motivation and tool use.

Being able to see and hear other students and the tutor while participating with chat might also be the reason why we did not find full support for our third hypothesis that taking part in more web-videoconferences is associated with the use of richer communication tools (H3). That is, there was a significant positive correlation between participation and average tool use, but the Jonckheere–Terpstra test showed a significant trend at the .1 confidence level only in the expected direction.

Regarding the effects on exam scores, we found a trend in line with our expectation that higher levels of autonomous motivation would be associated with higher scores on the final exam (H4), although again only for the IMTA subscale. In addition, while there was a significant positive correlation between the use of communication tools and scores on the final exam (H5),

only the number of times students participated in the web-videoconferences predicted scores on the final exam (H6).

The facultative nature of our setting offered a unique possibility to study the relations between student motivation, tool use, and participation in an e-learning course, because students were not obliged to participate or to use certain tools. This setting has several resemblances with distance education programs, where most participants join voluntarily, though some do so out of external motivation (e.g. job prospects), while others join these programs purely because of a specific interest in the topic (e.g. studying economics), and others join for a combination of motivational factors (Bernard et al., 2004; Marks et al., 2005). Similar to other distance education programs where retention rates range from 20% to 60% (Park & Choi, 2009; Rovai, 2003), a limitation of the facultative nature of our course is that attrition was quite high. Another limitation is that we cannot draw any conclusions about causal relations between variables. Finally, it is a potential limitation that attendance was used as a proxy for participation. Even though participants attended a web-videoconference, and all who attended communicated, they could have been distracted at least part of the time, and this might be more so when they were not sharing visual information. It should be noted though, that the PBL process (see Loyens et al., 2011), which lets students take centre stage, but with a tutor present who continuously involved students in the discussion irrespective of the communication tools they used, is likely to have strengthened actual participation and not just attendance.

Future research could aim to experimentally manipulate or control the variables used in this study to enable conclusions regarding causality. In addition, it would be interesting for future research to try and replicate our findings in other facultative and non-facultative e-learning courses using web-videoconferences (see also Hrastinski et al., 2010).

Nevertheless, the findings that average tool use correlated significantly with participation, and that more participation was associated with higher test scores, are interesting and might contribute to advise and/or guidelines for tutors and students in (facultative) e-learning courses on how to make the most of the learning process.

## 4.1 Practical Implications

As already mentioned, high drop-out rates are found often in online educational settings (Park & Choi, 2009; Rovai, 2003). In our setting, the largest proportion of drop-out occurred in the second week of the course, but no direct relationship between dropout and motivation was found, so apparently other environmental or individual factors next to motivation influenced participation. In future courses, we would therefore (recommend to) do two things: First, we would try to understand the reasons behind the drop-out by asking students personally why they chose not to participate in a web-videoconference. This can be done during the course via e-mail, but with a limited group of students even via telephone which may be more effective because it is more direct. If available, incorporating objective information about student behaviour like log data can further complement our understanding as this gives an indication of the time a student was logged in, where s/he clicked, etc. This so called 'learning analytics' perspective (Ferguson, 2012) is gaining popularity and may afford to uncover new patterns about online learning behaviour that otherwise remain hidden.

Second, it is important to try to actively engage students in an early stage. Though we did send regular personalized announcements and updates of occurrences in the course, this was not enough to limit drop-out. However, a solution that can be relatively easily implemented is to assign roles to students (Strijbos & De Laat, 2010). A role is a specific predefined task or set of tasks within the collaboration process like starting a discussion, contributing external sources, wrapping up a discussion, etc. In a face-to-face PBL setting, there usually are roles assigned like, for instance, discussion leader and scribe (Loyens et al., 2011). Assigning a role appeals to students' responsibility and can strengthen their sense of autonomy, competency, and relatedness and thereby may help them to persist in their engagement.

## Acknowledgement

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# Chapter 5

# A Dynamic Analysis of the Interplay between Asynchronous and Synchronous Communication in Online Learning: The Impact of Motivation*

With the increased affordances of synchronous communication tools, more opportunities for online learning to resemble face-to-face settings have recently become available. However, synchronous communication does not afford as much time for reflection as asynchronous communication. Therefore, a combination of synchronous and asynchronous communication in e-learning would seem desirable to optimally support learner engagement and quality of student learning. It is still an open question though, how to best design online learning with a blend of synchronous and asynchronous communication opportunities over time. Few studies have investigated the relationship between learners' actual use of synchronous and asynchronous communication over time. Therefore, this study addresses that relationship in an online course (N = 110), taking into account student motivation, and employing a dynamic intertemporal perspective. In line with our assumptions, we found some support for the expected association between autonomous motivation and engagement in asynchronous and synchronous communication, be it restricted primarily to the first course period. Also, positive relations between engagement in synchronous and asynchronous communication were found, with the strongest influence from using asynchronous to synchronous communication. This study adds to the knowledge base needed to develop guidelines on how synchronous communication can be combined with asynchronous learning.

## 1. Introduction

Recent developments in computer-assisted learning show an increase in the use of synchronous communication tools that offer more resemblance to face-to-face interaction. Widely available web-videoconference tools like Skype and ooVoo offer real-time communication through (a combination of) audio, video, and chat. This can be seen as a welcome addition to 'traditional' text-based asynchronous communication means in blended and online

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education, as findings from research in computer-mediated communication (CMC) show that different features of both synchronous and asynchronous communication may be beneficial in supporting different pedagogical aims (Pfaffmann, 2007; Hrastinski, Keller, & Carlsson, 2010). For example, it has been argued that asynchronous communication allows for more time to reflect on a contribution and refine it than synchronous communication (Davidson-Shivers, Muilenburg, & Tanner, 2001). However, Paulus (2006) argued that in text-only online environments even experienced online learners may have difficulties in conveying their message in a constructive manner. Indeed, it has been shown that asynchronous communication often leads to a misinterpretation of written contributions (like a post on a discussion forum) because of a lack of shared context, body language, or writing style (Bromme, Hesse, & Spada, 2005). In addition, learners may feel less engaged if only asynchronous communication is used, as is reflected by general findings that both quantity and quality of contributions to discussion forums often differ greatly across individual learners, depending on their motivation (Rienties, Tempelaar, Van den Bossche, Gijselaers, & Segers, 2009; Järvelä, Volet, & Järvenoja, 2010; Schellens & Valcke, 2005).

Synchronous communication tools such as web-videoconferencing allow for more direct social interaction and feedback amongst learners and teachers, which may leave less time for reflection but do allow for direct correction of misconceptions, and may lead to higher levels of learner engagement (Carr, Cox, Eden, & Hanslo, 2004, Hrastinski et al., 2010; Strømsø, Grøttum, & Lycke, 2007). Therefore, one would expect that the combination of synchronous and asynchronous communication in online learning would better support learner engagement and the quality of student learning than using only asynchronous communication (Hrastinski et al., 2010; Graham, 2006; Johnson, 2006). For example, Hrastinski et al. (2010) researched how synchronous online communication can support e-learning processes by taking multiple design exemplars as a basis. Findings include a positive effect of synchronous communication on the support of group-wide relations, strengthening weak class-wide relations, and social support. An intermediate to strong influence of synchronous communication for task support was found. Amongst others, Hrastinski et al. (2010) concluded that it is impossible to provide a success recipe for the application of synchronous communication as its characteristics

(based on text, audio, video, or a combination) can differ highly. They suggest letting the choice of communication media to be dependent of the way in which it can support the educational processes.

The initial positive findings of using synchronous communication in support of different contexts are promising and justify further research on applications in other designs of online learning. In addition, Johnson (2006) concluded in his literature review on the use of text-based synchronous and asynchronous communication, that asynchronous discussion is equal to or may be better than synchronous discussion to foster student satisfaction of course requirements. Next, he showed that students do not have a preference for one communication mode or the other. Further, he found that while participation in asynchronous discussion requires more of students' autonomy, it results in a retraceable backlog of the constructed knowledge. Synchronous communication, in turn, is more direct in the support of social processes. As both modes have their own specific merits, Johnson (2006) argued combining both modes may offer the best of both to enhance the online learning process. That is, direct feedback and support of social processes may best be supported through synchronous discussion, while asynchronous discussion may best support the development of higher-level thinking skills, for example, through the process of writing and enhanced reflection time. However, little is known about how to combine synchronous and asynchronous communication over time, in a way that effectively enhances student learning (Strømsø et al., 2007; Graham, 2006).

In addition, CMC research has suggested that the actual use of both synchronous and asynchronous communication tools and the resulting interactions in an online learning situation are related to individual differences between learners, and specifically strong relations have been found with motivation or self-determination (Rienties et al., 2009; Järvelä, Hurme, & Järvenoja, 2011; Roca & Gagné, 2008; Sørebø, Halvari, Gulli, & Kristiansen, 2009). Concluding an elaborated review of CMC in education, Luppicini (2007) argued that to increase our understanding of new CMC dimensions (e.g. web-videoconferencing) that did not exist ten or twenty years ago, researchers should approach CMC as a complex system encompassing multiple factors from an inter-temporal point of view. Though some studies are available on

the inter-temporal development of virtual teams in organization settings (e.g. Kanawattanachai, & Yoo, 2007; Maznevski, & Chudoba, 2000), there are only a few studies on online learning that take the time aspect into account. Even fewer studies provide useful insights for the use of combined communication modes. For example, Akyol, Vaughan, & Garrison (2011) compared two implementations of the same online graduate course on education, but with different duration (6 vs. 13 weeks). Communication took place asynchronously. Differences in group cohesion between the two courses were found, but could not be attributed to the difference in duration as group dynamics were argued to have the strongest influence. In their conclusion, Akyol et al. (2011) primarily point toward the importance of a course design that is reliable and coherent from the start of an online course onward. This conclusion is also supported by a study by Akyol and Garrison (2008) in the context of an online graduate course on blended learning that used combined synchronous and asynchronous communication. Collaborative activities were shown to increase group cohesion and students' sense of belongingness over time. Though this was not found to influence learning, it did influence student satisfaction with the course. Furthermore, the design of the course and the development of related aspects like direct instruction over time were shown to significantly influence learning.

Furthermore, Rienties, Tempelaar, et al. (2012) analysed the development of asynchronous group discussions over time by making a distinction in the level of learners' self-determination. Findings showed that in an early stage of the course, autonomy-oriented learners (i.e. learners with an intrinsic drive who can effectively steer their own learning) engaged significantly more in both task-related and non-task related discourse than control-oriented learners (i.e. learners with an external drive, who are less efficient in steering their learning process). Over time (2-3 weeks), the autonomy-oriented learners focused their discussion away from non-task related to task-related discourse, while the control-oriented learners did not. Interestingly, at an early stage in the course, autonomy-oriented learners already developed a preference to connect to other autonomous learners. Rienties, Tempelaar et al. (2012) suggested that this dynamic may have put control-oriented learners (for whom engagement already is a challenge) in an additional disadvantaged position already at an early stage in the course. Similar to Akyol and Garrison (2008)

and Akyol et al. (2011), they conclude that from the start of an online course, the learning environment and learning processes should provide sufficient structure and autonomy support (e.g. via scaffolding) to enhance engagement of all learners.

Although the number of studies addressing the time aspect of asynchronous communication (Akyol, & Garrison, 2008; Akyol et al., 2011; Rienties, Giesbers, Tempelaar, Lygo-Baker, Segers, & Gijselaers, 2012; Rienties, Tempelaar, et al., 2012), and the use of synchronous communication (Giesbers, Rienties, Tempelaar, & Gijselaers, 2013; Hrastinski, 2008; Hrastinski et al., 2010) in online learning has increased in the last years, to the best of our knowledge not a single study has investigated how learners balance the use of synchronous and asynchronous communication during the runtime of an online course, and how these decisions are related to learners' degree of self-determination.

We therefore investigated the relationship between the use of synchronous and asynchronous communication over time, by 110 participants in an online course, and how this was affected by student motivation. Performance on a final exam was also taken into account in order to address the question of how the relationships between the use of different communication tools and motivation affected learning outcomes; prior studies have shown that higher autonomy oriented motivation in e-learning leads to better learning outcomes (Rienties, Giesbers, et al., 2012). The findings of this study add to the knowledge base on how to combine asynchronous and synchronous communication in online learning in a way that effectively influences student learning. Before discussing the relationship between synchronous and asynchronous communication and motivation in e-learning in more detail, we will first discuss the role of motivation in e-learning, as conceptualized by Self-Determination Theory (SDT; Deci & Ryan, 1985, 2002; Ryan & Deci, 2000).

## 1.1 Online Learning and Self-determination

A factor that has been found to have a large influence on learning behaviour in both offline and online educational settings is self-determination (Rienties et al., 2009; Chen & Jang, 2010). Self-determination refers to learners' perception of the extent to which learners can steer their own

learning process and is therefore strongly related to motivation as it "is specifically framed in terms of social and environmental factors that facilitate versus undermine intrinsic motivation" (Ryan & Deci, 2000, p. 58). In SDT (Deci & Ryan, 1985, 2002; Ryan & Deci, 2000), a distinction is made between autonomy-oriented learners, who typically are intrinsically motivated and engage in learning because it is perceived as an enjoyable or challenging activity; and control-oriented learners, who show a strong disposition for extrinsic motivation and feel they have limited control over their learning process. The third orientation is the impersonal orientation, which is held by learners who neither have an internal or externally locus of control of their learning, and this orientation is therefore associated with amotivation. The autonomous and control orientations are not seen as mutually exclusive categories: extrinsic motivation, for instance, is perceived as a continuum of types that differ in how close they are to intrinsic motivation and vice versa (Deci & Ryan, 2002). Amotivation, obviously, is seen as distinct from the other two.

