Understanding social interaction in computer-supported collaborative learning

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Understanding social interaction in Computer-Supported Collaborative Learning

Bart Carlo Rienties

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door

Bart Carlo Rienties

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Dit stuk van het proefschrift wordt altijd het eerst en het meest gelezen. Maar waar moet ik beginnen? Dat ik in 2010 als een afgestudeerd econoom hoop te promoveren op een onderwijskundig onderwerp met de titel “begrijpen van sociale interactie in samenwerkend computergestuurd onderwijs” in Maastricht had ik 20 jaar geleden niet kunnen vermoeden. De Duitse taal heeft hiervoor het prachtig woord “das Schicksal” dat in het Nederlands zijn equivalent niet kent. Het woord das Schicksal is een combinatie van toeval, lot (destiny) en (on)geluk, wat Tom Tykwer prachtig heeft verfilmd in de filmklassieker *Der Krieger und die Kaiserin*. Das Schicksal heeft geleid tot dit resultaat. Eigenlijk paste ik 20 jaar geleden precies in het onderzoek dat we recentelijk hebben uitgebracht over Nederlandse studenten, in het bijzonder mannen. De Nederlandse man is vaak afgeleid, heeft een oppervlakkige leerstijl en is vaak extrinsiek en laag gemotiveerd. Pas aan het einde van de middelbare school werd ik gegrepen door iets wat ik echt leuk vond: economie gegeven door de Belgische leraar d’Hondt.

Na afronding van mijn VWO was het duidelijk dat ik economie ging studeren. Maastricht leek me wel wat, lekker samen in groepjes discussiëren over economie en andere zaken. Tijdens de eerste onderwijsgroep kwam ik mijn eerste buddy van Maastricht, Geranda, tegen. Als snel werd me duidelijk dat het Maastrichtse PGO onderwijssysteem me erg goed lag. Na een Erasmus in Zweden bracht het lot me in 2000 terug in Maastricht voor een baantje als tutor bij Algemene Economie. Hiermee begon mijn “onderwijs carrière” bij de Universiteit Maastricht. Ik bleek hetzelfde enthousiasme over economie te kunnen overbrengen als d’Hondt. Maar belangrijker, als ik weer eens vier onderwijsgroepen per dag aan het geven was merkte ik dat er altijd wel één onderwijsgroep was die niet liep. Hoe kon dit? Ik was toch dezelfde docent met hetzelfde enthousiasme? De sociale interactie tussen studenten leek op de één of andere manier niet los te komen.

In 2002 werd ik door Prof. Clemens Kool gevraagd om in een nieuw te vormen projectgroep te gaan zitten om “e-learning” in te voeren bij FdEWB, genaamd ELEUM. De eerste dag van het projectteam leerde ik o.a. Mark Arts en Dirk Tempelaar kennen. Dit ELEUM team en in het bijzonder Dirk heeft een sterke stempel gedrukt op het verdere verloop van mijn Schicksal. Met veel enthousiasme, ambitie en drive heeft het ELEUM team

binnen korte tijd een innovatie binnen het onderwijs van FdEWB gerealiseerd. Iets wat nu door iedereen als vanzelfsprekend wordt ervaren was toen echt pionierswerk. Nadat het fundament van het organisatorische ELEUM systeem er lag, was het tijd om te kijken hoe we e-learning konden inzetten voor echte onderwijsinnovatie. In 2004 hadden Mark, Dirk en ik het idee om iets met wiskunde bijspijkeren te doen, want veel studenten zien wiskunde als een struikelvak. Al snel vroegen we het eerste onderwijsinnovatie idee Web-spijkeren aan bij SURF samen met Natasa Brouwer & Leendert van Gastel (UVA) en Fons van Engelen (†). De successen van Web-spijker-achtige projecten bleven binnenlopen, iets wat een ander aspect van Schicksal is. Bas, Piet, Joost en Simon zijn toch de stille krachten in mijn transformatie van micro-econoom naar onderwijskundige.

De transformatie van een docent met gevoel voor onderwijs en ICT naar een onderwijskundig onderzoeker binnen CSCL is ook goed te volgen in de publicaties in dit proefschrift. De belangrijkste “onzichtbare hand” in dit proces is die van Mien en Wim. Bij het teruglezen van hoofdstuk 2 dacht ik dat de goede intenties wel duidelijk waren, maar wat is nu de theoretische en onderwijskundige meerwaarde? In de latere hoofdstukken zie je de transformatie wel, en dat is toch te danken aan mijn promotoren.

In hoofdstuk 6 komt naar voren dat de transformatie niet eindigt met dit proefschrift. De economiedocent die iets met ICT deed binnen O&O is inmiddels een pin in sterk team geworden met Bas, Danielle, Gwen, Therese, Anne en Henny. Belangrijker, het onderzoek spreidt zich steeds verder uit met intensieve samenwerking met Dirk, Nuria & Piet, Wolter, Dharma, Therese & Simon & Piet Kommers & Susan, Katerina, Miram & Linda, Martin, Alexandra & Tatiana en Jan. Ook wil ik Sandra, Steve, Maïke en Ellen bedanken voor hun enthousiasme in de transformatie van het EDINEB netwerk.

Als ik één ding heb geleerd in de afgelopen 33 jaar is dat het leven niet te plannen valt. Het leven, dat Schicksal, is als een achtbaan, waarvan je vaak niet weet welke bocht of looping er zo weer komt. Daarom is het fijn om met een groep vrienden in de achtbaan te zitten die je tijdig kunnen waarschuwen voor een scherpe bocht of samen steunen als het Schicksal eens tegen zit. In willekeurige volgorde wil ik Bas, Dirk, Dominique & Valerie, Douwe, Erik, Guido, Martin, Jasper & Ralph specifiek bedanken voor alle steun die jullie in de afgelopen jaren hebben gegeven. Het

“ongeluk” van het onverwachte niergebeuren geeft aan hoe belangrijk je familie is. Zonder de steun van Marjolein & Robert-Jan, Mien en Kees, papa en mama zou ik nu nog aan Bertus gezeten hebben. Je druk maken over een volgende publicatie of 50.000 euro extra subsidie is dan wel erg relatief. Van mama kreeg ik het ultieme (geluks)geschenk, een nieuw tweedehansje. Mam: wat je gedaan hebt is onbeschrijfelijk!!!

De belangrijkste persoon van mijn leven is nog niet in het verhaal voorgekomen. Dat komt omdat ik al niet meer aan ons als duo denk maar als eenheid in ons Schicksal. Keetie: je bent mijn Lance Armstrong, Salma Hayek, Michelle Obama, Robin van Persie, Femke Halsema en Mevrouw Keetie in één persoon. Zonder jou was dit alles niet mogelijk geweest!

Bart Rienties

Maastricht, 2010.

Chapter 1

INTRODUCTION

1. INTRODUCTION

The attention for Computer-Supported Collaborative Learning (CSCL) in recent years is fuelled by two separate yet mutually enforcing developments: The increasing possibilities of Information Technology (IT) to support collaboration (Bromme, Hesse, & Spada, 2005; Resta & Laferrière, 2007) and the growing amount of evidence that collaboration can enrich student learning through interaction (Jonassen & Kwon, 2001; Van den Bossche, Gijssels, Segers, & Kirschner, 2006). In general, it can be said that CSCL is built on the assumption that IT has the power to provide a rich learning experience by using a variety of IT-tools and learning methods. IT-tools like discussion forums, blogs, wiki's, chat, social network sites and web-videoconferencing "afford" learners to learn in a challenging and interactive manner. In particular, the interactivity of these IT tools as well as the possibility to work at one's own pace and time is considered to be a strong, highly valuable characteristic.

Despite the increased possibilities of IT-tools, recent findings in CSCL indicate that following courses in an online learning setting is more complex and demanding for learners and teachers than in a blended or face-to-face learning setting (Bromme et al., 2005; Järvelä, Järvenoja, & Veermans, 2008). That is, several researchers have found that in online courses limited interaction between learners occur. Furthermore, the participation of learners is unequally divided. For example, Caspi, Gosky and Chajut (2003)

* Part of this chapter is based upon Rienties, B., & Tempelaar, D. T. (2009). Mobility of lifelong learners and IT: Introduction to Special Issue. *Industry and Higher Education*, 23(4), 265-268.

analysed a total of 7706 messages of 47 courses at various faculties of the Open University and found that the majority (80%) of students contributed only a small amount (20%) of messages. Yet limited research has addressed the underlying mechanisms why some learners passively contribute to discourse, while others participate actively. Therefore, in this manuscript our primary focus will be on understanding social interaction of learners in CSCL.

2. ONLINE LEARNING: A PRACTICAL EXAMPLE

So who do learners interact differently in an online course? An example of an online learning setting where learners are learning together using discussion forums is illustrated in Figure 1.1. In this discussion forum, learners work and learn together on solving a complex task in an online economics course. The task that is discussed in Figure 1.1 is about a North Korean student called Lyiann, who is confronted with profound differences in the way markets are organised in Europe and North Korea. Learners can raise questions like “What are the main players in the market economy?” and can try to answer and/or elaborate on arguments given by other learners using the discussion forum. This is illustrated by the sig-saw pattern of discussion threads in Figure 1.1.

Figure 1.1 Contributions to discourse in Discussion forum Intro task 1

COURSES > ECONOMICS ONLINE SUMMER COURSE 3 (4-05CE3-0506) > POLARIS KNOWLEDGE BUILDER > FORUM: INTRO TO TASK 1 (CLOSED)

Start new thread

Enter thread

Questions and answers

References

Remove

User statistics

Item statistics

Search

Forum: Intro to Task 1 (closed)

Subject	Author	Date	?	!	🔍	&	📎	👤	#
☐ Summary of I.G.2	Jonas	21-07-06 16:03						0	0
☐ Summary of I.G.1	Jonas	21-07-06 16:02						0	0
☐ Ways to tackle each task	Teacher 3	20-07-06 11:42	■					0	0
☐ I.G.2. How do they interact, what is their role in the market?	Teacher 1	18-07-06 10:44						0	3
☐ Little example	Jonas	18-07-06 15:18						0	1
☐ remark and questions about the story	Teacher 3	19-07-06 10:29	■			▲		0	0
☐ "because the producer knows the beer is tasty, he ...	Jonas	19-07-06 12:04				▼		0	0
☐ More actors	Jonas	20-07-06 12:22				▲		0	1
☐ Picture	Jonas	20-07-06 12:28				▲	+	0	0
☐ different markets	Bernard	20-07-06 13:53	■					0	1
☐ Can producer also be consumer?	Felix	20-07-06 14:14				★		0	0
☐ consumer & producer	Teacher 4	26-07-06 10:04						0	0
☐ According to Dominique Waterval	Jonas	20-07-06 16:10				▼		0	1
☐ so?	Teacher 4	26-07-06 10:05						0	0
☐ different approach	Philipp	20-07-06 14:12	■					0	1
☐ Ideas about the government	Paul	22-07-06 18:39				★	▲	0	7
☐ Good,	Teacher 4	26-07-06 10:06						0	0
☐ more influence by government?	Jonathan	26-07-06 21:01						0	0
☐ I.G.1: What are the main players in our market economy?	Teacher 1	18-07-06 10:43						0	2
☐ Producer-Consumer	Jonas	18-07-06 14:53					▲	0	0
☐ government role	Philipp	18-07-06 17:08					▲	0	2
☐ Government role	Teacher 3	19-07-06 10:33					▲	0	0
☐ other players?	Paul	22-07-06 18:56					▼	0	0
☐ predictable things	Veronica	24-07-06 17:17	■					0	0

During Intro task 1 Jonas was a very active participant. In this task 16 of the 45 messages were posted by Jonas, while five were posted each by Peter and Paul. The remaining 7 messages were posted by the four of twelve other learners in team 6. In other words, during the first week of the course, some participants actively contributed to discourse, while others remained passive. *Why are some learners more active in contributing to discourse in online settings than others?*

In addition to measuring the number of contributions by each learner, in each discussion forum or in each online course, the “standard” practice in most CSCL literature in the last 10 years is to measure “what learners are contributing” to discourse (De Wever, Schellens, Valcke, & Van Keer, 2006; Rourke & Anderson, 2004). Typically, researchers use a quantitative Content Analysis (CA) of discourse, which aims to provide a quantitative description of discourse using a predefined Content Analysis scheme in order to better understand the social interaction of learners in online settings. For example, in Textbox 1 the actual discussions between two students (Bernard, Philippⁱ) from Figure 1.1 in the first week of the course are illustrated. The discussion about whether producers can also be consumers follows after an initial discussion of Jonas on how market players like consumers, producers or the government interact. The discussions about the role of producers between Philip and Bernard (and all other discussions in the online economics courses) were ex-post analysed by three independent coders using a Content Analysis scheme developed by Veerman and Veldhuis-Diermanse (2001) for social and cognitive discourse among studentsⁱⁱ. As Philipp added the concept of the Circular Flow Model, which is a conceptual model in economics that links the various market players and their interactions, this was coded as a new “Theoretical idea”. Afterwards, Bernard tried to answer the question of Philipp of whether producers can also be consumers by providing an answer using a new case study (beer market) and elaborating on the concept of consumers and producers, which was coded as an “Elaboration”. In other words, the learners are co-constructing knowledge together while working on solving the task.

Textbox 1 Discourse between Philipp and Bernard in week 1

Author: Philipp (High Intrinsic Motivation, High Extrinsic Motivation)

Type of message: Theoretical Idea

Subject: different markets

Statement

I think the main actors stay producer, consumer and government. A producer on one market can also be a consumer on another. The hairdresser for example produces service by giving people haircuts -> producer. On the other hand he also buys products like gel -> consumer.

If we take the Circular Flow Model from the book (Parkin/Bade) you are right, because it only takes households into account. But when we modify the model and put producers and consumers instead of households and firms, then a 'haircutter', is producer and consumer, just on different markets.

I don't know if it is better to keep a broad description or to split it up into more detail.

Question

Can producer also be consumer?

Author: Bernard (Medium Intrinsic Motivation, Medium Extrinsic Motivation)

Type of message: Elaboration

Subject: Can producer also be consumer?

Answer

i would say yes, but it depends on the definition of the "consumer".

for example:

the brewery needs the brewing-plants, the ingredients like water, hop and malt. For hop and malt a farmer is the producer. A better example is the brewing-plant, there the brewery is the consumer and the plantcompany is the producer. Another aspect is: if we see the producer as a whole thing, the producer is a consumer too, because it needs "everything" a normal household needs to like cleaning things, furniture..... and the producer also "consumes" services, like cleaning ladies, mechanics.

I hope you can understand my theory, and I would like to hear your comments about it.

By applying a Content Analysis, the discourse between learners can be distinguished in social and cognitive discourse. Consistently in CSCL research and in our own settings, large differences are found between learners in their contributions to the type of discourse. For example, De Laat et al. (2007) showed that students in an online E-learning Master's programme differed with respect to the type (cognitive, affective, metacognitive) of contributions. In a Bachelor's freshman course of educational science, Schellens and Valcke (2005) found significant differences with respect to both amount and type (social, cognitive) of

discourse. In our own settings we found consistent differences in social and cognitive discourse between individual learners as well as differences between teams. *Why do learners differ in their contributions to the type of discourse?*

Although a large number of studies in CSCL analyse discourse using Content Analysis, this research technique is less appropriate for analysing how social interactions between learners occur (De Laat et al., 2007; Katz, Lazer, Arrow, & Contractor, 2004; Strijbos & Fischer, 2007). Furthermore, limited studies in CSCL have addressed how social interaction among learners change in the duration of a course (De Laat et al., 2007). For example, in Textbox 2 the actual discussions between Veronica, Caroline and Chris in the third week of the course are illustrated, which was about the concept of “welfare” in economics. Welfare is a rather complex topic in economics, which is clear from the discussions that Veronica, Chris and Caroline had. They were consistently trying to find the borders of the welfare concept and were building upon previously raised arguments, which led to a co-construction of knowledge.

In this fourth task, Jonas, Veronica and Chris contributed each five messages of the total 33 messages, while Philipp and Bernard (see Textbox 1) did not contribute to the discussions any longer. In total nine from twelve members contributed to this task. In other words, in our settings we find that learners contribute differently to discourse. Some learners become active participants, while others become passive participants during the course.

Textbox 2 Discourse between Veronica, Caroline and Chris in week 3

Author: Veronica (High Intrinsic Motivation, High Extrinsic Motivation)

Type of message: Elaboration

Subject: Individual or public Welfare?

Statement

When I was starting a first attempt to define welfare I was not sure which welfare we are talking about - individual or public welfare.

Individual welfare could be the well-being of a single person. Then we would be talking about the questions if this person has a job and is earning enough money to keep a certain standard of living, if he has a place to live and if he is happy with his situation.

Whereas public welfare would rather consider the economic well-being of a state and its economy. Is there a high unemployment rate? Is the currency stable and not having too much inflation/deflation? How advanced is the technology? ...

What do you think? Which welfare are we talking about or do we just need to differentiate between these two types of welfare?

Author: Chris (*High Intrinsic Motivation, High Extrinsic Motivation*)

Type of message: Elaboration

Subject: I think you are right

Answer

I think you're right, we need to differentiate between individual and public welfare, but always bear in mind that even though we are talking about welfare, there is no general agreement what it really is. Just like when politicians talk about a subject matter, there is no general agreement upon the things they talk about. Every one values the subject differently. Just like that, every person values welfare differently.

Author: Caroline (*High Intrinsic Motivation, High Extrinsic Motivation*)

Type of Message: New idea, basic fact

Subject: How do economists measure welfare?

Statement

Veronica already mentioned some ideas how to measure welfare. Public welfare is measured by economic growth -> GDP, per capita income, inflation/ deflation rate, unemployment rate, ...

Individual welfare is measured by average income, spending capacity, family situation, unemployment rate, ... I think there are more possibilities how to measure welfare. Any ideas?

Author: Caroline (*High Intrinsic Motivation, High Extrinsic Motivation*)

Type of Message: Elaboration

Subject: Welfare?

Statement

I'm little confused,

I thought welfare means the financial aid paid by the government to people who are dependent on financial assistance.

If and how much welfare people receive is measured by their well being: average income, spending capacity, family situation and unemployment.

I think both, welfare and well being is correct for your definitions.

So how do we define welfare now?

In due time, some learners in our setting became and remained active participants, while others became passive contributors to discourse. A technique that allows researchers to visualise and analyse the social interaction patterns of learners in online settings is Social Network Analysis (De Laat et al., 2007; Wassermann & Faust, 1994). The social network of

3. SOCIAL INTERACTION: HOW TO CREATE SUSTAINABLE INTERACTION?

As was illustrated by the above figures and throughout this manuscript, participation and making contributions to discourse in online settings can not be taken for granted when learners work and learn together in online settings. In particular when learners are interacting using discussion forums, establishing a critical mass of interaction whereby all participants contribute actively to cognitive discourse is troublesome (Caspi et al., 2003; Schellens & Valcke, 2005). However, little is known about the underlying mechanisms that explain why some learners like Veronica or Jonas in Figure 1.2 became active contributors to discourse, while others remained passive (Bernard, Elena, Jonathan) or even dropped out of the online course (Michael). Some learners may be more inclined to start (e.g. Jonas) and actively contribute to a discussion than others. Other learners may prefer to wait for a while before contributing to a discussion (e.g. Veronica, Caroline), in particular when the members of the online course are seeking for effective working and learning strategies.