SDT states that learners' motivation and well-being are determined by the extent to which three basic needs are satisfied: the need for autonomy (i.e., learners' perception of the amount of control they have over the learning process), the need for relatedness (i.e., learners' perceived amount of social inclusion), and the need for competency (i.e., how learners perceive their ability to deal with learning activities). All three needs are affected by contextual factors, like the interaction between learners, teachers, and the learning materials (Ryan & Deci, 2000).

Several scholars have argued that the role of self-determination in the complex dynamics of online learning is not well understood (Rienties et al., 2009; Järvelä et al., 2010; Martens, Gulikers, & Bastiaens, 2004). Online learning settings are much more open and flexible than classroom settings, because they offer a limited amount of external regulation and structure, and thereby allow a learner to be more autonomous in making choices regarding their learning behaviours (Chen & Jang, 2010; Chen, Jang, & Branch, 2010). This requires more self-determination from a learner and because of this, not all learners are able to learn efficiently in online setting (Kirschner & Erkens, 2013; Liu, Horton, Olmanson, & Toprac, 2011). Nevertheless, even though processes such as monitoring learners' activity, providing timely feedback, and

fostering learners' sense of competence, autonomy, and relatedness are different in online learning (Chen & Jang, 2010), it can be done, especially when synchronous communication tools are used. Offering autonomy support and structure has been shown to profoundly influence student engagement both in classroom (Guay, Ratelle, & Chanal, 2008; Jang & Deci, 2010) and in e-learning settings (Rienties, Tempelaar, et al., 2012; Chen & Jang, 2010).

## 1.2 SDT and the Interplay between Asynchronous and Synchronous Communication

Findings from CMC research, which are primarily based on asynchronous communication, have found self-determination to influence student engagement and knowledge construction in online learning; more specifically, learners with stronger intrinsic or autonomous motivation have been found to learn more effectively in online settings (Rienties et al., 2009; Rienties, Giesbers, et al., 2012; Martens et al., 2004).

Moreover, adding synchronous communication to an online course further enhances the choices learners can make to steer their learning behaviour. Limited research is available about the effect of synchronous communication opportunities on the engagement in asynchronous communication, and it is therefore an open question whether such opportunities would replace or enhance the use of asynchronous communication, and whether this effect depends on learners' motivation. Hrastinski (2008) compared two cohorts of learners in a professional setting that used a combination of discussion forums and text-based chat. Findings included that using the synchronous text-based chat as a complement positively influenced student engagement in asynchronous discussions. The main explanation Hrastinski offered for this finding was that the synchronous communication made learners more aware of the activity of, and interaction with, other learners.

Translated in terms of SDT, this would mean that synchronous communication may increase learners' sense of relatedness by affording more direct and personal social interactions and feedback. Furthermore, synchronous communication, via the affordance to limit the delay in monitoring activity, may positively affect learners' sense of competency (e.g. by providing timely content related feedback by both learners and tutors), and

the sense of autonomy (i.e. by providing timely process-related feedback). In turn, an increase in perceived autonomy, perceived competence, and perceived relatedness has been found to have a positive influence on learners' motivation to use ICT (Roca and Gagné, 2008; Sørebø et al., 2009). In other words, it might be hypothesized that the use of synchronous communication may enhance the use of asynchronous communication in online learning.

## 1.3 The Present Study

In line with previous research, we would argue that engagement in synchronous communication supports engagement in asynchronous communication. Also, we expect that learners with stronger intrinsic or autonomous motivation would engage more in both types of communication, and would show better knowledge construction both in terms of more task-oriented asynchronous discourse and in terms of better performance on a final test. To address the effects over time, the online course was divided into four periods, each characterised by a web-videoconference followed by a phase of asynchronous communication that incorporated the core of the collaborative knowledge construction. That is, the largest part of student-activity took place in the asynchronous discussion forums and reflected students' self-study of the literature (also see section 2.2.1). Each period lasted about a week; as the timing of the next web-videoconferences were planned collaboratively. The learning process Figure 5.1 shows the main variables in this study and the transition between course periods as the course progresses over time.

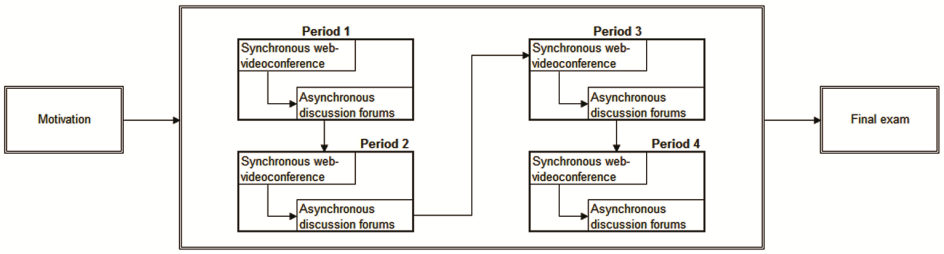


*Figure 5.1. Model of the variables in this study*

Regarding asynchronous communication, in line with previous findings regarding the relation between motivation and engagement in asynchronous discussions (Rienties et al., 2009; Rienties, Tempelaar, et al., 2012; Martens et

al., 2004), we expect that engagement in asynchronous communication both in quality (more task-related posts) and quantity (more posts in general) would be positively associated with higher levels of autonomous motivation (H1a), in each period in the course (H1b).

In line with prior studies (Hrastinski, 2008; Hrastinski et al., 2010), we would expect that participation in the synchronous web-videoconferences would be associated with a higher number and a higher quality of contributions to the asynchronous discussion forums (H2a), for both autonomy-oriented learners as well as for control-oriented learners (H2b), and in each phase of the course (H2c). However, based on findings on self-determination (Roca and Gagné, 2008; Sørebø et al., 2009) we can expect that autonomy-oriented learners who participate in the web-videoconference to be more engaged in the asynchronous discussion forums in terms of both quality and quantity than control-oriented learners who participated in the web-videoconference (H3). After testing each of these hypotheses separately, a path analysis was also conducted, which does justice to the recommendations by Luppicini (2007) to approach CMC in education as a whole of complex interrelated factors over time.

# 2. Method

## 2.1 Participants and Context

Participants were students in a facultative summer course in economics for prospective Bachelor students of an international business and economics degree programme at a Dutch business school which was offered entirely online and aimed to bridge potential gaps in prior knowledge of economics (Rienties et al., 2006; 2009). The course was part of a wider summer course program that has been offered since 2004 to over a thousand participants, and has been integrated in the admission and application processes of the respective business school. The authors of this study were actively involved as course designers within the wider remedial program and two were actively involved as tutors in the economics course.

Students who subscribed to the Bachelor program received a letter that informed them of the possibility to participate in this course. The letter contained information about the course purpose and content as well as a link

to a prior knowledge test with which students could assess the benefit they could get from the course. When students got a low score on the prior knowledge test but did not enrol for the course, they received a follow-up e-mail recommending enrolment. After enrolment, the course team assigned students at random to a small group in which they would work and learn together throughout the course.

Participants in this study came from two consecutive years of the same course, and the total number of groups was 11 (M group size = 14.09; range = 6-16). An entry questionnaire including demographic questions and a motivation questionnaire (see materials section) that was taken directly after enrolment showed no significant differences in gender, age, ICT skills, previous e-learning experience, and motivation between participants in the two cohorts. Most students reported to have intermediate ICT skills, and less than 10% had followed an online course before. Of the total number of 155 students, 45 students had not or only partly filled in the motivation questionnaire; as a consequence, only 110 students were included in this study (M age = 19.5; SD = 1.28; 39% female). No significant differences on the study variables between omitted and included students were found.

## 2.2 Materials and procedure

### 2.2.1 Online preparatory course

For this course, team collaboration was facilitated via a Microsoft Sharepoint based online environment that supported storage and delivery of the course manual and course materials, and supported asynchronous communication via discussion forums. Integration with Adobe Connect enabled the use of online web-videoconference, during which participants could communicate via (a combination of) audio, video, and chat (also see Giesbers, Rienties, Gijselaers, Segers, & Tempelaar, 2009). No special hardware was needed to access the course material and the discussion forums. For the use of audio-visual functionalities during a web-videoconference a regular webcam and/or headset was sufficient.

The course design was based on principles of Problem-Based Learning (PBL, see Loyens, Kirschner, & Paas, 2011) by letting groups of students collaboratively solve six authentic problems on basic economic concepts,

micro-economics, and macro-economics (two problems each). The learning process was structured using the PBL Seven-Jump model (see Schmidt & Moust, 2000; Segers, van den Bossche, & Teunissen, 2003;) which was adapted slightly to accommodate the online setting (Rienties et al., 2009; Rienties, Giesbers, et al., 2012), and required students to: 1) identify difficult terms; 2) identify the main problem(s) and brainstorm to formulate learning goals; 3) start to solve the learning goals by referring to personal experience, course literature and/or additional literature; 4) elaborate on the findings in the previous step; 5) reach agreement on the answers through discussion, 6) check if all learning goals are answered and; 7) summarize the main points of the entire discussion. This process was guided by a tutor.

The course ran for a maximum of six weeks and had an estimated study load of 10 to 15 hours per week of which the majority was spent on asynchronous discussion forums. For each task, a dedicated discussion forum was available where students could post and discuss the learning goals connected to that particular task. At the beginning of each of the first four weeks, a web-videoconference was organised in addition to the forum discussions. The first web-videoconference started with a personal introduction by all participants, followed by an explanation of the content and procedures of the course. The second part consisted of a pre-discussion (Seven-Jump steps 1-3) of the introductory tasks. In the second meeting, the introductory tasks were post-discussed (Seven-Jump steps 4-7).

For example, the first task was on an introductory level and dealt with the case of a young girl from North Korea who comes to Maastricht to study economics. She is confused by the differences in economic systems she experienced and she is looking to find an overview that could explain the main players and their interaction in different economic systems. During the web-videoconference, the task was read and it was made sure everyone understood the used terms (Seven-Jump 1). This was followed by a discussion of the main problems and the formulation of learning goals (Seven-Jump 2). An example of a learning goal would be “Characterize the differences between different economic systems”. This learning goal was then discussed based on the experience and knowledge of participants (Seven-Jump 3). After the web-videoconference, students started to self-study the literature and continued

the discussion of the learning goals in the discussion forums (Seven-Jump 3 and 4). During this period, additional learning goals may have come up (e.g. “Are the two dominant economic systems (planned economy and market economy) mutually exclusive or are there forms in between? Identify examples if possible.”), that could be answered during the asynchronous discussion. Also during this period, a date and time for the next web-videoconference were set based on availability as indicated in an online agenda containing multiple options. In the next web-videoconference, the task at hand was post-discussed by elaborating on and clarifying the self-study findings (Seven-Jump 4), reaching agreement on the answers through discussion (Seven-Jump 5), checking if all learning goals were answered (Seven-Jump 6), and summarize the main points of the entire discussion (Seven-Jump 7). A new pre-discussion of the next task was then started and the cycle continued. The implementation of web-videoconference is in line with Strømsø et al. (2007), who suggested that synchronous communication is most useful to support generating ideas, like was done during the pre-discussion (Seven-Jumps 2 and 3).

Because the course was facultative, participation in the discussion forums and web-videoconferences was also voluntary but encouraged by a rating (by the tutor) of each student’s contributions which counted as 10% of that student’s final grade for the course (which should not be confused with the final exam score used in this study).

With permission from the students, all web-videoconferences were recorded. These recordings could be watched by group members, which allowed students who had been unable to attend a particular videoconference to catch up with the key discussion points, but this option was only seldom used.

### 2.2.2 Final exam

All course topics were addressed in a final exam that consisted of 20 multiple choice items and one open item. The exam was voluntary and was completed by only 45.5% of the participants (n = 50), who did not differ from the other participants in terms of demographics nor motivational profile (see also Giesbers et al., 2013). Low retention rates are a common finding in online courses (Park & Choi, 2009; Rovai, 2003), and although the final exam was not the main focus of our study, we decided to include it as a variable in the path

model (see section 3.3) to give further indication of student performance. We analysed the data both with and without inclusion of the final exam, which showed similar results.

### 2.2.3 Content analysis

A common way to analyse individual contributions to online discussion fora is content analysis (CA), in which the asynchronous discourse taking place is coded, using a validated coding scheme, to reveal evidence of knowledge transfer and learning (De Wever, Schellens, Valcke, Van Keer, 2006; Strijbos, Martens, Prins, & Jochems, 2006). In line with previous studies in asynchronous learning in this context (Rienties et al., 2009, Rienties, Tempelaar, et al., 2012) the coding scheme developed by Veerman and Veldhuis-Diermanse (2001) was used. The coding scheme employs non-task-related and task-related discourse as the main categories. Within the category non-task-related, messages are further divided into the categories 1) planning; 2) technical; 3) social; and 4) nonsense. Messages coded as task-related are further divided into the categories 5) facts; 6) personal experience; 7) theoretical ideas; 8) explication; and 9) evaluation. Appendix A provides examples for each of the coding categories and examples of messages.