Although recent research findings indicate that individual learners differ with respect to the amount and type of discourse contributed (Caspi, Chajut, Saporta, & Beyth-Marom, 2006; Caspi et al., 2003; De Laat et al., 2007; Rehm, Giesbers, & Rienties, 2009; Schellens & Valcke, 2005), little is known about what the causes of these differences in discourse are. Within the field of CSCL, researchers try to understand what the underlying reasons for a lack of contributions to cognitive discourse are and how to solve them. In addition, several researchers have tried to influence the social interaction patterns and cognitive knowledge co-construction among learners by (re-) scaffolding the learning process by designing scripts (Weinberger & Fischer, 2006) or regulating the interaction processes (Beers, Boshuizen, Kirschner, & Gijssels, 2005, 2007). For example, by increasing the regulation of interaction processes, Beers et al. (2005) found that interaction among participants could be enhanced significantly. By establishing argumentative scripts, learners contributed more argumentative discourse than when other scripts were used (Weinberger & Fischer, 2006). Nonetheless, individual differences to contributions to discourse still persisted.

A *first challenge* in CSCL research is that limited research has integrated social interaction between learners with their social and cognitive discourse. As some learners are more active than others to contribute to discourse, we need to understand why contributions to discourse and interaction patterns among learners vary. Furthermore, we need to distinguish contributions made by learners solely in cognitive discourse, as task-related communication has been found to be positively related to

individual knowledge acquisition (Schellens & Valcke, 2005; Weinberger & Fischer, 2006). Therefore, recent research (De Laat et al., 2007; Hurme, Palonen, & Järvelä, 2007) has suggested that using a combination of Content Analysis (type of discourse) with Social Network Analysis (position of learner relative to others) leads to a clearer understanding of interaction patterns in CSCL. In particular when Social Network Analysis (SNA) is combined with other instruments, SNA provides a powerful instrument to measure dynamics of social interaction (De Laat et al., 2007; Martinez, Dimitriadis, Rubia, Gomez, & de la Fuente, 2003). For example, Martinez et al. (2003) found that by using log data of users and SNA the dominant central role of the teacher in discussion forums could be identified. De Laat et al. (2007) measured the centrality of learners at three distinct phases using SNA in combination with CA, which was afterwards used to as primary input for a critical event recall by the teachers. In this way, the teachers were able to link their own behaviour to the dynamics of the learning processes of the group. Hurme and colleagues (2007) analysed the interaction patterns among secondary school children who worked online in pairs on mathematical problems. Metacognitive activity varied among participants, which subsequently influenced the interaction among pairs of learners. Furthermore, by using SNA some pairs became visible as central contributors to discourse, while others were less active and were positioned on the outer fringe of the social network (Hurme et al., 2007). Although De Laat et al. (2007) and Hurme et al. (2007) used both CA and SNA, they only qualitatively link the methods together. To our knowledge not a single study in CSCL has quantitatively integrated the results of CA into SNA. By linking the type of discourse (cognitive, social, affective) to the social interaction patterns within virtual teams, in this manuscript we will investigate the underlying mechanisms that explain why some learners become active contributors to discourse in online settings while others eventually drop out.

3.1 The role of motivation on social interaction

A *second challenge* in CSCL research is that limited research has been conducted how differences in individual traits influence the interaction patterns of learners in networks (Caspi et al., 2006; Hair, Renaud, & Ramsay, 2007; Hills & Argyle, 2003; Martens, Gulikers, & Bastiaens, 2004; Scealy, Phillips, & Stevenson, 2002). Research highlights that motivation has a strong influence on how learners contribute to discourse (Boekaerts & Minnaert, 2006; Järvelä et al., 2008; Järvelä, Volet, & Järvenoja, 2010; Martens et al., 2004; Pintrich, 2003; Rienties, Tempelaar, Van den Bossche, Gijssels, & Segers, 2009; Ryan & Deci, 2000; Veermans & Lallimo, 2007; Yang, Tsai, Kim, Cho, & Laffey, 2006). Tai (2008) argues that strong motivation is a prerequisite for online learning. Motivation has an

important influence on a learner's attitude and learning behaviour (Boekaerts & Minnaert, 2006; Deci & Ryan, 1985; Pintrich, 2003; Vallerand et al., 1992). If social interaction is difficult to achieve and maintain in online learning settings, this might have a negative impact on the motivation of learners.

In face-to-face settings the teacher has a strong influence on the type of motivation of students (Roth, Assor, Kanat-Maymon, & Kaplan, 2007). In online settings, the role of the teacher seems to be more complex (De Laat et al., 2007; Lou, Bernard, & Abrami, 2006; Vonderwell, 2003), whereby providing accurate and timely instruction and feedback is notoriously difficult due to barriers in space and time. The limited role of the teacher might refrain externally regulated learners who are triggered mainly by external regulation to actively participate.

In fact, four recent studies have found that motivation indeed influences behaviour of learners in online settings (Järvelä et al., 2008; Martens et al., 2004; Veermans & Lallimo, 2007; Yang et al., 2006). In line with these studies, in this manuscript we will link the motivational profiles of learners to their type of contributions to discourse as well as their interaction patterns with other learners using an integrated multi-method approach. That is, our integrated multi-method approach of Content Analysis (what are learners contributing?), Social Network Analysis (with whom are learners interacting and about what?) and motivation (how do motivational differences influence with whom a learner is interacting?) is to our knowledge a new and innovative approach to understanding social interaction in CSCL.

3.2 Social interaction in relevant and authentic settings

A *third challenge* in CSCL research is that most studies on social interaction in online learning are conducted in “unnatural settings” such as experimental or blended learning settings and/or are primarily situated in specific disciplines like educational psychology. In classic experimental CSCL settings, learners are placed together in virtual teams under controlled conditions for a limited duration of time, whereby the conditions by which learners interact are adjusted. For example, in research by Beers et al. (2005, 2007) learners were working and learning together in a computer room for a duration of 90 minutes. Lowry et al. (2006) found that smaller groups who worked in an experimental setting for 40 minutes establish higher levels of communication quality, in particular when face-to-face groups are supported by IT. However, the extensive body of research on group development (Roschelle, 1992; Wheelan, 2004; Wheelan & Lisk, 2000) indicates that groups and teams need considerable time and effort in order to effectively work and learn together. For example, Wheelan (2004)

found that groups need several weeks or months in order to develop an effective group identity and group process. Understanding social interaction patterns of virtual teams in experimental settings is therefore not the most appropriate format for understanding social interaction among learners given its limited ecological validity.

More importantly, most experimental settings are not related to actual learning programmes. In these settings, participants join these experiments in return for extrinsic rewards like money or recognition by the teacher rather than a motivation to learn something that is relevant for their future studies or career. As a result, it is difficult to determine the longitudinal impact of learning outcomes as the experiments are in general not linked to the actual educational program. For example, when economics students are tested on a flight simulator in different training conditions, the learning that takes place is less relevant for their actual education. In contrast, when economics students learn in different conditions in an online management game, the learning experience is relevant for their studies and the structural learning impact of this game can be assessed in a longitudinal manner.

Furthermore, a large number of studies in CSCL focus on blended learning settings, whereby participants interact in online settings but also meet each other in face-to-face settings. Frequently in executive training programmes professionals work and learn at the same time and work together in blended learning teams (Cope Pence & Wulf, 2009; McLuckie, Naulty, Luchoomun, & Wahl, 2009; Rehm, 2009). These studies provide valuable insights in how learners contribute to discourse and how teams develop over time. A limitation of these kinds of studies is that the social interaction patterns occurring in online settings are influenced by the personal relationships developed over time, during the face-to-face meetings or even before the programme started. For example, when there are conflicts among professionals in a face-to-face meeting, these personal conflicts will be transferred as well in an online setting. The interaction patterns in online settings will therefore be influenced and might even prevent some professionals to contribute to discourse. In other words, the contexts in which learners work and learn together can (unintentionally) influence the social interaction process in online settings.

Finally, a large number of studies in CSCL are conducted in schools of psychology, education, educational science or educational psychology (e.g. De Laat et al., 2007; De Smet, Van Keer, & Valcke, 2008; Häkkinen & Järvelä, 2006; Hara, Bonk, & Angeli, 2000; Järvelä et al., 2008; Nussbaum, 2005; Schellens & Valcke, 2005; Schellens & Valcke, 2006; Veerman, Andriessen, & Kanselaar, 2000; Veermans & Lallimo, 2007; Vonderwell, 2003; Weinberger & Fischer, 2006; Yang et al., 2006). However, given that educational psychology students are likely to be aware of the expected impact of an intervention and are intrinsically more motivated to contribute to innovative teaching and learning practices, it is questionable whether the

findings reported in these studies can also be found in non-educational psychology settings such as economics, biology or mathematics.

4. OVERVIEW OF DISSERTATION

In this dissertation, our primary focus will be on understanding the social interaction of learners in CSCL. In particular, we will look into the role of motivation on contributions to discourse and social interaction among learners in virtual teams, who worked and learned together in an authentic and relevant context. The following four questions will be raised in this dissertation:

1. To what extent are learners satisfied with the course design of the online courses and their own learning?
2. To what extent does participation in these online courses lead to long-term learning outcomes?
3. What are the effects of differences in academic motivation of learners on their contribution to discourse?
4. To what extent does academic motivation influence social interaction patterns among virtual teams?

The interrelationships between the four studies in this manuscript are illustrated in Figure 1.3, whereby the core of the manuscript is situated in Chapter 4 and Chapter 5.

Figure 1.3 Overview of manuscript

The present PhD project sought for online settings that allowed us to assess the role of personal traits like motivation on the contributions to discourse and social interaction (1st and 2nd Challenge). More importantly, we looked for a setting where we could allow learners to learn and work

together in an authentic and relevant (i.e. for their future studies) learning environment (3rd Challenge). Finally, in order to minimise any disrupting effects of previous social relationships on social interaction patterns, we designed a setting whereby learners did not know each other before the online course started. Therefore, this manuscript is built upon the idea of offering online preparatory courses to prospective students. Since 2005, the Maastricht University School of Business and Economics has offered a range of preparatory coursesⁱⁱⁱ for 1200+ prospective bachelor and master students in the field of economics (Rienties, Tempelaar, Waterval, Rehm, & Gijsselaers, 2006), statistics (Tempelaar, Rienties, & Giesbers, 2009), mathematics (Tempelaar et al., 2006), finance, marketing and accounting. The primary aim of these courses is to help prospective students with deficiencies to increase their prior knowledge before entering their next step in higher education.

Given that these preparatory course students were aware of the fact that they had deficiencies before entering their program, these students had a real incentive to participate (3rd Challenge). These online courses were given over a period of six weeks in which participants were assumed to work for 10-15 hours per week. The participants never met face-to-face before or during the course and had to learn using the virtual learning environment “on-the-fly”. With the exception of the mathematics and statistics courses, each course was designed based on the principle of collaborative learning (Rienties et al., 2006). Hence, this setting provides a unique opportunity to assess how social interaction patterns develop in virtual teams as the learners had never met each other before and collaborated exclusively in the virtual learning environment. In order to assess the role of social interaction in CSCL, in this manuscript we will look at two cohorts of prospective bachelor students who followed economics preparatory courses in the summer of 2005 and 2006. Further analyses of the effects of redesigns of the online preparatory courses economics in 2007, 2008 and 2009 can be found elsewhere (Giesbers, Rienties, Gijsselaers, Segers, & Tempelaar, 2009; Rehm, 2009). Further analyses of the self-directed preparatory courses can be found elsewhere (Tempelaar et al., 2009).

Before we can address the role of motivation on contributions to discourse and social interaction among learners in online settings, we first need to verify the ecological validity of the course designs and the relevance of the online courses in our research setting. Therefore, in chapter 2 we will investigate whether learners were satisfied with the overall course design, the instructors and their own learning.

A second step in our analysis of an authentic and relevant online learning environment is that we need to assess whether there are structural and longitudinal learning effects of the intervention. Therefore, in Chapter 3, we will explore the long-term learning effects of the online courses described in

Chapter 2. If we find proof that the course design was perceived as positive and relevant by participants and if we find proof that participating in such a course lead to structural learning effects, the ecological validity and relevance of our findings in the remaining chapters is enhanced.

In Chapter 4, we will look into the effects of motivation of learners on their contribution to discourse using the Deci and Ryan (1985) framework of (intrinsic/extrinsic) motivation. An integrated multi-method model of Content Analysis, Social Network Analysis and Academic Motivation Scale (Vallerand et al., 1992) is used in order to examine the impact of academic motivation on the type of discourse activity contributed and on the position of the learner in the social network.

In Chapter 5, we will continue our research on the role of academic motivation on the social interaction. We will investigate the underlying mechanisms of social interaction when motivational profiles of learners differ. Afterwards, the different motivational profiles were added to the social network of each virtual team in order to provide an integrated multi-method approach to understand social interaction in CSCL.

Finally, in Chapter 6 we will reflect upon the theory and concepts that were used, the methodology of this research, the empirical results, and the implications for educational research and practice.

By answering the four research questions we hope to contribute to the knowledge in the field of social interaction in Computer-Supported Collaborative Learning. In the following chapters, which are based on journal articles and a book chapter, each research question is discussed separately. This dissertation is not a book in the traditional sense but a collection of highly relevant articles. Since every chapter is written to be read on its own, repetitions and overlap across chapters are inevitable.

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ⁱ The names of the participants are replaced by fictive names in order to guarantee privacy of participants.

ⁱⁱ For an elaborate description of the codes schemes use, see Chapter 4 and Appendix. In addition, for the role of the teacher in the online course a CA scheme of Anderson and colleagues (2001) was used by the three independent coders

ⁱⁱⁱ <http://www.unimaas.nl/onlinepreparatorycourse/>. The online preparatory courses are structurally supported by Maastricht University. In addition, the initial courses were developed and implemented as part of the following national and European projects: SURF Web-spijkeren (<http://www.web-spijkeren.nl/>), SURF Web-spijkeren 2 (<http://www.web-spijkeren2.nl/>), SURF NAP Acculturatie (<http://www.acculturation.nl/>), SURF NAP NKBW and NKBW2 (<http://www.nkbw.nl/>), E-Merge Competentie-gericht toetsen (<http://www.e-merge.nu/index.php?id=398>), EU MINERVA M.A.S.T.E.R. (<http://www.masterproject.info/>), EU KA3 ICT S.T.E.P (<http://www.transitionalstep.eu/>).

Chapter 2

REMEDIAL ONLINE TEACHING ON A SUMMER COURSE*

This chapter is based on the experiences with remedial online learning from a national collaboration initiative of University of Amsterdam, Erasmus Rotterdam University and Maastricht University (<http://www.web-spijkeren.nl>). The central question is how prior knowledge tests and online remedial summer courses can contribute to mitigating the problems of heterogeneous enrolment of students.

Although the insights gathered in for this chapter come from pilots for first year bachelor programmes, the insights on how to successfully implement an online summer course programme can also be applied to other organisations.

1. INTRODUCTION

Acceptance to a bachelor or master programme has traditionally been based on a required (combination of) degree(s), experience and/or skills. However, due to increasing internationalisation of students (Ministerie van OCW, 2005), changes in secondary school programmes in the Netherlands (De Vries & Van der Velden, 2005; Tweede Fase Adviespunt, 2005), the introduction of the bachelor-master structure and the new accreditation procedures by the Treaty of Bologna (Dittrich & Frederiks, 2005; Onderwijsraad, 2005), higher education institutions face several tough challenges in selecting the “correct” student. According to Ministerie van OCW (2005), the average percentage of foreign students in higher education in the Netherlands is 4% and most institutes strive for an increasing internationalisation in the years to come.

* Based upon:

Rienties, B., Tempelaar, D. T., Waterval, D., Rehm, M., & Gijselaers, W. H. (2006). Remedial online teaching on a summer course. *Industry and Higher Education*, 20(5), 327-336.

In the Netherlands, the two universities with the highest percentage of foreign students are University Wageningen (19%) and Maastricht University (24%). The experiences at the university with the highest amount of foreign students in both absolute as relative numbers show that prior knowledge levels of mathematics and economics of foreign students are more diverse and often lower than for students with a Dutch secondary education degree (Rienties, Dijkstra, Rehm, Tempelaar, & Blok, 2005). Although foreign students formally should be accepted because of the Treaty of Bologna, for some (international) students, the lack of prior knowledge is too large and remedial teaching before entering a programme is desirable. In addition, most students are unable to judge whether they possess sufficient prior knowledge and/or experience to start a bachelor or master programme (Prins, 1997).

In the past, several remedial teaching programmes have been developed (e.g. Colloquium Doctum, James Boswell Institute). However, their success in terms of students completing the programme is highly dependent on the motivation of students, the involvement of teachers and the learning environments (Van Leijen, 2005). As higher education institutions now have to compete on a European or even global market, offering (only) regional/national remedial courses in a fixed (geographical) location with traditional teaching methods seems to neglect the effects of a changing world (of education). In order to increase the success rates of higher education, an online remedial programme could offer a solution to the problems of (lacks of) prior knowledge.

Therefore, in this chapter a general framework for an efficient and effective online summer course will be developed. Subsequently, the online remedial teaching model will be tested in practice by analysing two online remedial teaching courses at Maastricht University, which is part of the experiences of the project Web-spijkeren¹. Finally, the evaluation results of the summer courses will be used to answer the following three questions: How can students assess their current level of mastery before joining a (bachelor) programme? In addition, if the level of mastery of individual students appears to be low, how can “online summer courses” help to tackle these potential deficiencies? And finally, how can online summer courses be designed to increase completion rates of students joining an online summer course?

2. ONLINE REMEDIAL TEACHING MODEL

Van Leijen (2005) conducted research in various remedial teaching programs in the Netherlands. A programme offered during the summer period induces an incentive problem as most graduated high school students have a strong preference to do other things than studying. Hence, the challenge arises to construct a programme that achieves a balance between study time and time for summer activities in such a way that it provides sufficient motivation to keep students engaged in the course. An online summer course might be able to strike this balance, as it in theory should be possible to teach and learn regardless of time and place. On basis of various research on the use of ICT in education and distance education (Bryant, Khale, & Schafer, 2005; Keegan, 2002; Roblyer & Wiencke, 2003; Schellens & Valcke, 2005; Vrasidas & Mclsaac, 1999) and research on remedial teaching (Van Leijen, 2005), the following five aspects should be taken into consideration when an institute aims to design and implement an online remedial summer course:

1. Access and availability 24/7 online
2. Adaptiveness
3. Interactivity
4. Responsiveness of feedback
5. Flexible learning method and assessment

Access and availability 24/7 online

According to Bryant et al. (2005), there are many definitions about online and/or distance education. Distance education encompasses two important elements, namely distance teaching and distance learning. Distance teaching regards mainly the way in which instruction is provided, whereas distance learning concerns optimising student learning behaviour (Keegan, 2002). Various definitions are used for online education. Although in most of the definitions terms like “web-enabled” and “online” point at the way instruction is provided, it does not automatically lead to distance education (Bryant et al., 2005). However, in this article the term online (education) is used instead of distance education as it allows bridging the limitations of time and geographical distance. In this way, students can work and study whenever they want, or so-called ubiquitous learning. Note that the term online mainly refers to technical educational issues. In order to learn independent of time and place, also organisational and didactical aspects have to be aligned.