The discourse material was analysed by two coders (both economists) who were trained in using the coding scheme and who received a financial compensation for their work. When there was a difference between the two coders, the first author acted as a third coder to assess the message. In total, 1766 messages were posted of which 1742 (98.6 %) proved to be codeable. Cronbach α scores for the coding of these messages was .907 which is well above the recommended value of .75 to .80 that is reported in most studies (see De Wever et al., 2006). Agreement between the two coders was assessed via Cohen's κ which, with a value of .640, was within the range of fair to good agreement (κ range .40 to .75), as argued by De Wever et al. (2006) and in line with previous studies (Rienties et al., 2009; Rienties, Tempelaar, et al., 2012).

### 2.2.4 Participation in the synchronous web-videoconferences

Based on findings by Hrastinski et al. (2010) and Johnson (2006), we were primarily interested in the relation between participation in synchronous communication and the main knowledge construction during the asynchronous communication process. Therefore, participation in the web-videoconferences was operationalized for each period by a dichotomous variable (0 = not participated, 1 = participated).

### 2.2.5 Academic motivation scale

At the beginning of the course, students' motivation was measured using the Academic Motivation Scale (AMS; Vallerand, 1997; Vallerand & Bisonnette, 1992), which is based on SDT (Deci & Ryan, 1985, 2002). The AMS consists of 28 items on a 7-point Likert scale divided into seven subscales. Three subscales concern intrinsic motivation: (1) motivation to know (IMTK, learning driven by the need to understand something new, Cronbach $\alpha$ = .82); (2) motivation to accomplish (IMTA, learning driven by the need to accomplish something, $\alpha$ = .77); (3) motivation to experience stimulation (IMES, learning driven by the need to experience stimulations, $\alpha$ = .81). Three subscales concern extrinsic motivation and display a range on the continuum of self-determined behaviour from (1) identified regulation (EMID, which is closest to intrinsic motivation. Here, learning behaviour follows a conscious valuation of a goal or regulation, giving it personal importance; $\alpha$ = .60), (2) introjected regulation (EMIN, where retaining self-worth is the prime reason for learning; $\alpha$ = .83) to (3) externally regulated learning (EMER, where learning is steered through external means such as rewards, $\alpha$ = .85). The final scale concerns amotivation (AMOT, $\alpha$ = .81) or the absence of regulation that can be directed either external or internal. The reliability as reflected by Cronbach $\alpha$ scores is in line with previous studies (Fairchild, Horst, Finney, & Barron, 2005; Vallerand & Bisonnette, 1992; Vallerand & Pelletier, 1993).

The separate scales were aggregated to assess the degree to which participants were autonomy-oriented, and control-oriented in line with SDT literature (Deci & Ryan, 2000; Ryan & Deci, 2000): Autonomy orientation is associated with intrinsic motivation and well-integrated (or identified) extrinsic motivation; corresponding AMS scales are IMTK, IMTA, IMES, and EMID.

Control orientation is associated with introjected regulation and external regulation, which corresponds with the EMER and EMIN subscales respectively. Finally, amotivation measured by the AMOT subscale corresponds to an impersonal orientation. By calculating a Relative Autonomy Index (Black & Deci, 2000; Chen & Jang, 2010; Ryan & Deci, 2010), the scores on all individual subscales can be transformed into a single number, that, after performing a median split, allowed to discern between autonomy-oriented students (high RAI) and control-oriented students (low RAI). Previous research in a similar context using asynchronous discussion only showed learners scoring high on autonomy (high RAI) to contribute more to the overall discourse (quantity), but also to contribute more task-related messages (quality) (see Rienties, Giesbers et al., 2012).

# 3. Results

A first investigation of the 1742 codeable messages that were posted to the discussion forums showed large differences between individual contributions ($\chi^2$ (41) = 92.36, $p < .001$). The values of the standard deviation, skewness and kurtosis per content analysis category further illustrated this large variation in discourse activities and showed contributions followed a non-normal (right-hand tailed) distribution (see Table 5.1). As an indication of the extent of knowledge construction activities (quality of contributions), we made a distinction between task-related (TR) and non-task-related (NTR) messages. On average, more task related messages than non-task related messages were posted (Table 5.1). What stands out with respect to the individual coding categories is the relatively low average of posts on the categories 'social' (cat.3) and 'evaluation' (cat. 9) which had also been found in previous studies in this voluntary online course context using asynchronous discussion forums only (Rienties et al., 2009).

*Table 5.1. Contributions to discourse in total, and divided per category*

| | *M* | *SD* | *Skewness* | *Kurtosis* | $\chi^2$ *(df)* |
|---|---|---|---|---|---|
| *Non-task related* | 5.83 | 6.81 | 2.45 | 8.87 | 96.55 (19) |
| Planning (Cat. 1) | 1.05 | 2.10 | 3.36 | 13.49 | 301.55 (8) |
| Technical (Cat. 2) | 1.17 | 1.77 | 2.38 | 6.67 | 204.18 (8) |
| Social (Cat. 3) | .87 | 1.79 | 3.56 | 15.17 | 315.29 (8) |
| Nonsense (Cat. 4) | 2.74 | 2.89 | 1.73 | 3.39 | 128.26 (13) |
| *Task-related* | 9.81 | 12.52 | 2.15 | 6.66 | 206.20 (32) |
| Facts (Cat. 5) | 2.20 | 4.64 | 4.24 | 25.65 | 446.95 (13) |
| Experience (Cat. 6) | 1.85 | 2.47 | 1.71 | 2.58 | 183.8 (10) |
| Theoretical Ideas (Cat. 7) | 1.81 | 3.19 | 3.20 | 13.20 | 269.20 (11) |
| Explication (Cat. 8) | 3.66 | 4.67 | 1.55 | 1.73 | 190.76 (17) |
| Evaluation (Cat. 9) | .27 | .73 | 3.16 | 10.33 | 281.09 (4) |
| *Total* | 15.83 | 17.77 | 1.55 | 2.18 | 92.36 (41) |

Total N = 110, all $p < .001$

Tables 5.2 and 5.3 present the Spearman correlation coefficients for the variables in this study and show a positive association between autonomy orientation and posting in the first three course periods which is in line with our expectations. Correlations of the individual AMS subscales suggest this is mainly due to the intrinsic motivation to know (IMTK) and to accomplish (IMTA). Similarly, a positive relation was found between autonomy orientation and taking part in the third and fourth web-videoconferences, which again seems mainly due to the positive association of the individual subscales IMTK and IMTA. Furthermore, there was a strong correlation between participation in the consecutive periods of asynchronous discussion and the consecutive web-videoconferences, except that the latter showed a low correlation between participation in the first and second web-videoconference. Participation in synchronous and asynchronous communication was highly related, except for the correlation between participation in the first web-videoconference and all consecutive periods of asynchronous discussion. Finally, positive associations were found between the final test grade and the consecutive instances of synchronous and asynchronous communication, where participating in the latter showed the strongest relation.

*Table 5.2. Spearman intercorrelations between the variables in the research model (part 1)*

| | *M* | *SD* | IMTK | IMTA | IMES | EMID | EMIN | EMER | AMOT | AUT | CON |
|---|---|---|---|---|---|---|---|---|---|---|---|
| *Synchronous communication* | | | | | | | | | | | |
| Participation in VC1 | .70 | .46 | 0.14 | 0.10 | 0.06 | 0.13 | 0.03 | 0.08 | -0.15 | 0.15 | 0.02 |
| Participation in VC2 | .50 | .50 | 0.17 | 0.27** | -0.01 | 0.08 | 0.15 | 0.14 | -0.06 | 0.16 | 0.15 |
| Participation in VC3 | .40 | .49 | 0.24* | 0.24* | 0.15 | -0.01 | 0.04 | 0.03 | 0.03 | 0.22* | 0.03 |
| Participation in VC4 | .38 | .49 | 0.22* | 0.28** | 0.20* | 0.05 | -0.02 | -0.02 | -0.03 | 0.23* | -0.3 |
| *Asynchronous communication* | | | | | | | | | | | |
| Posts Period 1 | 10.62 | 10.13 | 0.39** | 0.41** | 0.20* | 0.12 | -0.04 | 0.12 | -0.13 | 0.38** | 0.04 |
| Posts Period 2 | 6.36 | 7.33 | 0.21* | 0.31** | 0.07 | 0.19 | 0.01 | 0.21* | -0.12 | 0.25** | 0.10 |
| Posts Period 3 | 5.53 | 4.84 | 0.28* | 0.31** | 0.16 | 0.10 | -0.02 | 0.12 | -0.09 | 0.29** | 0.03 |
| Posts Period 4 | 2.54 | 2.52 | 0.21* | 0.22* | 0.08 | 0.1 | -0.08 | 0.00 | -0.04 | 0.19 | -0.08 |
| *Performance* | | | | | | | | | | | |
| Final exam grade | 7.50 | 1.19 | .19* | 0.26** | 0.09 | -0.01 | -0.02 | 0.03 | 0.04 | 0.18 | -0.02 |

N = 110; * $p < 0.05$; ** $p < 0.01$

IMTK = Intrinsic Motivation to Know; IMTA = Intrinsic Motivation to Accomplish; IMES = Intrinsic Motivation to Experience Stimulation;

EMID = Extrinsic Motivation Identified Regulation; EMIN = Extrinsic Motivation Introjected regulation; EMER = Extrinsic Motivation External Regulation

AMOT = Amotivation

AUT = Autonomy oriented; CON = Control oriented

*Table 5.3. Spearman intercorrelations between the variables in the research model (part 2)*

| | *M* | *SD* | VC1 | VC2 | VC3 | VC4 | Posts1 | Posts2 | Posts3 | Posts4 | Final test grade |
|---|---|---|---|---|---|---|---|---|---|---|---|
| *Synchronous communication* | | | | | | | | | | | |
| Participation in VC1 | .70 | .46 | - | | | | | | | | |
| Participation in VC2 | .50 | .50 | 0.18 | - | | | | | | | |
| Participation in VC3 | .40 | .49 | 0.25** | 0.41** | - | | | | | | |
| Participation in VC4 | .38 | .49 | 0.23** | 0.41** | 0.50** | - | | | | | |
| *Asynchronous communication* | | | | | | | | | | | |
| Posts Period 1 | 10.62 | 10.13 | 0.16 | 0.43** | 0.42** | 0.36** | - | | | | |
| Posts Period 2 | 6.36 | 7.33 | 0.04 | 0.32** | 0.42** | 0.38** | 0.41** | - | | | |
| Posts Period 3 | 5.53 | 4.84 | 0.14 | 0.32** | 0.35** | 0.46** | 0.52** | 0.63** | - | | |
| Posts Period 4 | 2.54 | 2.52 | 0.13 | 0.28** | 0.37** | 0.42** | 0.31** | 0.40** | 0.31** | - | |
| *Performance* | | | | | | | | | | | |
| Final exam grade | 7.50 | 1.19 | 0.19* | 0.46** | 0.64** | 0.61** | 0.60** | 0.59** | 0.69** | 0.63** | - |

N = 110; * $p < 0.05$; ** $p < 0.01$

IMTK = Intrinsic Motivation to Know; IMTA = Intrinsic Motivation to Accomplish; IMES = Intrinsic Motivation to Experience Stimulation;

EMID = Extrinsic Motivation Identified Regulation; EMIN = Extrinsic Motivation Introjected regulation; EMER = Extrinsic Motivation External Regulation

AMOT = Amotivation

AUT = Autonomy oriented; CON = Control oriented

## 3.1 Asynchronous Communication and Motivation

A distinction between autonomy and control-oriented students was made through a median split on the RAI score. A two-tailed Mann-Whitney U-test showed that autonomy-oriented participants posted more messages in total ($U = 1220$, $z = -1.74$, $p < .1$, $r = -0.17$) and also more TR messages ($U = 1234.5$, $z = -1.66$, $p < .1$, $r = -0.16$) than control-oriented students, although both differences were only marginally significant. There were no significant differences in the number of NTR messages.