Adaptiveness

As each student is unique, the programme should ideally allow for an individualised learning path based on prior knowledge, learning style and preferences of the student (Abdullah, 2003; Doignon & Falmagne, 1999). This means that the module should be flexible in meeting the needs of each individual participant.

Interactivity

Generally, in a face-to-face setting it is assumed that interaction is one of the key issues in the learning process (Vygotsky, 1978). According to Vrasidas and Mclsaac (1999), interaction is also a central component of online distance learning. "A fundamental component of distance education is the communication medium" (Bryant et al., 2005, p. 257). Being solely available online, the course and learning environment should stimulate interpersonal contact in order to motivate participants to remain engaged (Ronteltap & Eurelings, 2002). However, in comparison to face-to-face education, it is harder to transfer communication elements like body language or intonation in a virtual education. Therefore, online courses have to make more intensive use of the available interaction methods (Roblyer & Wiencke, 2003). Interaction is not just a technical mechanism; it is also a social and psychological way to generate relations. By forming small groups, students will experience peer-pressure, which forces them to interact more intensively. At the same time, group processes and learning processes remain clear and manageable for tutors (Schellens & Valcke, 2005). In a model of Problem-based Learning setting (Moust, Bouhuijs, & Schmidt, 2002), it is assumed that tutors together with students are responsible for stimulating interaction as well as stimulating the learning process.

Responsiveness of Feedback

Vrasidas & Zembylas (2003) argue that feedback is a crucial factor in the interaction of a course. Besides the fact that it is pedagogically better to provide rapid feedback on performance, it is also important because the period before the summer course starts is short and often fully planned with other activities.

Flexible learning method and assessment

Given the fact that learning and assessment methods are subject to change, the programme should be flexible enough (Segers, 2004). Depending on the educational vision of an institute, different aspects of the model can be emphasized. In a more teacher-centred educational vision, communication between students will be less important. In a didactical

model based on social constructivism and problem-based learning (Moust et al., 2002), more emphasis will be placed upon interaction among students.

Figure 2.1 Online remedial teaching model

In Figure 2.1, our online remedial teaching model is illustrated by the aforementioned aspects and their interrelations. The model makes a distinction between technology and virtual learning environment (VLE). In other words, the model can be adjusted to different educational settings depending on the educational vision. In an individual learning programme, the interaction will mainly take place between the technology and the student (by offering learning materials, assignments and assessments) as well as between student and lecturer. In a problem-based learning setting, the interaction between students will increase with help of the technology (discussion-forums, chat, e-mail, etc.), whereas the lecturer will perform a coaching role. The way in which the student is assessed will essentially depend on the chosen didactical model (Segers, 2004). In addition, the online remedial teaching model will also determine the evaluation method.

3. DESIGN OF ONLINE SUMMER COURSES

As Maastricht University has the highest percentage of international students (24% in 2005) in the Netherlands (Ministerie van OCW, 2005), and the Faculty of Economics and Business Administration has more than 70% of enrolments from abroad, the differences in prior knowledge are enormous. The experiences how to tackle these problems provides an interesting case-study for higher educational institutes focussing on moving towards internationalisation.

Most 1st and 2nd year students in the “regular” curriculum at Maastricht University have (some) problems with mathematics and/or economics (Rienties, Dijkstra et al., 2005). Therefore, the first online summer courses were specifically developed for tackling these problems. As the majority of the target group lived abroad, the programme was offered completely online, with no physical presence required. An economics as well as the mathematics online summer course were offered twice during the summer period. This allowed for more flexibility, which enhanced the match between a student’s efforts to tackle possible deficiencies for the respective topics and his/her other “summer” activities. This enabled participants to work anywhere they liked and at times that suit them best. Important to note is that participation was completely voluntary and in no way related to the official admission procedures of the university. Moreover, participation in the summer course was free of charge and the only bonus was an unofficial certificate and a graduation ceremony and drink.

3.1 Prior knowledge tests

A fundamental assumption is that not every student will need an online summer course. Therefore, a so-called online prior knowledge (diagnostic) test was developed before the start of the academic year. The online tests of economics and mathematics were available and accessible 24/7 via the Internet and were a combination of exercises in open-question type form and self-assessment of mastery of knowledge. Anyone who completed in the online entry test received elaborate feedback via E-mail. If the results were deemed to be below a specified threshold, students were invited to take part in the applicable summer course to remediate the apparent deficiency. If a student was willing to invest 60 to 80 hours to remediate his/her knowledge deficiency, the student was enrolled in the summer course.

Overall, the economics test was viewed 379 times and 211 prospective students from 34 different countries, ranging from Spain, Peru, Australia to

Kazakhstan, completed the test. Surprisingly, 151 (71%) prospective students scored below the threshold level for economics. For mathematics, 230 prospective students took the test and 83% scored below the pre-defined threshold-level. In total 50 students registered for economics and 55 for mathematics, mostly German students with the basic level mathematics (Abitur Grundkurs Mathematik) and no economics.

3.2 Online summer course economics

The online summer course economics was a virtual version of the collaborative Problem-Based Learning (e-PBL) approach used at Maastricht University (Rienties, Rehm, & Dijkstra, 2005). The course was given over a period of six weeks in which students were assumed to work for 10-15 hours per week. There were neither obligatory meetings nor a schedule of appointments. The students themselves decided when to work on a task. They discussed six tasks that covered introductory topics of economics in general (e.g. economic way of thinking), microeconomics (e.g. demand and supply model) and macroeconomics (e.g. gross domestic product, inflation and unemployment). The 50 participants were divided in three groups (depending on the time of enrolment) of 14 to 18 students, in line with analyses by Schellens & Valcke (2006) about optimal group sizes for collaborative learning. All groups were guided by two tutors.

Online Training

Because participants had no experience with the seven-jump method of PBL (Moust et al., 2002) and most of them were unfamiliar with using a virtual learning environment, a lot of emphasis was placed upon training and schooling. This was a challenge since there was no face-to-face contact between tutors and participants. Therefore, three steps were taken to overcome these difficulties.

1. The six tasks were preceded by "Task 0". The purpose of this task was to demonstrate students the process of PBL in a discussion board. The coordinators of the course simulated a discussion on a related, but non-economic topic.
2. The summer course manual included a chapter that explained the content and sequence of the different steps in the seven-jump as well as a manual for the VLE.
3. During the first week, extra attention was paid to the first contributions of participants. If mistakes were made, immediate positive feedback was given (Schellens & Valcke, 2005).

Virtual Learning Environment

In order to participate in the discussion of the tasks, students were given access to the VLE used in Maastricht. ELEUM incorporates most of the characteristics of the online remedial teaching model. It allows students to do quizzes and give immediate feedback on their results and learning process (Rienties & Woltjer, 2004; Tempelaar & De Gruijter, 2004). In addition, ELEUM has some interactive communication tools like discussion boards, chat and E-mail (Ronteltap & Eurelings, 2002). As primary learning materials, an electronic version of a first year economics book from Parkin and Bade (2004) was used, which includes chapters of the book, videos, interactive materials and animated graphs.

Formative and Summative Assessment

The course used various formative as well as summative assessment forms. According to Marshall (1999), formative assessment supports the learning process of students without grading, while summative assessment gives insight in the (end) level of a student with an accompanying mark. The students had the opportunity to make three formative tests and they could themselves decide when to take the tests. These tests were used to provide the students with feedback on their level of mastery of the learned subjects. The course was concluded with a final summative exam. The students had to work on a problem similar to the ones they discussed during the course and were asked to answer it by applying the newly acquired knowledge.

Interactive communication

With regard to the problem of ensuring rapid feedback, interaction tools prove to be a very attractive mechanism. The use of a discussion-board (a-synchronous communication) makes it possible for students to interact with each other, share new insights and help in case certain aspects need clarification. This is in contrast to synchronous communication (e.g. chat or MSN-messenger), which requires all participants to be online at the same time. By designing a course around a-synchronous communication, a substantial degree of flexibility is created and this has been extensively researched by Computer Supported Collaborative Learning (CSCL) analyses (De Wever, Schellens, Valcke, & Van Keer, 2006; Gunawardena, Lowe, & Anderson, 1997). This allows students to actively participate in a discussion at their preferred time without running the risk of missing vital parts. Moreover, it allows for group dynamics that are missing when a student has to follow a remedial course alone (Rienties, Rehm et al., 2005). Hence, a discussion board can be used as a formative assessment tool.

3.3 Online summer course mathematics

The procedure used for the online summer course mathematics is to a large extent similar to the economics course. The workload is equivalent, namely 10-15 hours per week in a period of 4 to 6 weeks. In contrast to the economics course, the mathematics course is largely an individual course. It is based on individual learning, where nearly all interaction is between the student and the learning environment. Students worked with an online programme (ALEKS), which again assessed the prior knowledge level of students and afterwards offered a unique individual learning path. This programme is based on so-called Knowledge Space theorem (Doignon & Falmagne, 1999). If a student goes faster (or slower) through the learning material, then ALEKS will immediately adapt the learning path. In principle, this implies that the program adapts the learning path depending on knowledge, progress and learning style of the student.

The lecturer, who is also responsible for the 1st year introduction course mathematics in the “regular” curriculum, chose a module which is similar to the complete mathematics programme in Dutch secondary education. Students had to solve mathematical problems and if necessary ALEKS provided hints. Although students worked individually, they could contact the lecturer if the explanations of the program were insufficient or unclear to the student. The pass-fail decision was made based on the endpoint (knowledge level) a student achieved.

3.4 Evaluation

In order to analyse whether the two online summer courses were developed effectively, an evaluation was used which is based on a protocol developed by Kaper, Blok, Brouwer and Wieland (2005). This evaluation protocol takes into consideration the specific demands of flexible education with heterogeneous students. In order to be able to measure the expectations of the participants at the beginning as well as at the end of the course, online questionnaires were distributed. At the beginning, students were asked about their motives and incentives for participating in the online summer course programme.

4. RESULTS

4.1 Results of online summer course economics

According to the entry questionnaire, students were mainly joining the course since they were not satisfied with their level of mastery in economics. The students indicated that they liked the idea of working online to remediate their knowledge and at the same time liked the opportunity to contact other students as well as the tutor. In general, the participants indicated that at the start of the course they received sufficient information about the goal and context of the course. Furthermore, the students clearly expressed their preference for teamwork instead of working individually.

During the course, the students had to collaborate on solving problems derived from PBL-tasks. When the summer course started, the students briefly introduced themselves in the “Café/Small Talk”-section with a picture and personal background information. The Café/Small Talk-section was intensively used for getting acquainted with each other, as recommended by Roblyer and Wiencke (2003). In addition, it was used for arranging practicalities such as “how to find a room?” or “where do I apply for a grant?” Thus, the online course also contributed to establishing of fidelity within the group and with the institution. One can reasonably assume that students who are more convinced about their choice of study will commit more to the institute and will put more effort in their study. By early fidelity of students towards the institute, the chance that a student gets isolated in a new environment and drops out the study in a preliminary stage is thus reduced. In the beginning, students found it difficult to understand the seven-jump. Students placed daily threads and reacted on each others’ contributions. Six weeks later, an average of 370 threads per group were placed, which can be seen as a rough approximation of the intensity of usage. The highest performing student placed 27% of the messages and the lowest performing student 2% of the messages.

At the end of the course, an evaluation was conducted to see whether the course matched the expectations of the students (see Table 2.1). Students were very positive about both the functioning of the instructors as well as the online summer course as such. More specifically, students felt that the course had offered them a lot and enabled them to remediate their knowledge to such an extent that they feel ready to start in Maastricht University. Students worked over a period of six weeks 13 hours per week for the summer course on average. The group of students who did not pass only worked for six hours per week. With regard to the VLE, students found the digital materials to be of very good quality. Moreover, there is evidence that students liked the fact that they could collaborate with each other in this summer course. The students thought that it was fun to make use of

Table 2.1 Students' end evaluation of online summer course economics

	M	SD
This Summer course offered me a lot	4. 1	0. 8
The contents of the Summer course were inspiring	4. 1	0. 6
The format of the Summer course was good	4. 0	0. 9
The Summer course was well organized	4. 0	0. 9
The quality of the digital material was good	4. 3	0. 7
The digital material motivated me to keep up with the subject matter	3. 5	1. 0
Learning with an E-book is not different from learning from a hard-copy book	2. 3	1. 0
It was fun that I could attend this Summer course via the internet	3. 8	0. 8
The goals of the Summer course were clear to me	3. 9	0. 8
It was clear to me what was expected of me this Summercourse	3. 9	0. 8
The assignments/tasks stimulated me to collaborate with the other group	3. 6	0. 9
The assignments/tasks stimulated me to study	3. 6	0. 8
I am satisfied with what I learned in terms of knowledge, skills and insight	3. 7	0. 9
I gained enough knowledge and skills in economics to start with my study in Maastricht	3. 7	0. 6
I think that by attending this Summer course I will get better results in my future study in Maastricht	3. 7	0. 7
The group in which I participated functioned well	3. 7	1. 0
It was fun to collaborate with others in this Summercourse	3. 9	1. 0
Collaborating with others facilitated my understanding of the subject matter	3. 7	0. 7
The group in which I participated functioned well	3. 8	0. 9
I think I learned more in this Summer course through collaboration with others than I would have learned if I had to work	3. 2	0. 9
I participated actively in the online group discussions	3. 0	1. 2
I think I was motivated to finish this Summer course because I could work in my own pace	3. 4	1. 1
It is good that I could attend this Summer course independently	4. 1	0. 6
I was given the support that I needed	4. 1	0. 6
The Online Summer course team was enthusiastic in coaching our group	4. 1	0. 8
The Online Summer course team stimulated participation of all group members in the online group discussions	3. 5	0. 9
The Online Summer course team helped us to apply what we had learned on other situations than those mentioned in the assignment	3. 7	0. 7
The entry test on the UM Website was a good test to show me what	3. 5	1. 1

I did know and what I did not know		
The questions in the final test were clear	3. 8	0. 9
The instructions for making the final test were clear	4. 0	0. 8
The Weekly tests (intermediate tests) in this Summer course gave me a good picture of what I still had to study	3. 7	0. 7
The programme used for the tests was easy to work with	4. 2	0. 8
I have made out of 3 Weekly (intermediate) tests	2. 5	0. 9
Give an overall grade for the quality of the Online Summer course team (1 = very bad - 10 = very good)	8. 3	1. 2
Give an overall grade for the functioning of the Online Summer course team (1 = very bad - 10 = very good)	8. 1	1. 4
Weekly I have spent hours on this course and additionally I have spent . . . hours on preparing the final test	12	13

Note: All questions on 1(= totally disagree) till 5 (= totally agree) Likert Scale except last four questions

discussion-boards and they perceived the general atmosphere in the group to be friendly. Furthermore, students had a strong feeling that the teamwork setting helped them in their process of tackling their knowledge gaps. The observation that increased interactivity in distance education is related to higher student satisfaction (and therefore higher passing rates) has already been confirmed by earlier findings by Roblyer and Wiencke (2003).

Eventually, 25 out of 50 students passed the course. In comparison to other remedial courses (Van Leijen, 2005) and taking into account that students never physically met one another and that participation was completely voluntary, a passing rate of 50 per cent can be considered to be fairly high.

4.2 Results of online summer course mathematics

Regarding the mathematics course, the students indicated at the beginning of the course to be highly motivated and were mainly joining the course since they were not satisfied with their level of mastery in mathematics. Students pointed out that they received sufficient information about the goal and context of the course. In contrast to the economics summer course, there were no questions regarding any form of collaboration, for the aforementioned reasons related to the usage of the individual learning tool of ALEKS. The students indicate to be motivated to complete the Summercourse as they could work at their own pace.

In the end, 29 of 55 (53%) students successfully completed the course. Again, the students were positive about the tutor as well as the course. The course offered a lot of added value as well as a stimulating environment and had useful learning materials. Students signify that they gained enough

Table 2.2 Students' end evaluation of online summer course mathematics

	M	SD
This Summer course offered me a lot	4.5	0.6
The contents of the Summer course were inspiring	4.2	0.5
The format of the Summer course was good	4.3	0.7
The Summer course was well organized	4.4	0.7
The quality of the material in ALEKS is good	4.3	0.7
The material in ALEKS motivated me to keep up with the subject matter	3.9	0.7
Learning in an e-learning environment as ALEKS is not different from learning from a hard-copy book	2.4	0.9
It was fun that I could attend this Summer course via the internet	4.2	0.8
The time allocated was sufficient to study the amount of subject matter	3.2	0.8
The goals of the Summer course were clear to me	4.1	0.6
The contents of the Summer course fitted well with my pre-existing knowledge	3.6	0.9
The format of the Summer course was good	4.2	0.5
The way one has to work in ALEKS is straightforward	4.0	0.9
The assignments/tasks stimulated me to study	3.9	0.8
I gained enough knowledge and skills in mathematics to start with my study in Maastricht	3.5	0.8
I think that by attending this Summer course I will get better results in my future study in Maastricht	3.9	0.8
It is easy to understand how to operate in the ALEKS learning environment	4.5	0.6
It was fun to work with ALEKS independently	4.2	0.7
It was good that I could work on the subject matter at my own pace	4.5	0.6
I think that I have learned more by individually attending this course than I would have learned if I had to collaborate	3.5	1.0
I was given the support that I needed	4.0	0.8
The explanation in ALEKS in case one is unable to solve a question is generally sufficient	3.8	0.9
Next to the explanations in ALEKS I have used hard-copy books on mathematics	1.9	1.1
Questions via e-mail were answered well by the teacher	3.8	0.8
The entry test on the UM Website was a good test to show me what I did know and what I did not know	3.8	1.0
The questions in the ALEKS-tests were clear	3.9	0.8
It was easy to see how the ALEKS-tests had to be done	4.1	0.8
The intermediate tests in ALEKS were instructive	3.6	0.8
The intermediate tests in ALEKS gave me a good picture of what I	4.0	0.8

still had to study		
I worked regularly on the assignments/tasks in this Summer course	3.5	1.2
It was easy to motivate myself to finish this Summercourse	3.6	1.1
Give an overall grade for the quality of this Summer course(1 = very bad - 10 = very good)	8.6	0.9
Give an overall grade for the quality of support you were given by ALEKS in this Summer course (1 = very bad - 10 = very good)	8.3	1.1
In total, I spent hours on this Summercourse	53	29

Note: All questions on 1(= totally disagree) till 5 (= totally agree) Likert Scale except last four questions

knowledge and skills to make a successful start of their study. Students worked on average 53 hours during the course. In contrast to economics, they preferred to work individually rather than working together. In table 2.2, the complete evaluation results are given.

Remarkably, students who participated in both courses judged both didactical scenarios to be adequate. The question which arises is: are students indifferent about the didactical scenario, or do they judge that individual learning best suits the mathematics summer course, and collaborative learning best suits the economics summer course, and that the designers of both types of summer courses made appropriate choices for the didactical scenarios?