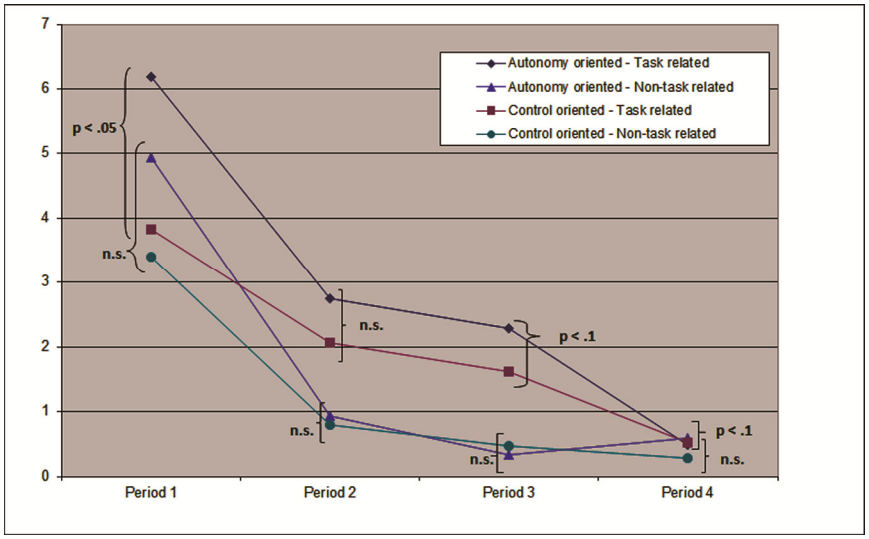


*Figure 5.2. Average contributions for autonomy and control-oriented students for each course period.*

Figure 5.2 shows the average contributions to discourse over the four course periods for autonomy and control-oriented participants. In general, after the first course period, activity in the discussion forums rapidly dropped. The second and third period show some decrease though far less steep, after which a steeper drop follows in the fourth period. When comparing the total number of posts per course period, only in the first period a (marginally) significant difference was found between autonomy and control-oriented students ($U = 1210$, $z = -1.80$, $p < .1$, $r = -0.17$). With respect to quality, a mixed picture emerged: In the first course period, a significantly higher amount of TR messages was posted by autonomy-oriented students ($U = 1180$, $z = -2.00$, $p <$

.05, r = -0.19), but the difference on NTR messages was not significant. Differences between both TR and NTR messages posted by autonomy and control-oriented students in the second period were not significant. During the third period, autonomy-oriented participants posted slightly more TR messages (U = 1250.5, z = -1.76, p < .1, r = -0.17), and again differences on NTR messages were non-significant. Finally, during the fourth period, autonomy-oriented participants posted slightly more NTR messages (U = 1266.5, z = -1.81, p < .1, r = -0.17), and differences between the number of TR messages were non-significant. Figure 5.3 visualises the findings by depicting the correlations between autonomy motivation, TR and NTR posts.

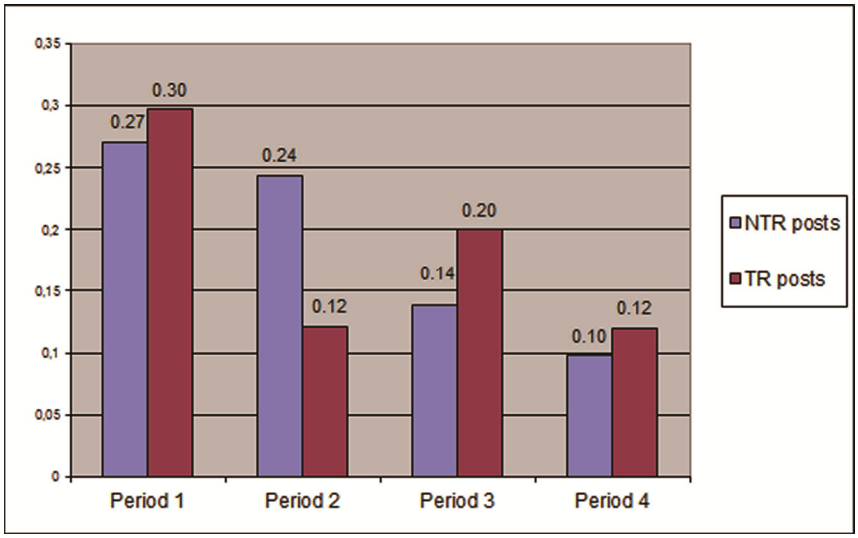


*Figure 5.3. Correlations between autonomy motivation, TR and NTR posts per course period*

In sum, although there were indications that autonomy-oriented students engaged more in asynchronous communication both in terms of quantity and quality (H1a), there is mixed support for this hypothesis. The same is true for H1b as differences in quantity and quality of forum posts were not associated with higher levels of autonomous motivation in each separate course period. Autonomous motivation seemed to primarily have an effect at the beginning of the course, but this effect seemed to wear off in subsequent periods.

## 3.2 Including Synchronous Communication

In each course period, a distinction was made between participants and non-participants attending the web-videoconference during that period. Table 5.4 contains the descriptives and Mann-Whitney U-test statistics for the total number of messages, and for TR and NTR messages posted by autonomy and control-oriented participants per period.

As can be seen in Table 5.4, for total and TR postings, students who took part in the web-videoconferences posted more on average than those who did not, which is true for both autonomy and control-oriented students separately, with the exception of the first course period for autonomy-oriented students. These findings largely support our expectations that participation in a web-videoconference is associated with higher engagement in the asynchronous forums, both in terms of quantity and quality (H2a).

Interestingly, when looking at participants in the web-videoconferences only, a Mann-Whitney U-test showed none of the differences between autonomy and control-oriented students in total or TR postings to be significant. The same was found for autonomy and control-oriented students who did not participate in a web-videoconference. Thus, the support for H2b, H2c, and H3 is inconclusive as differences between the motivational orientations could not be confirmed: participants and non-participants posted alike regardless of their motivational orientation.

*Table 5.4. Mann-Whitney U-test (two-tailed) results comparing average postings of web-videoconference participants and non-participants for each motivational orientation and course period separately*

| | | Web-videoconference participation | | | | | | Mann-Whitney U-test | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | | *Yes* | | | *No* | | | | | | |
| | | *n* | *M* | *SD* | *n* | *M* | *SD* | *U* | *z* | *p* | *r* |
| *Autonomy oriented* | | | | | | | | | | | |
| Period 1 | | 37 | | | 16 | | | | | | |
| | Total | | 11.86 | 12.08 | | 9.69 | 12.05 | | | n.s. | |
| | NTR | | 5.35 | 6.80 | | 4.00 | 5.92 | | | n.s. | |
| | TR | | 6.41 | 6.35 | | 5.69 | 7.04 | | | n.s. | |
| Period 2 | | 27 | | | 26 | | | | | | |
| | Total | | 6.67 | 9.44 | | 0.81 | 1.65 | 146.0 | -3.86 | .000 | -0.53 |
| | NTR | | 1.37 | 2.02 | | 0.46 | 1.17 | 255.5 | -2.05 | .040 | -0.28 |
| | TR | | 5.11 | 8.99 | | 0.31 | 0.68 | 163.5 | -3.74 | .000 | -0.51 |
| Period 3 | | 27 | | | 26 | | | | | | |
| | Total | | 4.11 | 4.12 | | 1.15 | 2.92 | 157.0 | -3.68 | .000 | -0.51 |
| | NTR | | 0.30 | 0.72 | | 0.38 | 1.3 | | | n.s. | |
| | TR | | 3.78 | 3.99 | | 0.73 | 1.71 | 154.0 | -3.77 | .000 | -0.52 |
| Period 4 | | 24 | | | 29 | | | | | | |
| | Total | | 1.95 | 2.91 | | 0.38 | 1.05 | 149.5 | -3.95 | .000 | -0.54 |
| | NTR | | 0.96 | 1.16 | | 0.28 | 0.65 | 200.0 | -3.07 | .002 | -0.42 |
| | TR | | 0.96 | 2.05 | | 0.10 | 0.56 | 232.0 | -3.04 | .002 | -0.42 |
| *Control oriented* | | | | | | | | | | | |
| Period 1 | | 40 | | | 17 | | | | | | |
| | Total | | 8.70 | 7.94 | | 3.94 | 5.40 | 185.0 | -2.71 | .007 | -0.36 |
| | NTR | | 4.03 | 3.40 | | 1.88 | 2.89 | 178.5 | -2.86 | .004 | -0.38 |
| | TR | | 4.58 | 4.79 | | 2.06 | 3.17 | 214.5 | -2.23 | .025 | -0.30 |
| Period 2 | | 28 | | | 29 | | | | | | |
| | Total | | 4.03 | 5.36 | | 1.90 | 4.09 | 233.5 | -2.92 | .004 | -0.39 |
| | NTR | | 1.14 | 1.84 | | 0.44 | 1.02 | | | n.s. | |
| | TR | | 2.71 | 3.49 | | 1.44 | 3.22 | 245.0 | -2.74 | .006 | -0.36 |
| Period 3 | | 17 | | | 40 | | | | | | |
| | Total | | 4.24 | 6.83 | | 1.18 | 2.61 | 240.0 | -2.05 | .041 | -0.27 |
| | NTR | | 0.88 | 0.76 | | 0.30 | 1.96 | | | n.s. | |
| | TR | | 3.35 | 5.34 | | 0.88 | 1.98 | 228.5 | -2.36 | .018 | -0.31 |
| Period 4 | | 18 | | | 39 | | | | | | |
| | Total | | 2.06 | 2.51 | | 0.23 | 0.54 | 176.5 | -3.64 | .000 | -0.48 |
| | NTR | | 0.67 | 0.77 | | 0.10 | 0.31 | 205.5 | -3.42 | .001 | -0.45 |
| | TR | | 1.39 | 2.40 | | 0.13 | 0.47 | 219.5 | -3.28 | .001 | -0.43 |

Mann-Whitney U-test results include *U*-statistic, *z*-values, *p*-levels, and effect size (*r*)
N = 110 for every period

## 3.3 An Integrated Dynamic Path Model

A path model was calculated to obtain insights into the complex relations between the study variables over time, relating motivational orientation, participation in the synchronous web-videoconferences, and postings in the asynchronous discussion forums. Because the number of students who completed the final exam was 45.5% of this study's population, including this variable would lead to a sample size that is too small for path modelling (Anderson and Gerbing (1988) postulate a minimal sample size between 100 and 150), this variable is not included in the path model and relations with other variables are calculated using regression analysis. As the main focus of this study is on the relation between the actual use of synchronous and asynchronous communication, and motivation, we feel this choice to be legitimate.

Because we aimed to make visible any influence of the three motivational orientations, these were included based on their corresponding AMS subscales (i.e. IMTK, IMTA, IMES, and EMID for autonomy orientation; EMER and EMIN for control orientation, and AMOT for amotivation) and not the weighed RAI score. Using LISREL 8.8, several models were calculated, with and without making a distinction in the quality of postings (TR and NTR). Because differences in quality were shown to be inconclusive in previous analyses, and to obtain a model that best allows us to illustrate the transition over time between synchronous and asynchronous communication, total posts per period were favoured over making the distinction in quality. The dynamic nature of the model is that of a growth-model, so time-lagged relationships provide the specification of the several paths: synchronous communication intensity is hypothesized to depend on the level of intensity in the previous videoconference, and asynchronous communication intensity in the period in between the two videoconferences, whereas the number of postings is hypothesized to depend on the number of posts in the previous period, and activity in the previous videoconference.

The fit indices provided by LISREL show the resulting model adequately fits the data ($\chi^2$ (40)=34.75 (n.s.), SRMR = 0.069, RMSEA = 0.000, 90% CI RMSEA = [0.000 – 0.047], NFI = 0.93, NNFI = 1.00, CFI = 1.00). Figure 5.4 depicts the path model with standardized estimates (beta's) of the relations between the

model factors through time. Non-significant relations are depicted by a dashed arrow, all other relations are significant at p < .05.

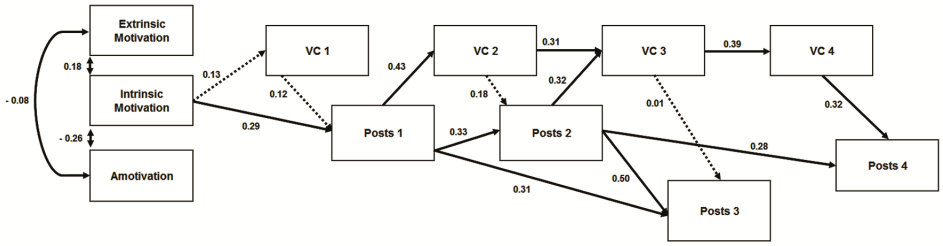


*Figure 5.4. Path model (N=110) with standardised Beta scores depicting the relations between study variables*

The main conclusion to be read from the path diagram was that the impact of motivation on synchronous and asynchronous communication intensity was solely through autonomous (intrinsic) orientation. Neither control (external) orientation nor amotivation did have any impact on videoconference participation in any period, or posts to the forum in any period. Interestingly, autonomous motivation was shown to be the only motivational variable with predictive value for engagement in asynchronous communication only, and only for the first course period.

Furthermore, the direct impact of autonomous orientation was limited to the first period, with a strong, positive impact on asynchronous communication, and a somewhat weaker, positive impact on synchronous communication. In later periods, any direct impact of motivation was suppressed by an indirect impact through communication intensity in the previous period. The absence of a direct path from autonomous orientation to communication intensities in later periods was in line with our earlier observations of a steadily decreasing role of the motivational variables. Instead, activity in the preceding period acted as the main predictor from period 2 onwards.

The path across the four separate course periods in Figure 5.4 (thus reading from left to right) was strongest via asynchronous communication, which makes sense as the core of the knowledge construction took place there. Engagement in asynchronous discussion in the second course period is strongly related to engagement in asynchronous discussion in the subsequent two periods, especially between the second and the third (B = 0.50).

Furthermore, the influence of engagement in asynchronous discussion on participation in the subsequent web-videoconference (in the next course period) was relatively strong, with beta's ranging from 0.32 to 0.43.

The expected mutual influence of synchronous and asynchronous communication appeared to be most strong in the paths from asynchronous to synchronous communication, with all paths being significant at $p < .05$ and of moderate size. Paths in the reverse direction were somewhat weaker, except for the last period. The positive beta's indicate a mutual influence of engagement in synchronous and asynchronous communication, however stronger in one direction and not all are significant.