4.3 Comparing the didactical scenarios

The two summer courses are based on completely different didactical scenarios. The mathematics course is based on purely individual learning, where nearly all interaction is between the student and the learning environment. Neither interaction with peer students takes place nor extensive interaction with the tutor. In contrast, the economics course is based on collaborative learning supported by a VLE. One of the aims of having both summer courses founded in such different learning paradigms was to collect empirical evidence on the appropriateness of both scenarios when applied for online, distance summer courses. As indicated above, both summer courses appeared to be successful in terms of better preparing students with deficient prior knowledge for their regular study. Comparing drop-out ratios, no strong differences have been found. A similar remark refers to students' satisfaction based on the evaluation questionnaire: both courses, and thus both didactical scenarios, achieve positive evaluations on all criteria.

To answer this last question, one item in the evaluation questionnaire of both summer courses asked the students to judge the appropriateness of the didactical scenario, with the other didactical scenario as benchmark. In

the mathematics course, students were asked to express themselves on the statement 'I think that I have learned more by individually attending this course than I would have learned if I had to collaborate'. In contrast to this, the statement has been formulated in the reverse way for the participants of the economics course. This statement received an average score of 3.5 for the mathematics summer course, and a 3.2 score for the economics summer course. Thus, although scores are less pronounced than in most other evaluation items, there is a tendency that individual learning is regarded more suitable for the mathematics summer course, and collaborative learning most suitable for the economics summer course. Students' opinion on the appropriateness of the didactical scenario is dependent upon success in the summer course. In fact, it is the only evaluative statement where a "passing student" provides an answer that is significantly different from the answer provided by a "failing student". This might indicate that some students fail the summer course because they regard the didactical scenario applied in the summer course as suboptimal.

5. DISCUSSION

In this chapter, the question how prior knowledge tests and online remedial summer courses can contribute to mitigating the problems of heterogeneous enrolment of students has been dealt with. First of all, an online remedial teaching model was developed. The five success factors that an online remedial course developer should take into account are 24/7 access and availability via Internet, adaptiveness, interactivity, rapid feedback, and flexible learning methods and assessment.

Afterwards, the online remedial teaching model was implemented in practice at for two summer courses of the Maastricht University. Before students were allowed to join one/both of the courses, they had to make an online prior knowledge test. More than 200 prospective students out of more than 30 countries made use of this possibility. A large amount ($\geq 75\%$) of the prospective students scored below the threshold on the prior knowledge test mathematics and/or economics. This suggests some proof for our assumption that, due to internationalisation, problems in higher education with regard to prior knowledge in mathematics and economics are wide-spread. Eventually, approximately 2 * 50 students took part in one or both of the online summer courses. As most (prospective) students of Maastricht University live abroad before joining the academic programme, the courses were offered 100% online.

Although both courses implemented a different didactical scenario, both matched with the online remedial teaching model. The didactical model fitted the content of the course of economics and mathematics, respectively ePBL and working individually with ALEKS. Positively, most of the

participants spent a substantial amount of time on the course and the passing rates are at least similar to other experiments of online virtual learning. The student evaluations of both courses were very positive and students indicated they felt ready to start their study at Maastricht University. More specific, there seems to be some evidence that individual learning is regarded more suitable for the mathematics summer course, and collaborative learning more suitable for the economics summer course. The implementation of both summer courses was mainly focused on didactical and organizational aspects, since the technical infrastructure was already in place. Both courses are implemented using existing ICT-infrastructures, comparable to other higher education institutes. As long as sufficient expertise and resources are invested, the problems accompanying the increasing internationalization of students can be tackled.

Further research is necessary to prove whether online summer courses have a temporary or structural effect on the (prior) knowledge level of students. In addition, it remains to be investigated whether the participants, in comparison to those who did not take part at the summer course, perform better in the respective courses in the curriculum. Furthermore, a so-called “sample bias” might have occurred. Therefore, the participation of students will be followed during their “regular” curriculum by means of a longitudinal study. Finally, more research is needed on the motivation of participants. In future summer courses, the subgroups of participants of the summer courses will be enlarged and the didactical scenarios will be implemented at other institutes. To enlarge the statistical power of the research, more specified and detailed information about the subgroups will have to be gathered.

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Chapter 3

LONGITUDINAL STUDY OF ONLINE REMEDIAL EDUCATION EFFECTS

An increasing number of students are choosing to follow a bachelor or master programme at a foreign university. As the transparency in higher education is still limited, a student might make an inefficient decision when selecting a programme. Several studies have found that lack of knowledge, skills, or academic integration lead to higher drop-out rates. Although remedial programmes might mitigate these problems, the rates of long-term success of online remedial programmes in terms of knowledge retention are unclear. In this contribution, we compared the short- and long-term effects of two online remedial courses, each with a distinctly different educational philosophy (problem-based learning vs. cognitive learning theory). The success of these courses was measured in a longitudinal study of the 850 participants in a first-year international business bachelor programme. We found some empirical support that both courses improved study performance as well as study success.

1. INTRODUCTION

In Europe, heterogeneity of enrolled students has increased due to increasing internationalization in higher education, the introduction of the Bachelor-Master structure and the new accreditation procedures of the Treaty of Bologna. In addition, an increasing number of higher education institutes is orienting towards the international market of bachelor and

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master students (Van der Wende, 2001). For example, at Maastricht University the percentage of foreign students following a bachelor in business has increased from 10% in 1996 to 60% in 2006. Given this recent increased heterogeneity of student enrolments in Europe, it is reasonable to expect that transitional problems from secondary education to university have become larger. The primary reason is that secondary educational programmes in Europe are determined on a national rather than on a European level (Van der Wende, 2003). In fact, differences in secondary educational programmes across European countries are widespread. For example, in most European countries hardly any attention is paid towards statistics or economics, whereas in the Netherlands this is integrated in their secondary education. As a consequence, it has become necessary to design bridging courses, summer courses, or remedial courses to equip students with required knowledge before entering a programme (Rienties, Tempelaar, Waterval, Rehm, & Gijselaers, 2006; Wieland et al., 2007).

In the United States, remedial programmes are common at both colleges and universities (Hart & Speece, 1998; Roueche & Roueche, 1999). Bettinger & Long (2005) argue that the goal of remedial education is to provide underprepared students with necessary skills and knowledge to succeed at universities. In other words, remedial education aims to bridge gaps in domain knowledge (e.g. mathematics, economics) and skills (e.g. reading, writing) in order to establish a smooth transition in the next step of a student's career. In the U.S., most institutes offer some form of remedial education and recent research indicates that more than 40% of traditional undergraduates participate in at least one remedial course (Attewell, Lavin, Domina, & Levey, 2006; Kozeracki, 2002). The benefits of remedial education in the U.S. are heavily debated yet recent findings indicate several positive effects of remedial education (Attewell et al., 2006; Bettinger & Long, 2005).

While remedial programmes are common in the U.S., there is less of a tradition of remedial education in Europe. Nonetheless, in the last couple of years several European higher educational institutes have started to offer remedial education programmes (Wieland et al., 2007). A main difference with the United States is the reason to offer these remedial programmes. In the U.S., a common assumption is that remediation attracts underprepared students of low socio-economic status (Attewell et al., 2006; McCabe & Day, 1998). In contrast, in Europe a large part of the transitional problems are caused by differences among national secondary educational programmes (Van der Wende, 2003) which hamper foreign students to effectively start a bachelor or master programme.

As the number of foreign students enrolled into a European bachelor programme increase, one reasonable response to facilitate foreign students

in their transitional phase is to offer remedial education in a distance learning format. Information Technology (IT) has some powerful tools which might benefit remedial education (McCabe & Day, 1998). Already in the 1980s some small experiments with IT in remedial education were conducted yet with limited results (Boyd, Keller, & Kenner, 1982; Plomp, Pilon, & Reinen, 1991; Smit, Oosterhout, & Wolff, 1996). Recently, IT has gained the power to support independent learning as well as to learn irrespective of time and geographical constraints with the wide-spread implementation of Internet (Bromme, Hesse, & Spada, 2005; Jonassen & Kwon, 2001). In addition, IT has some powerful tools for learning in collaborative settings where students work and learn together (Bryant, Khale, & Schafer, 2005; Schellens & Valcke, 2005). In particular in a context of foreign students, offering remedial education in virtual settings has shown to be effective (Rienties et al., 2006). The perceptions of the learning environment by these students were found to be positive. In particular, the interactivity of these online courses as well as the possibility to work at one's own pace and time was considered to be a strong highly valuable characteristic.

While European higher educational institutes are increasingly using remedial courses supported by IT to facilitate transitional issues of foreign students, to our knowledge no research has been done in order to determine whether participating in such programmes lead to a smoother transition from secondary education to university. In this exploratory study, we aim to provide a first attempt to assess whether online remedial education helps foreign students to bridge the gap from secondary to university education. Therefore, the purpose of this study is to assess to what extent participating in an online remedial course positively influences study performance as well as study success of foreign students in an academic curriculum. In this longitudinal study, we will distinguish short-term effects (i.e. study performance on the relevant course the remedial course aims to bridge) from long-term effects (i.e. study success after one year) in order to test the effectiveness of online remedial education.

2. ONLINE REMEDIAL EDUCATION MODEL

While remedial education has according to Phipps (1998) been around since the 17th century, remedial education has become a common practice at colleges and universities around the United States since the 1960s. According to Bettinger & Long (2005, p. 19) the aim of remedial education is "to provide underprepared students with the skills necessary to succeed in college and gain employment in the labour market". Hart & Speece

(1998) argue that open-door admission policies as well as an increased number of community colleges increased the number of underprepared postsecondary education students. As a consequence, colleges and universities started to offer remedial courses in order to meet the needs of these students (McCabe & Day, 1998; Phipps, 1998; Roueche & Roueche, 1999).