A multiple regression analysis was performed including only the students who completed the final exam. This choice was made to avoid a confound from the high number of students that did not complete the final exam and may have or have not been active in the synchronous and/or asynchronous communication. No significant effect of the motivation nor communication variables on the final exam score was found except for the number of posts made in the third course period ($R^2 = .20$, B(SE) = .07 (.02), $\beta = .45$, $F(1, 49) = 11.90$, $p < .01$). This gives some indication that persistence in activity during the course leads to better results. A summary of the main findings is presented in Table 5.5.

*Table 5.5. A summary of the results per hypothesis*

| Hypothesis | Independent variable(s) | Dependent variable | Dynamics | Expectation | Outcome |
|---|---|---|---|---|---|
| H1a | Motivation | Quality and quantity of asynchronous communication | All course periods | Positive association with higher levels of autonomous motivation | Mixed support: indications that autonomy-oriented students engaged more in asynchronous communication both in terms of quantity and quality. The path model confirmed this direct relationship for the first period of the course. |
| H1b | Motivation | Quality and quantity of asynchronous communication | Per course period | Positive association with higher levels of autonomous motivation | Mixed support: Autonomous motivation seemed to primarily have an effect at the beginning of the course, but this effect seemed to wear off in subsequent periods. This was supported by the path model. |
| H2a | participation in synchronous web-videoconferences | Quality and quantity of asynchronous communication | Per course period | Positive association | Supported: students who took part in the web-videoconferences posted more , and more TR messages on average than those who did not. |
| H2b | Motivation participation in synchronous web-videoconferences | Quality and quantity of asynchronous communication | All course periods | Positive association, both for autonomy and control oriented motivation. | Mixed support: taken separately, both autonomy and control-oriented students who took part in the web-videoconferences posted more on average and more TR messages than those who did not, but with marginal significance. |
| H2c | Motivation participation in synchronous web-videoconferences | Quality and quantity of asynchronous communication | Per course period | Positive association, both for autonomy and control oriented motivation. | Inconclusive: after the first course period, participants and non-participants in synchronous communication posted alike regardless of their motivational orientation. The path model supported the direct effect of autonomy oriented motivation in the first period, which became indirect in subsequent periods. |
| H3 | Motivation participation in synchronous web-videoconferences | Quality and quantity of asynchronous communication | All course periods and Per course period | Positive association,highest for autonomy oriented motivation. | Inconclusive: after the first course period, participants and non-participants in synchronous communication posted alike regardless of their motivational orientation. The path model supported the direct effect of autonomy oriented motivation in the first period, which became indirect in subsequent periods. |

# 4. Discussion

This study explored the dynamic interrelations between synchronous and asynchronous communication in online learning, including the impact of motivation. We expected to find a positive relation between participation in synchronous communication on engagement in asynchronous communication (H2a), for both autonomy and control-oriented students (H2b), over all course periods (H2c), but stronger for autonomy-oriented students (H3). Our results showed that engagement in synchronous communication indeed positively affected engagement in asynchronous communication, with participants who did engage in video-conferences posting more, and more task-related messages in all periods than participants who did not, both for autonomy (with the exception of the first period) and control-oriented students. Moreover, the findings that: a) participants in a web-videoconference on the whole contributed more to the asynchronous discussions both in quality and quantity, b) autonomy and control-oriented students who participate in the web-videoconference post alike, and c) the influence of autonomous motivation was found to be limited in the path model, further point toward a positive influence of synchronous communication, as control-oriented students seem to be as much engaged into collaborative knowledge construction as autonomy-oriented students. However, the path model showed that the effect of asynchronous communication on synchronous was stronger than the reverse relation.

Based on previous research (Rienties et al., 2009; Rienties, Giesbers, et al., 2012), we expected that engagement in asynchronous communication both in terms of quality and quantity would be positively associated with higher levels of autonomous motivation (H1a) in each course period (H1b). Our results could not unambiguously confirm these expectations; both the non-parametric tests as well as the integrated path model revealed a mixed picture. Offering an integrated perspective over time, a path model showed only autonomous motivation to moderately explain the use of the discussion forums but only for the first course period. This is remarkable, since previous findings in a similar setting - but using only asynchronous communication - (Rienties et al., 2009; Rienties, Giesbers, et al., 2012) did show a strong (continued) effect of motivation on posting behaviour.

Reasons to help explain our findings most likely are different from demographic background of the population, and drop-out rates, as these were similar to previous years of the course (Giesbers et al., in press). Our findings regarding the fact that the influence of motivation was limited to the first course period fits findings from previous research where intrinsic motivation has been found to be high at the beginning of a course but to decrease later on (Guay et al., 2008; Guay, Vallerand, & Blanchard, 2000).

An alternative explanation could for example be that offering synchronous communication afforded control-oriented learners to be equally engaged in knowledge construction as autonomy-oriented learners. What may have also influenced our results is the extent to which the use of combined communication modes provided support for the tasks or learning activities at hand. Hrastinski et al. (2010) argued synchronous communication to have an intermediate to strong effect as task-support, but in their studies no distinction was made between different kinds of tasks, or in motivational profiles of the learners. It may be that there are certain learning tasks that are better supported by (a combination of) synchronous or asynchronous communication, and that the combination of tasks and communication mode influences student motivation.

Furthermore, Järvelä, Volet, and Järvenoja (2010) and Guay et al. (2008) suggested that motivation may very well be influenced by peers and therefore can also be seen as a dynamic result of group interaction compared to a more static individual characteristic. As such, participating in a web-videoconference, which enlarges the interpersonal dynamics, may have provided opportunities for students to mutually influence each other's motivation to engage in learning.

Future research should therefore include the role of tasks or learning activities, social factors, and collaborative construction of motivation when combining asynchronous and synchronous communication in online learning. This leads to three recommendations for further research: First, a dynamic analysis of motivation (i.e. via repeated measurement) is needed to identify changes over time. Second, in order to validate whether changes are influenced by task attributes or social factors, repeated motivational measurements should be combined with an analysis of synchronous discourse. The latter can, for example, be done in the form of content analysis of

transcribed synchronous communication. Third, using social network analysis in combination with content analysis has been found to be a powerful tool to help understand group behaviour in online learning situations (De Laat, Lally, Lipponen, & Simons, 2007; Rienties et al., 2009). Using this method would allow to gain further insight in the effect of combined communication modes on the development of group relations over time.

A potential limitation of this study is the fact that the course was facultative and students could choose to be active or not. This, for example, may explain the finding that the influence of asynchronous communication on synchronous communication was stronger than the reverse. On the one hand, our context provided a unique opportunity to study the interrelation of variables in an authentic environment, but at the same time it may have influenced our results and may limit their generalizability to obliged courses. However, freedom of participation applies to many online course settings, where students voluntarily join for a variety of reasons (Bernard et al., 2004; Marks, Sibley, & Arbaugh, 2005). A high drop-out rate also is a characteristic of facultative courses where retention rates have been found to differ from 20-60% (Park & Choi, 2009; Rovai, 2003), in which our course is no exception. Apparently, the use of synchronous communication did not forestall the large drop-out rate. We therefore feel it is useful to conclude this study with a number of practical implications derived from our experiences that may help to improve online education based on a combination of synchronous and asynchronous communication.

## 4.1 Practical Implications

The path model indicated that autonomous motivation only had an impact at the start of the course, and the results presented in Table 5.4 showed that for autonomy-oriented students, it did not matter for the quantity and quality of posts whether they did or did not attend the videoconference in period 1. This suggests that at the start of an online course, efforts to enhance students' engagement in synchronous communication would mainly benefit control-oriented learners, but after the first course period, the motivational profile does not have a significant impact and autonomy-oriented students may benefit just as much from active encouragement to continue to attend the videoconferences and actively

engage in the discussion forums. As we found a positive mutual influence between the two communication modes, it is interesting to find ways that stimulate engagement in both.

Group decisions to use asynchronous online communication have been found to depend on three aspects (So, 2009) that we feel could also apply to the use of synchronous communication. The first is a successful experience during the first trial of online communication. During the course, this has been explicitly supported by active tutoring in both synchronous and asynchronous communication. The second and third aspects are students' perceived affordances of the communication tools, and the interplay between the perceived efficiency and the nature of the collaborative tasks. It may be that engagement in synchronous communication may increase by emphasising these two aspects more explicitly.

Offering one web-videoconference per week for the first four weeks may have been too little, as many students engage in work or holiday activities during the summer period. In addition, offering synchronous meetings also decreases the freedom of time and place as students need to have access to a computer with internet at a certain time. These issues can be remedied by offering two or more per week, and allow students to choose when to participate, thereby increasing the flexibility of the course.

A more direct way to keep students actively involved is for example by scripting (i.e., a structured description on how to work on a specific task and/or how to collaborate with each other; Weinberger, Reiserer, Ertl, Fischer, & Mandl, 2005) or by assigning roles (Strijbos & De Laat, 2009). Face-to-face PBL settings usually assign roles like, for instance, discussion leader and scribe (Loyens et al., 2011) that are aligned with the function to give direction the discussion and to create a backlog of what is discussed. Wise, Padmanabhan, & Saghafian (2010) provide usable examples of how to implement roles based on functions. For example, assigning the roles of elaborator (who has the task to expand ideas that are brought into the discussion), questioner (who has the task to stimulate others to go deeper and elaborate on their contributions) and devil's advocate (who has the task to take a contrary position to ideas that are brought in and find arguments in support of their position) can be used to stimulate responses. A concrete and unambiguous description of the roles is necessary to support students in taking a certain role and avoid confusion

(Wise et al., 2010). Assigning a concrete task in the form of a script or a role may on the one hand limit autonomy, but on the other hand, it may actually provide more structure and support for autonomy, helping students to shape their own learning process.

A final remark regarding future developments we would like to make, is that possibilities on the use of artificial intelligence (AI) to support teachers moderating discussions have advanced considerably. For example, McLaren, Scheuer, and Mikšátko (2010) reported initial positive results of an AI-based system (ARGUNAUT) that helps teachers identify key contributions and patterns when moderating multiple asynchronous group discussions. Further developments in this area are very promising, as this type of functionality enables teachers to focus autonomy support and structure more appropriately and timely, either through asynchronous or synchronous communication, in order to support student self-regulation and enhance student activity.

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## Appendix A: Content Analysis Model of Veerman & Veldhuis-Diermanse

| | Message | | Example in Economics |
|---|---|---|---|
| | ***Not Task-Related*** | | |
| **Cat 1** | - *Planning* | | "Shall we first complete Task 1, before we go on with the next one?" |
| **Cat 2** | - *Technical* | | "Does anybody know how to add a graph to my thread?" |
| **Cat 3** | - *Social* | | "Good summary!" |
| **Cat 4** | - *Nonsense* | | "Who wants to join us for a drink in the pub?" |
| | ***Task-Related*** | | |
| | - *New Idea* | | |
| **Cat 5** | | *Facts* | "The average rate of inflation in the U.S. for 2004 is 2.7 %." |
| **Cat 6** | | *Experience / Opinion* | "I think that VAT-taxes should be reduced to increase demand." |
| **Cat 7** | | *Theoretical Ideas* | "According to Perloff (2003), consumers maximize utility subject to a budget constraint." |
| **Cat 8** | - *Explicitation* | | "Moreover, this process necessitates that MR = MC." |
| **Cat 9** | - *Evaluation* | | "Overall, combining the concept of utility and welfare, social welfare is maximized when every individual can sets MR = MC, without distortions." |

Note: This table is based on Veerman and Veldhuis-Diermanse (2001), p.626. The examples in Economics are extracts from the discussion boards of the online course. For a more detailed description of the application of the content analysis in this context, see Rienties et al. (2009).

# Chapter 6

# General Discussion and Conclusion

## 1. Results of this dissertation

In this dissertation, I aim to contribute to the body of knowledge on the complex dynamics of learner interactions in computer-supported collaborative learning (CSCL) by addressing the combined use of asynchronous and synchronous communication in e-learning, and the effect of learner motivation thereon. Where previously online communication had been asynchronous and text-based, technological developments have recently made it possible to support online learning processes by the use of rich synchronous communication tools, like Skype or web-videoconference. These tools are widely available nowadays and offer real-time communication that resembles face-to-face interaction through (a combination of) audio, video, and chat. This development is very promising to alleviate several challenges that occur in asynchronous collaborative learning.

CSCL research shows that a delay in response in asynchronous communication may lead learners to experience the communication process as impersonal and distant (Hrastinski, 2008; Hrastinski, Keller, & Carlsson, 2010; Yang, Tsai, Kim, Cho, & Laffey, 2006). Furthermore, text-based asynchronous communication incorporates an increased risk of misconceptions to occur. The delay in response in turn causes a delay in the correction of these misconceptions (Haythornthwaite, 2000; Rummel & Spada, 2005). Finally, large differences between learners' participation and activity levels in asynchronous collaborative learning were frequently found (Schellens & Valcke, 2005), quite often contributed to learners' individual levels of motivation (Chen & Jang 2010; Järvelä, Volet, & Järvenoja, 2010; Martens, Gulikers, & Bastiaens, 2004; Rienties, Tempelaar, Van den Bossche, Tempelaar, & Segers, 2009).

It has been suggested that synchronous communication is superior to asynchronous communication in establishing discourse, because synchronous communication can overcome the lack of bodily communication, delayed feedback, and barriers of meaning that occur when communicating asynchronously (Beers, Boshuizen, Kirschner, & Gijselaers, 2007; Derks, Bos, & Van Grumbkow, 2007; Haythornthwaite, 2000; Rummel & Spada, 2005; Tu,

2002). Synchronous tools add 'humanness' to online communication, which may especially be useful to engage less motivated learners into the learning process (Hrastinski et al., 2010). A downside of using synchronous communication in CSCL settings, however, is that it decreases the flexibility of learners, as they have to be online at a specific time and at a place that offers sufficient bandwidth. Also, using an extra mode of communication further increases the complexity of the learning process and requires learners to get acquainted with new technology.

The availability of rich synchronous online communication tools that go beyond textual communication is very recent, and therefore no conceptual framework concerning the pedagogical use of combined online communication modes has been available. Research findings regarding a combined use of asynchronous discussion forums and synchronous chat provide an indication that combining both can indeed improve online student learning, engagement, and satisfaction (Hrastinski et al., 2010; Johnson, 2006). As the use of combined communication modes in CSCL connects to the social, technological, and motivational dimensions, three conceptual models (Community of Inquiry, Technology Acceptance Model, Self-Determination Theory: see next section) are used in this dissertation as a basis to approach the subject. Chapters 2 and 3 therefore focus on the social aspect of combining both communication modes in the online collaborative learning process. Chapters 4 and 5 are based on an integrated and temporal approach referring to the technological and motivational levels. The following will first summarize and discuss the findings regarding the separate research questions from each of the conceptual models. This will be followed by a discussion of practical implications of the findings. The chapter will be concluded with a view toward future developments in research and practice.

## 1.1 The Social Presence Dimension: The Effect of Combining Synchronous and Asynchronous Communication on Learner Satisfaction and Performance

The first part of this dissertation (Chapters 2 and 3) consists of two studies on the effect of using both synchronous and asynchronous communication on learners' perceived learning experience and learner performance. Both studies

depart from the basis that the use of synchronous communication via rich tools is expected to enhance the social aspect of online collaborative learning. The Community of Inquiry (CoI) model (Garrison, Anderson, & Archer, 2000) has been chosen as the model of reference, as it is a well-researched model that identifies meaningful online learning by the interrelation of three factors: cognitive presence (i.e. "the extent to which the participants in any particular configuration of a community of inquiry are able to construct meaning through sustained communication." (Garrison et al., 2000, p. 89)), teaching presence (i.e. the organisation of the learning process and instructional design, facilitating discourse, and direct instruction (Anderson, Rourke, Garrison, & Archer, 2001)), and social presence (i.e. "the ability of participants […] to project their personal characteristics into the community, thereby presenting themselves to the other participants as 'real people'" (Garrison et al., 2000, p. 89)). Adding synchronous communication tools to asynchronous communication is expected to afford higher levels of social presence, in this way remedying the previously mentioned challenges of asynchronous communication (e.g. delay in feedback, feelings of isolation) and foster higher learner engagement.

Collaborative learners using synchronous web-videoconferences in combination with asynchronous discussion forums are expected to be more positive about their learning experiences (in terms of course design, goals and tasks, group collaboration, instruction, and learning satisfaction), and to show improved performance compared to collaborative learners using discussion forums only. In Chapter 2, two designs of the same online course (the ePBL design that uses asynchronous discussion forums only, and a web-videoconference design in which these forums are combined with weekly web-videoconferences) are compared with respect to (self-reported) learner satisfaction and performance rates. In Chapter 3, two additional implementations of this design are added to provide a more robust replication of the initial study.

A comparison of learner satisfaction scores shows that participants in the ePBL course design (using asynchronous discussion forums only) have been less positive about the clarity of goals and tasks of the module. No differences are found regarding the learners' evaluations of the learning experience, group collaboration, teacher presence and self-determination. Furthermore, learners

in the web-videoconference design (using combined communication modes) have significantly lower pass rates: Fewer learners have been able to complete (and thus pass for) the course when collaborating with web-videoconferencing tools in addition to asynchronous discussion forums. These findings are surprising, as many researchers in CSCL would argue that the affordances of synchronous communication tools will lead to an improved and more authentic learning experience, which would lead to higher overall evaluation results (Hrastinski, 2008; Hrastinski et al., 2010; Rummel & Spada, 2005; Strømsø, Grøttum, & Lycke, 2007) and better academic retention. The implementation of rich synchronous tools in combination with asynchronous tools in itself provides little insight that help explain these findings. Adding rich synchronous communication tools decreases learner flexibility as it poses restrictions to time and place, and it increases the complexity of the online learning process. It may thereby lead to distraction from learning rather than being a constructive addition (cf. Rogers and Lea, 2005). Furthermore, the degree to which learners actually use rich synchronous tools is unknown and may (in part) be determined by individual factors like self-determination. Thus, more insight in learner behaviour and related learner characteristics is needed to help understand the findings.

## 1.2 The Technological and Motivational Dimension: Usage Behaviour of Synchronous Communication Tools and the Influence of Self-determination

The findings in Chapters 2 and 3 that learner retention does not improve and learner performance is lower in the context based on combined communication modes can be interpreted and accepted as putting an end to all efforts to find an effective combination of synchronous and asynchronous communication tools in CSCL. However, doing this means to ignore previously found potential of synchronous communication in CSCL (Hrastinski, 2008; Hrastinski et al., 2010; Rummel & Spada, 2005; Strømsø et al., 2007). More importantly, concluding an elaborate meta-analysis of research on communication in CSCL, Luppicini (2007) argued that to enhance the understanding of new dimensions in CSCL that did not exist ten or twenty years ago (e.g. web-videoconferencing), it has to be approached as a complex

system encompassing multiple factors from a temporal point of view. In other words, conducting in-depth and inter-temporal research may help to enhance the understanding of learner behaviour regarding the use of synchronous and asynchronous communication in CSCL. Identification of factors explaining the higher drop-out and lower performance is useful in order to formulate advice and/or design guidelines for teachers and learners in (facultative) online courses on how to enhance the learning process.

Before investigating the dynamic and temporal interrelation between synchronous and asynchronous communication in online learning, I first focus on learners´ usage behaviour of synchronous communication tools separately (Chapter 4). The influence of individual motivation is taken into account, as well as the mutual impact of motivation and learners' usage of synchronous communication on learner performance. The study is based on the propositions that: 1) rich synchronous tools foster more direct interaction and interaction fosters engagement, and 2) the actual use of tools and the resulting interactions in the learning situation are related to learners' motivation. In addition, Self-Determination Theory (SDT) (Deci & Ryan, 1985, 2002) has been chosen as conceptualisation of motivation. SDT enables to make a distinction between autonomy-oriented learners (i.e. learners with an intrinsic drive who can effectively steer their own learning), and control-oriented learners (i.e. learners with an external drive, who are less efficient in steering their learning process). Individual self-determination is expected to explain the use of rich synchronous communication tools, and the combination of self-determination and rich tool usage is expected to explain learner performance.

The findings in Chapter 4 show that drop-out (learners not completing the final exam) is reflected by non-participation in the web-videoconferences of which the largest proportion occurred already in the second week of the course. A positive trend is found regarding the use of rich communication tools and participation in the web-videoconferences. Regarding the influence of self-determination, higher levels of autonomous motivation are indeed associated with participation in more web-videoconferences. However, these associations are not as strong as expected. In addition, the expected relationship between higher levels of intrinsic motivation and the use of rich synchronous communication tools cannot be confirmed. A similar mixed pattern is found for relationships between autonomous motivation and performance as indicated

by final exam scores. While there is a significant positive correlation between the use of communication tools and scores on the final exam, only the number of times learners participated in the web-videoconferences is positively associated with the final exam scores.

The indication that the use of rich synchronous tools is positively associated with the number of web-videoconferences participated in adds to the knowledge base built by previous research in which rich synchronous tools have been suggested to foster higher levels of learner engagement (Carr, Cox, Eden, & Hanslo, 2004; Hrastinski et al., 2010; Strømsø et al., 2007). However, the use of rich tools could not be explained from learners' level of self-determination, a relation that was suggested by previous research (Roca & Gagné, 2008; Sørebø, Halvari, Gulli, & Kristiansen, 2009). It seems likely that the expected link between autonomous motivation and the use of rich tools was weakened by the fact that regardless of the tools used, all learners could experience beneficial effects on their sense of competency, relatedness, and autonomy (e.g. despite the fact that others could not see or hear them, participants using only chat could have felt a quite high degree of direct and personal contact because they could see and hear others).

Many studies found that engagement in asynchronous communication is determined by self-determination (Järvelä et al., 2010; Martens et al., 2004; Rienties et al., 2009; Rienties, Tempelaar, Giesbers, Segers, & Gijselaers, 2012; Schellens & Valcke, 2005) which also seems to be the case for synchronous communication. Furthermore, research regarding asynchronous communication suggested that efforts to engage learners should start as early as possible (Rienties, Tempelaar, et al., 2012). The finding that participation rates in the synchronous web-videoconferences already give an indication of the eventual drop-out point in the same direction: Also when using synchronous communication, efforts to engage learners in the learning process should start in an early stage of the course, and should include a focus on the use of rich synchronous tools.

Though the view on learner behaviour in synchronous communication provided useful insights, it leaves questions unanswered regarding the mutual influence of synchronous and asynchronous communication in online learning over time, and the influence of self-determination thereon. For example, how do learners balance the use of synchronous and asynchronous communication

during the runtime of an online course, and how are these decisions are related to learners' degree of self-determination? Therefore, the fourth and final study (Chapter 5) aims to investigate the dynamic and temporal interrelation between synchronous and asynchronous communication in online learning, by also including the impact of motivation and learner performance. Like in Chapter 4, motivation has been conceptualised via SDT. The temporal approach of the study in Chapter 5 relates to the fact that learning processes are distinguished in subsequent time-periods of about a week, each characterized by a synchronous web-videoconference followed by a period of asynchronous discussions.

A first expectation is that the quantity and quality of asynchronous discourse will be positively associated with autonomous motivation, in each of the four course periods. Second, it is expected to find a positive relation between participation in synchronous communication and the quantity and quality of asynchronous discourse, both for autonomy and control-oriented learners. Third, the positive association between participation in synchronous communication and quantity and quality of asynchronous communication is expected to be strongest for autonomy-oriented learners.

After analysing the relations between individual variables, an integrated path model has been calculated including all variables to investigate the joint associations. Including the variables per sub-period creates a dynamic view of the relations between variables over time which allows making inferences about the causality of the associations.

As expected, findings from this dynamic approach show engagement in synchronous communication to positively affect engagement in asynchronous communication: Participants engaged in synchronous web-videoconferences posted more messages overall and more task-related messages in all periods than participants who did not attend the synchronous web-videoconferences. The integrated perspective of dynamic descriptors of engagement in synchronous and asynchronous online communication over time as depicted by the path model shows autonomous motivation to primarily explain the engagement in asynchronous discussion forums but with moderate impact. That is, only in the first course period a direct effect of autonomy-oriented motivation is found. In all subsequent periods, the effect of autonomous

motivation is shown to be indirect and both autonomy- and control-oriented learners post alike.

Previous research showed a positive and direct effect of autonomy-oriented motivation on engagement in asynchronous communication (e.g. Järvelä et al., 2010; Martens et al., 2004; Rienties et al., 2009; Rienties, Tempelaar et al., 2012; Schellens & Valcke, 2005). The findings from Chapter 5 are interesting in this respect, as control-oriented learners seem to be as much engaged into asynchronous communication as autonomy-oriented learners when participating in synchronous communication. Some caution should be taken into account here, because the path model showed that the effect of asynchronous communication on synchronous was stronger than the reverse relation. In addition, the findings from Chapter 5 give further weight to the previously made observation of the importance to start engaging learners in the learning process as early as possible, and to focus on the use of rich synchronous tools.

The combined findings from all studies in the present dissertation indicate the following:

1) Only in the first week a direct effect from autonomy and control-orientation is visible, and motivation primarily explains differences in qualitative and quantitative aspects of asynchronous discussions;
2) From the second week onwards, the influence of motivation is indirect via the engagement in synchronous and asynchronous communication in earlier sub-periods of the course;
3) Active participation in web-videoconferences explains qualitative and quantitative aspects of asynchronous discussions;
4) Both synchronous and asynchronous communication in the last half of the course, from the third course period onward (as shown in the path model), have a positive influence on the final exam grade;
5) The combination of the previous points can be interpreted as a positive effect of combining synchronous and asynchronous communication on online collaborative learning: engagement in both modes leads to better results which cannot be directly attributed to autonomous motivation. This adds to previous findings in a similar context- but using only asynchronous communication - (Chen & Jang, 2010; Järvelä et al., 2010; Martens et al., 2004; Rienties et al., 2009;

Rienties, Tempelaar et al., 2012; Schellens & Valcke, 2005), where a strong (continued) effect of motivation on posting behaviour, both from a static as well as a dynamic perspective was found.

These findings show that when looking at a combination of factors over time, it is possible to extend the initial findings and provide an in-depth view of learning behaviour in a CSCL setting based on a combination of synchronous and asynchronous communication, and the role of motivation thereon. In the following section, the findings from the four studies will be put in perspective into advice/design guidelines for practical implementation.

# 2. Practical Implications for Online Education

Hrastinski and colleagues (2010) pointed out that that it is impossible to provide a success recipe for the application of synchronous communication as its characteristics (based on text, audio, video, or a combination) can differ highly. Furthermore, the context and pedagogical model of an online course also determines the way in which communication media are implemented to support the educational processes. To situate the practical implications derived from this dissertation, it is important to briefly sketch the main underlying aspects of the course:

1) The PBL pedagogical model: This forms the pedagogical basis of the course as part of its aim is to make learners familiar with this model. Learner engagement is promoted by guiding active collaborative knowledge building via the seven-jump method (Loyens, Kirschner, & Paas, 2011).
2) Voluntary setting: Because the course is offered outside the curriculum, no official credits can be gained from participation. Based on the score of a pre-knowledge test, prospective students can estimate if participation would benefit their transition to university.
3) Enhanced scaffolding: offering autonomy support and structure has been found to profoundly influence learner engagement and learning in online settings (Rienties, Giesbers, Tempelaar, Lygo-Baker, Segers, & Gijselaers, 2012; Chen & Jang, 2010). Autonomy support and structure are offered by explicitly listing the seven-jump steps and what is

expected of learners for each step, and by sending regular announcements and updates of occurrences in the course.

These three elements form the basis of the course that has been established already in 2005 (see Rienties, 2010) and in which the combined use of synchronous and asynchronous communication was implemented as an additional step aimed to further increase learner engagement and improve the learning process. Given that this course is based on online PBL it implies a collaborative learning approach. The findings and experiences presented in this dissertation therefore can benefit other online collaborative learning settings as well. The voluntary setting offers a unique possibility for studying learner behaviour, engagement, and the role of self-determination, that can have value not only for voluntary, but also for non-voluntary settings. In addition to the existing scaffolds, the use of synchronous communication in combination with asynchronous communication enhances the possibilities to provide autonomy support and structure. Also from this respect, the results from this dissertation may benefit other settings in online learning.

## 2.1 Practical Implications from the CoI and Social Presence Dimension

In terms of the CoI model, combining asynchronous discussion forums with synchronous web-videoconferences increases the "humanness", which adheres to social presence (Garrison et al., 2000), and which has been suggested to support learner satisfaction and student learning (Hrastinski et al., 2010). However, results from Chapters 1 and 2 did not confirm this. A critical examination of the course context and underlying processes shows one common denominator: the pedagogical model, the scaffolding, and the increase in social presence were all directed at facilitating groups of learners' progress through the course. As a consequence, most structure and autonomy support (cf. Chen & Jang, 2010; Jang & Deci, 2010; Rienties, Giesbers, et al., 2012) was offered at the group level instead of the individual level. The teachers' approach of learners most likely also was influenced by the group approach. The fact that participation in the course was voluntary, thereby making the learners responsible to participate, may have tempted teachers to mainly focus their effort at those who are visibly active. Based on these experiences and research outcomes, I would argue to focus scaffolding both on

a group level (as has been done in the context of the articles presented in this thesis) and on an individual level. Teachers should be aware not to ignore the individual level in favour of the group level when teaching voluntary online courses. With the increased powers of learning analytics (i.e. user statistics in online environments, e.g. see Buckingham Shum & Ferguson, 2012; Siemens & Long, 2011) to track user interactions, teachers are provided with increased opportunities to monitor each learner's engagement, and where needed provide individual support.

In addition, more explicit attention should have been paid to the development of a shared group identity, which Rogers and Lea (2005) argued to be crucial for the development of a powerful online learning experience. They postulate that a shared identity lies at the basis of social presence. If so, this emphasizes the importance to focus on the development of the team identity especially at the beginning of an online collaboration process, in order to optimally benefit from an increase in social presence throughout the course. In addition, I argue to explicitly aim at the development of a shared group identity. This can for example be done via ice breaking exercises (e.g. let learners tell two remarkable facts about themselves of which only one is true. The others have to vote which one it is) during the videoconferences at the start of the course to aim building a shared identity.

## 2.2 Practical Implications from the Motivational and Technological Dimensions

As shown in the previous, CSCL studies show that differences in learner engagement in asynchronous online learning can largely be explained by individual (autonomous / control-oriented) motivation (Chen & Jang, 2010; Järvelä et al., 2010; Martens et al., 2004; Rienties et al., 2009; Rienties, Tempelaar et al., 2012; Schellens & Valcke, 2005). The main result from the studies in this dissertation is that using synchronous communication may level the differences between learners with autonomy- versus control-oriented motivation regarding the quantity and quality of messages posted in the asynchronous discussion forums. That is, a positive direct association between autonomy oriented motivation and learner engagement in the first week of the course has been found, but in later weeks, the direct effect changed into an indirect effect through prior engagement in synchronous and asynchronous

communication. This finding is interesting for practitioners, as the engagement (or lack thereof) of learners in online collaborative learning is a commonly found challenge (Park & Choi, 2009; Rovai, 2003).

A practical inference of this finding would be that efforts to engage all learners should start as early as possible and that motivational data may be helpful to identify learners who are at risk of being less engaged. Asking learners to fill in a motivation questionnaire before the start of the course give teachers insights into the motivational profiles of each group of learners.

In addition, pro-active use of other available user information may further enable timely interventions to enhance learner engagement. For example, as consistent presence in the web-videoconferences enhances the chance to successfully finish the course, the observation of someone being not present can be used to individually address this person and stimulate him or her to be present next time. This can be done by individually mailing each learner, or even better call or skype each learner to know whether there were any problems or issues for non-attending. Likewise, activity levels in a period of asynchronous discussion has been found to be associated with activity levels in consecutive periods of asynchronous discussion and presence in the web-videoconferences. Thus, the number of posts a learner makes, relative to other learners, serves as an indicator of learner activity that may be used to signal learners at risk of inadequate engagement levels, with the aim to stimulate these learners to higher activity levels.

In sum, I advise to:

- Start efforts to engage learners as early as possible;
- Actively focus on the development of group identity as early as possible (e.g. by using ice breaker exercises at the beginning of the course);
- Focus efforts to engage learners in both communication modes, and specifically in rich synchronous communication;
- Focus efforts to engage learners on both group level as well as individual level;
- Try to get insights in the motivational profile of a group and make use of available user statistics (e.g. log-data that represent user interactions).

# 3. The Road Ahead: Future Research and Developments

The studies presented in this dissertation highlighted the complex interaction in online learning between learners, learner satisfaction, learner performance, the actual use of synchronous and asynchronous communication tools, and the role of individual motivation. The fact the research presented in this dissertation has been situated in a voluntary context, which is also what many current developments in online learning like Massive Open Online Courses (MOOC, see e.g. Kop, Fournier, & Mak, 2011) are based on, further enhances its practical relevance. Future research should be aimed to further enhance the understanding of the complex dynamics of online learning using a combination of synchronous and asynchronous communication. As technological developments continue, a thorough understanding is necessary of how to design powerful online courses making the most of the affordances of combined synchronous and asynchronous tools. Therefore, more research is needed on how the combined modes can be used in the design of online courses to yield maximum engagement and performance. This can, for example, be done by building on existing design exemplars, like the course that formed the context of this dissertation, and the work by Hrastinski et al. (2010) or Kirschner & Erkens (2013).

As a first step, I encourage more systematic research on motivation as underlying mechanism that influences learner behaviour and interaction with technology. I would argue for a dynamic measurement of motivation which is fuelled from two lines of research. Recent developments in motivation research show a shift from perceiving motivation as an individual aspect to motivation as the result of a group process (Guay, Ratelle, & Chanal, 2008; Järvelä et al., 2010). Second, technology acceptance research in the context of online education suggests that motivation can result from an interaction between learner and technology (Roca & Gagné, 2008; Sørebø et al., 2009). Furthermore, these studies acknowledge a social influence in the actual usage behaviour by learners (also see Venkatesh & Morris, 2000). The use of combined synchronous and asynchronous communication enhances the complexity of the learning process and enlarges the interpersonal as well as the learner-technology dynamics, which may very well lead to changes in

motivation over time. Unravelling these complex dynamics may be useful, for example, to learn how to best offer autonomy support and structure optimally over time in order to engage learners more in the learning process.

As a second step, an aspect that has not been touched in this dissertation but may give more insight in the complex dynamics of synchronous and asynchronous online learning is its impact on the development of social networks of online collaborative learners. Social Network Analysis (SNA) has been shown to be a powerful and helpful tool to understand the social interaction in groups of online learners, especially when combined with methods such as Content analysis (CA; De Laat, Lally, Lipponen & Simons, 2007; Engel, Coll, & Bustos, 2013; Rienties et al., 2009). Also in face-to-face (Hommes, Rienties, de Grave, Bos, Schuwirth, & Scherpbier, 2012) and blended asynchronous learning contexts (Rienties, Heliot, & jindal-Snape, 2013; Rienties, Hernandez-Nanclares, Jindal-Snape, & Alcott, 2013), dynamic social network analyses provide a thorough understanding of the complex dynamics of team-learning, which acts as a primary predictor for learning performance. This is an interesting approach as initial results by Hrastinski et al. (2010) suggest that synchronous online communication can strengthen the ties in a social network of learners and enhance participation in smaller groups. As I have found limited evidence of enhanced participation in the context of this dissertation, a combination of SNA with CA might shed light on the effect of synchronous communication on the development of the social networks over time.

As a third step, the fact that almost everything done on a computer, be it offline or online, is registered or logged in some way makes it possible to use objective data (i.e. log data, clicks, etc.), which may be used to provide further insights in actual usage behaviour of synchronous and asynchronous communication by online learners. In (online) education, this so called learning analytics approach recently became more popular (e.g. see Buckingham Shum & Ferguson, 2012; Siemens & Long, 2011). Current developments show useful applications of this approach differing from a means to raise self-awareness of underperformers by giving insight in the performance of their peers compared to themselves (Fritz, 2011), to the design and development of early warning tools that allow staff to identify learners at-risk based on their actual usage of a virtual learning environment (MacFadyen & Dawson, 2010). Combining these

types of data with other measures like motivation or drop-out data potentially reveals patterns that are valuable for educators and that otherwise remain hidden.

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# Samenvatting

De vier studies die beschreven worden in dit proefschrift leveren een bijdrage aan onderzoek op het gebied van computerondersteund samenwerkend leren, ofwel Computer-Supported Collaborative Learning (CSCL). De studies zijn gericht op het begrijpen van de complexe dynamiek van online samenwerkend leren waarbij een combinatie van synchrone en asynchrone communicatie wordt gebruikt, en het effect van individuele motivatie op dit gebruik. Tot op heden was online communicatie in CSCL voornamelijk asynchroon en tekstgebaseerd, bijvoorbeeld door het gebruik van discussiegroepen. Huidige technologische ontwikkelingen maken het mogelijk om online samenwerkend leren te ondersteunen met behulp van synchrone communicatiemiddelen die een grotere rijkdom aan informatie overdracht toestaan dan enkel tekst. Denk bijvoorbeeld aan tools als Skype of online videoconferentie die vandaag de dag breed beschikbaar zijn en via een combinatie van audio, beeld en chat de mogelijkheid bieden te communiceren op een manier die overeenkomt met face-to-face interactie. Hierdoor kunnen problemen die vaak voorkomen bij het gebruik van enkel asynchrone tekstgebaseerde tools mogelijk verlicht of voorkomen worden.

CSCL onderzoek laat een aantal algemeen vookomende problemen zien wanneer online samenwerkend leren enkel met asynchrone communicatie wordt ondersteund: Ten eerste zorgt de vertraging die inherent is aan asynchrone communicatie (na het posten van een bijdrage aan een discussieforum of het versturen van een e-mail moet een student wachten op antwoord) er vaak voor dat het communicatieproces als onpersoonlijk en afstandelijk ervaren wordt (Hrastinski, 2008; Hrastinski, Keller, & Carlsson, 2010; Yang, Tsai, Kim, Cho, & Laffey, 2006). Ten tweede brengt het gebruik van tekstgebaseerde asynchrone communicatie een vergroot risico op misconcepties met zich mee (Haythornthwaite, 2000; Rummel & Spada, 2005). Daarnaast betekent de eerder genoemde vertraging dat opheldering van misconcepties ook met vertraging gepaard gaat. Ten derde heeft CSCL onderzoek aangetoond dat er vaak grote verschillen bestaan in het activiteitsniveau van individuele studenten in asynchrone communicatie (Rienties, Tempelaar, Van den Bossche, Gijselaers, & Segers, 2009; Schellens &

Valcke, 2005). Deze verschillen kunnen grotendeels verklaard worden vanuit indivuduele motivatie (Chen & Jang 2010; Järvelä, Volet, & Järvenoja, 2010; Martens, Gulikers, & Bastiaens, 2004; Rienties et al., 2009).

Synchrone communicatie wordt regelmatig aangeduid als superieur ten opzichte van asynchrone communicatie als het gaat om het ondersteunen van een online communicatie proces. Immers, door middel van synchrone communicatie kan het gebrek aan lichaamstaal en intonatie dat bestaat in tekstgebaseerde asynchrone communicatie (Beers, Boshuizen, Kirschner, & Gijselaers, 2007; Derks, Bos, & Van Grumbkow, 2007; Haythornthwaite, 2000; Rummel & Spada, 2005; Tu, 2002) gecompenseerd worden. Daarnaast kent synchrone communicatie geen vertraging waardoor direct feedback gegeven kan worden en misconcepties snel hersteld kunnen worden. Ten slotte kan door synchrone communicatie de 'menselijke factor' van het communicatieproces worden versterkt (Hrastinski et al., 2010), wat het gevoel van afstand kan verkeinen en bevorderend kan zijn voor het betrekken van vooral extrinsiek gemotiveerde studenten in het discussieproces.

Een nadeel van synchrone communicatie in CSCL is echter dat de flexibiliteit van lerenden in termen van tijd en plaats minder wordt. Een synchrone online bijeenkomst vereist immers dat de deelnemers op een vastgestelde tijd online zijn, op een plaats waar een computer en/of voldoende bandbreedte beschikbaar is. Daarnaast vereist het het gebruik van extra communicatie tools dat deelnemers leren omgaan met deze tools en verhoogt het gebruik ervan de complexiteit van het online leerproces.

Initiële studies met betrekking tot een combinatie van asynchrone en synchrone communicatie tools in online onderwijs settings (Hrastinski et al., 2010; Johnson, 2006) tonen aan dat deze combinatie bevorderend kan werken voor het engagement van lerenden, hun leerprestatie en hun tevredenheid met het leerproces. Omdat de beschikbaarheid van synchrone communicatie tools die rijker zijn dan tekstgebaseerde communicatie zeer recent is, bestaat er echter geen conceptueel kader met betrekking tot het gebruik ervan in CSCL. Het gecombineerd gebruik van synchrone en asynchrone communicatie tools is gerelateerd aan sociale, technologische en motivationele aspecten. In dit proefschrift worden daarom drie conceptuele modellen die relateren aan deze dimensies gecombineerd om het onderwerp te benaderen.

Het eerste deel van dit proefschrift (Hoofdstukken 2 en 3) is gebaseerd op het idee dat door asynchrone communicatie te combineren met synchrone communicatie het sociale aspect van het leerproces vergroot wordt. Het Community of Inquiry model van Garrison, Anderson en Archer (2000) is daarbij gekozen als basis. Dit model stelt dat een betekenisvolle online leerervaring wordt gedefinieerd door de interrelatie van drie factoren: 'cognitive presence' (de mate waarin online lerenden in staat zijn betekenis te construeren door communicatie); "teaching presence" (de organisatie en het design van het leerproces, het ondersteunen van discussie en het bieden van directe instructie); en "social presence" (de mate waarin deelnemers aan het online leerproces zichzelf aan anderen kunnen presenteren als 'echte mensen'). Het aanbieden van synchrone communicatie brengt naar verwachting een hogere mate van social presence met zich mee en kan daardoor de eerder genoemde uitdagingen (zoals vertraagde feedback, gevoelens van afstand) ondersteunen en engagement van lerenden verhogen.

In Hoofdstuk 2 worden tevredenheid en leerresultaat vergeleken tussen twee designs van dezelfde online cursus (een ePBL design waarin enkel asynchrone communicatie wordt gebruikt, en een web-videoconferentie design waarin asynchrone communicatie wordt gecombineerd met synchrone web-videoconferentie). In hoofdstuk 3 worden twee additionele implementaties van dezelfde cursus toegevoegd om een meer robuuste replicatie van de eerste studie te kunnen doen.

Een vergelijking van tevredenheidsscores laat zien dat deelnemers in het ePBL design (met enkel asynchrone communicatie) minder tevreden waren met de duidelijkheid van doelen en taken in de cursus. Er zijn geen verschillen in evaluatie van de leerervaring, teacher presence en de mate waarin lerenden vonden dat ze hun eigen leerproces konden sturen. Het web-videoconferentie design laat echter significant lagere slagingspercentage zien: minder lerenden zijn in staat geweest de cursus succesvol te doorlopen. Dit is opvallend aangezien diverse CSCL studies aangeven dat het gebruik van synchrone communicatie leidt tot een meer authentiek leerproces, wat tot betere evaluaties en prestaties zou leiden (Hrastinski, 2008; Hrastinski et al., 2010; Rummel & Spada, 2005; Strømsø, Grøttum, & Lycke, 2007).

Het toevoegen van synchrone communicatie technologie biedt op zichzelf geen verklaring voor deze bevindingen. De combinatie van synchrone en

asynchrone communicatie vermnindert de flexibiliteit van het leerproces en zou mogelijk ook kunnen leiden tot afleiding van het leerproces (zie bijvoorbeeld Rogers & Lea, 2005). Daarnaast geven bestaande studies geen informatie over het daadwerkelijke gebruik van de verschillende tools en over een mogelijk effect van individuele motivatie. Er is dus verder onderzoek nodig om meer inzicht te krijgen in het gedrag van lerenden in deze context en de relatie met individuele karakteristieken als motivatie.

Alvorens in te gaan op de dynamische en intertemporele interrelatie tussen synchrone en asynchronbe communicatie in het online leerproces, wordt in het tweede deel van dit proefschrift eerst ingegaan op het gebruiksgedrag van synchrone communicatie tools en de relatie met individuele motivatie (hoofdstuk 4). Deze studie is gebaseerd op de aannamen dat: 1) rijke synchrone communicatie tools interactie bevorderen en interatie engagement bevordert; 2) het daadwerkelijk gebruik van communicatie tools en de interacties die daaruit voortvloeien gerelateerd zijn aan individuele motivatie. Daarbij wordt Self-Determination Theory (SDT) (Deci & Ryan, 1985, 2002) gebruikt als conceptualisatie van individuele motivatie. SDT staat toe om een onderscheid te maken tussen autonoom georienteerde lerenden (lerenden met een intrinsieke drijfveer die goed in staat zijn hun eigen leerproces te sturen) en controle georienteerde lerenden (lerenden met een externe drijfveer, die minder goed in staat zijn hun eigen leerproces te sturen). Verschillende studies die een relatie leggen tussen SDT en het Technology Acceptance Model (TAM) (Davis, 1989) geven aan dat het gebruik van technologie gerelateerd is aan motivatie zoals geconceptualiseerd door SDT (Roca & Gagné, 2008; Sørebø, Halvari, Gulli, & Kristiansen, 2009). TAM vormt daarmee het derde conceptuele model dat als achtergrond van dit proefschrift wordt gebruikt.

De bevindingen in hoofdstuk 4 laten een relatie tussen drop-out (lerenden die de eindtoets niet maken) en het niet deelnemen aan de web-videoconferenties. Al in de tweede week van de cursus is het aantal deelnemers aan de web-videoconferentie drastisch verlaagd, en een groot deel van de lerenden die niet deelneemt, zal later uitvallen. Daarnaast is een positieve trend zichtbaar tussen het gebruik van rijke tools en deelname aan een web-videoconferentie. Met betrekking tot motivatie blijkt dat een hoger niveau van autonome orientatie inderdaad gerelateerd is aan deelname aan

een web-videoconferentie. Deze relatie is echter niet zo sterk als verwacht. De verwachte relatie tussen autonome motivatie en het gebruik van rijkere tools kan echter niet bevestigd worden. Ook wat betreft de relatie tussen autonome motivatie en prestatie is geen eenduidig beeld gevonden.

Hoewel er een significant positieve correlatie is tussen het gebruik van rijke communicatie tools en scores op de eindtoets, vinden we enkel het aantal web-videoconferenties waaraan een lerende heeft deelgenomen als voorspeller van de score op de eindtoets.

In hoofdstuk 5 onderzoeken we de relatie tussen het gebruik van synchrone en asynchrone communicatie over tijd en de invloed van individuele motivatie hierop. Zoals verwacht laten de bevindingen zien dat engagement in synchrone communicatie een positief effect heeft op engagement in asynchrone communicatie. Deelnemers aan de web-videoconferenties postten gemiddeld meer bijdragen in totaal en meer taakgerelateerde bijdragen in alle perioden van de cursus dan niet-deelnemers. Een geïntegreerd perspectief dat wordt weergegeven door middel van een padmodel laat zien dat autonome (intrinsieke) motivatie voornamelijk het engagement in asynchrone communicatie verklaart maar dat deze relatie gematigd is. Enkel in de eerste week van de cursus kan intrinsieke motivatie als directe verklarende variabele van asynchrone communicatie worden aangetoond. In de weken erna wordt dit effect indirect, en de analysen laten zien dat zowel intrinsiek- als extrinsiek gemotiveerde lerenden een gelijk postgedrag vertonen in de weken die volgen. Dat is interessant, aangezien voorgaand onderzoek een sterk effect van intrinsieke motivatie op engagement in asynchrone communicatie laat zien (zie bijvoorbeeld Järvelä et al., 2010; Martens et al., 2004; Rienties et al., 2009; Rienties, Tempelaar et al., 2012; Schellens & Valcke, 2005). De bevindingen van hoofdstuk 5 suggereren dat controle (extrinsiek) georienteerde lerenden door deelname aan synchrone communicatie net zo engaged raken in asynchrone communicatie als autonoom (intrinsiek) georienteerde lerenden. Enige voorzichtigheid is echter geboden, aangezien het padmodel aangeeft dat het effect van engagement in asynchrone communicatie op engagement in synchrone communicatie sterker is dan andersom.

De bevindingen van hoofdstuk 5 ondersteunen eerder onderzoek waarin het belang wordt geschetst van het zo vroeg mogelijk engageren van lerenden in een online leerproces (zie bijvoorbeeld Akyol, Vaughan, & Garrison, 2011;

Rienties, Tempelaar, et al., 2012). Daarnaast geven de bevindingen van hoofdstuk 5 aan dat het belangrijk is de lerenden actief te sturen in het gebruik van synchrone communicatie wanneer een combinatie van asynchrone en synchrone communicatie wordt gebruikt.

Het belangrijkste resultaat van dit proefschrift is dat het gebruik van synchrone communicatie de verschillen tussen autonoom (intrinsiek)- en controle (extrinsiek) georienteerde lerenden met betrekking tot de hoeveelheid en kwaliteit van berichten in asynchrone communicatie mogelijk gelijk kan nivelleren. Het feit dat een direct effect van autonome motivatie enkel in de eerste week van de cursus aangetoond werd betekent praktisch gezien dat acties die gericht zijn op het verhogen van engagement van lerenden zo vroeg mogelijk in de cursus moeten plaatsvinden. Daarnaast tonen onze studies aan dat de activiteit in asynchrone communicatie gerelateerd is aan activiteit in synchrone communicatie. Activiteiten die gericht zijn op het verhogen van engagement kunnen daarom het best gericht worden op engagement in beide modi van communicatie. Ten slotte laat een kritische blik op de cursus zien dat belangrijke aspecten als ondersteuning van de autonomie van de lerende en het bieden van structuur (Chen & Jang, 2010; Jang & Deci, 2010; Rienties, Giesbers, et al., 2012) zowel in de synchrone als in de asynchrone communicatie gericht was op de groep en niet op het individu. Activiteit gericht op het vergroten van engagement bij lerenden zou op beide gericht moeten zijn om een maximaal effect te bereiken. Gevens over het motivationele profiel van lerenden in combinatie met objectieve data (bijvoorbeeld logdata) van het gebruikersgedrag van lerenden kunnen waardevolle inzicht geven en mogelijke aanknopingspunten bieden voor directe en gerichte interventies op individueel en groeps niveau. Samengevat leiden de studies in dit proefschrift tot de volgende aanbevelingen voor het online smaenwerkend leerproces waarbij asynchrone en synchrone communicatie gecombineerd worden:

- Start zo vroeg mogelijk met het verhogen van het engagement van lerenden in het online leerproces;
- Zorg actief voor het ontwikkelen van een groepsidentiteit (bijvoordeeld door gebruik te maken van zogenaamde ´ice breaker´ oefeningen aan het begin van een cursus);

- Richt acties om engagement te verhogen zowel op deelname aan asynchrone als aan synchrone communicatie;
- Richt acties om engagement te verhogen zowel op de groep als op het individu;
- Probeer inzicht te krijgen in het motivatieprofiel van een groep en maak gebruik van beschikbare indicatoren en statistieken die informative geven over gebruikersgedrag van online communicatie tools (bijvoorbeeld van logdata).

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# About the Author

## Biography

Bas Giesbers was born September 6th, 1976, in Breda, the Netherlands. He obtained a Masters degree in Educational Psychology from Tilburg University in August 2000. From 2001 to 2008 he worked at the Open University of the Netherlands as an educational technologist on several innovative e-learning projects. In April 2008, he moved to the Department of Educational Research and Development of the School of Business and Economics at Maastricht University. As projectleader and researcher, he worked on several national and European e-learning innovation projects of which most revolved around remediation of knowledge deficiencies and competences of prospective Bachelor and Master students as well as professionals. Since March 2012, he works as project-leader e-learning at the Rotterdam School of Management of Erasmus University. Here, his main task is the set-up and implementation of an e-learning centre with the focus to support teaching staff in implementing educational innovations, provide services such as webcast and online assessment, and perform research on the implemented innovations.

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