Recent figures indicate that large numbers of students follow remedial education in the U.S. More than 40 percent of first-year students at public two-year colleges take remedial courses (U.S. Department of Education National Center for Education Statistics, 2003). For example, New York City provided summer help for 70,000 students in 1999 (Jacob & Lefgren, 2004). According to Attewell et al. (2006), mathematics was the most common remedial subject, followed by reading and writing.

While remedial courses in the U.S. are implemented across the board, they also remain controversial (Jacob & Lefgren, 2004; Kozeracki, 2002; Roueche & Roueche, 1999). Critics argue that remediation indicates some students are not academically strong enough to start at a university. In addition, critics argue that the government should not pay a second time for something the student should have learned at secondary education anyway. Proponents of remedial education provide rationales based on economic outcomes and societal benefits (Lavy & Schlosser, 2005; McCabe & Day, 1998) as well as issues of fairness. According to Kozeracki (2002), the term remedial education is inappropriate as it has a stigmatising flavour. Therefore, Kozeracki (2002) considers the term developmental education more appropriate as it takes into consideration holistic approaches to student learning based on human development theory. Developmental education is "intended to bring together academic and student support services to assist students in preparing to make choices appropriate to their current stage in development" (Kozeracki, 2002, p. 85). Important to note is that developmental education is seen as appropriate for all students, rather than only for underperforming students. In this chapter, we use the term remedial education and development education interchangeably.

According to McCabe & Day (1998), the ideal comprehensive developmental programme combines both individual growth and learning theories which address cognitive as well as affective development. "[S]uccessful development programmes offer a wide variety of comprehensive instructional support services, including assessment, placement, orientation, tutoring, advising, counselling, peer support, early alert programmes, study skills training and support groups" (McCabe & Day, 1998, p.21). Kozeracki (2002) conducted a review of success factors of remedial education and found that offering a high degree of structure, clear

goals and objectives, social and emotional support, adequate staff training and professional development are important elements for remedial education.

While the number of students participating in remedial courses is increasing, several researchers state that little is known about the causal effect of remediation on student outcomes. According to Bettinger and Long (2005), most studies on remedial education are descriptive and provide only simple comparisons between those who participated in remedial courses and those who did not. "The majority of community colleges do not know how effective their remediation is because they do not assess their effectiveness very well, do not know how to assess it, or do not want to know" (Roueche & Roueche, 1999, p.27).

Recently, more empirical research has become available which measures the effectiveness of remedial education in a longitudinal manner while also taking into consideration demographical and socio-economic issues. For example, Jacob and Lefgren (2004) found a modest but positive net impact on student achievement scores for third-grade students participating in a summer school. In a study of 6800 high school students, Attewell et al. (2006) found that the effects of remedial education depend on the type of institution. In two-year colleges, students who passed remedial courses were more likely to graduate than students with equivalent backgrounds who never took remediation. In four-year institutions, remedial courses reduced students' chances of graduation, even when controlling for academic skills and background (Attewell et al., 2006). Bettinger and Long (2005) took a different dataset and found that mathematics remediation improved student outcomes, while English remediation did not improve student outcomes. In other words, recent research indicates that the effects of remedial education might depend on the particular context, type of institution as well as type of domain knowledge or skill.

While in the United States remedial education is a common phenomenon, in Europe remedial activities were until recently scattered among only a couple of institutes. However, with the Treaty of Bologna and the establishment of a European policy of open-access to higher education, several European institutes started to offer bridging courses in mathematics, language and writing (Hoyles, Newman, & Noss, 2001; Tempelaar et al., 2006; Wieland et al., 2007). A crucial difference with respect to the U.S. situation is that the reasons for offering remedial education are different. While assessment criteria in secondary education across the U.S. are harmonised, in Europe each country has the legal right to design and implement their own educational programme and criteria (European Commission, 2004; Van der Wende, 2001, 2003). As a consequence, when a European student wants to study at a different

European country, he/she will likely be confronted with different prior knowledge and skills requirements. For example, it is common in the Netherlands to follow courses in statistics and economics, while in most European countries hardly any attention is given to these topics at secondary education. The fact that a foreign student is deficient in for example economics when starting a bachelor in the Netherlands has nothing to do with his/her cognitive, motivational or financial capabilities. In contrast, most U.S. participants of remedial education are underprepared for university due to a weak academic skills or preparation in high school and/or low socio- economic status (Attewell et al., 2006). "Many underprepared community college students come from economically deprived circumstances and have attended less than adequate schools" (McCabe & Day, 1998, p.29). In other words, while the research findings at U.S. universities provide some important insights, the context of remedial education in Europe is different.

As the number of foreign students enrolled into a European bachelor programme increase, one reasonable response to facilitate foreign students in their transitional phase is to offer remedial education in a distance learning format. We define online remedial education as an instruction method using IT which helps students to provide knowledge and skills necessary to succeed in university. In this way, foreign students can study at their home country, which reduces their costs while at the same time offering flexibility to develop their knowledge and skills. IT has the power to support independent learning as well as to learn irrespective of time and geographical constraints with the wide-spread implementation of Internet (Bromme et al., 2005; Jonassen & Kwon, 2001). In addition, recent research findings indicate that IT has some powerful tools for learning in collaborative settings where students work and learn together (Bryant et al., 2005; Schellens & Valcke, 2005). Although research in remedial education in physical settings provide important factors for success (Kozeracki, 2002; McCabe & Day, 1998; Roueche & Roueche, 1999), in online settings four additional issues need to be taken into consideration.

Firstly, the term online in this article refers to the internet. To overcome barriers of time and place in a group of international students, the summer course should be available online 24/7. Only then participants are able to work anywhere they like and at times that suit them most (ubiquitous learning). The continuous availability also requires a different instruction method, which allows students to learn at their time of preference (Rienties et al., 2006).

Secondly, every student is unique in prior knowledge, learning style and study progress (Tempelaar, Gijsselaers, Schim van der Loeff, & Nijhuis, 2007). Therefore, a Virtual Learning Environment (VLE) ideally should be

adaptive, to allow for individualised learning progression (Doignon & Falmagne, 1999). In contrast to physical remedial courses, IT has the power to offer an adaptive learning path for each learner.

Thirdly, interaction is one of the most influencing elements, not only in online learning, but in all kinds of education as interaction stimulates motivation (Hmelo-Silver, 2004; Schellens & Valcke, 2005; Vrasidas & Zembylas, 2003). In completely virtual settings, where no face-to-face meetings take place, interaction becomes more difficult to facilitate (Bromme et al., 2005). Important elements of interaction like context, body language and intonation are difficult to transmit online (Jonassen & Kwon, 2001). Since interaction is an important mechanism to stimulate motivation of students, it is crucial for VLEs that interaction is actively stimulated by instructors (Bryant et al., 2005; Schellens & Valcke, 2005).

Fourthly, rapid feedback stimulates interaction in an online course. Various IT assessment tools allow students to test their mastery of knowledge and receive immediate individualised feedback, which is known to be beneficial for learning (Marshall, 1999). Nothing is more demoting in an online course than a non-response to your own contribution(s) (Schellens & Valcke, 2005).

3. METHODOLOGY AND RESEARCH DESIGN

3.1 Setting

In order to test whether online remedial programmes lead to improved study performance and study success, we designed two courses based on two distinctly different pedagogical frameworks which have proved to be appropriate in distance learning settings¹. The *online remedial course mathematics* was designed based on principles of cognitive learning theories. Cognitive learning theories provide important insights on internal processes of the learner on the learner's mind. The act of learning is regarded as an active process where new information is interpreted on the basis of prior knowledge. Learning is therefore seen as an active processing of information, which influences the learner's cognitive structures and as a result changes future learning processes. Thus, the learner is an active participant in his or her own learning process (Bryant et al., 2005). An instructor has to plan educational objectives, appropriate learning situations, and pedagogical means so the students are led (and guided) to taking the necessary steps (operations) for successful internal learning processes (Wieland et al., 2007). The course architecture can be designed in such a way that the amount of new information is limited. In

other words, new learning contents should be connected to knowledge already gained (Doignon & Falmagne, 1999; Heck & Van Gastel, 2006). In particular when differences in prior knowledge among students are large, offering adaptive individual learning paths through the use of IT might be beneficial (Tempelaar et al., 2006). Therefore, the module 'College Algebra' of a program called 'ALEKS' (<http://www.aleks.com/>) was used. This program is based on Knowledge Space Theory, which assumes there are various paths to achieve certain knowledge on a certain level (Doignon & Falmagne, 1999). The program adapts the learning path depending on knowledge, progress and learning style of the student. Although the students had to work individually, they could contact a teacher if the explanations of the program were insufficient or unclear to the student (Tempelaar et al., 2006). The pass-fail decision was made based on the endpoint (knowledge level) a student achieved.

The second course, *online remedial course economics*, is based on principles of working and learning together. In contrast to more individual approaches to learning, socio-constructivist theories are based on the idea that learning takes place through social encounters. Meaning is constructed as a result of interaction between human beings, their environment, and the surrounding artefacts. Learning is regarded as an act of actively processing new information and continually (co-)constructing knowledge. Problem-based learning (PBL) is a typical application that fosters socio-constructivist learning. It focuses student learning on complex situations and on a variety of realistic information (Dochy, Segers, Van den Bossche, & Gijbels, 2003). One of the key issues in PBL is that students are actively constructing knowledge in collaborative groups (Hmelo-Silver, 2004). Hence, the second course was an electronic form of PBL (Dochy et al., 2003; Rienties et al., 2006). Students participated in groups within a collaborative learning environment using discussion forums and announcement boards. Within six weeks, students had to collaborate together on solving six tasks through a problem-based learning method. The group, together with the tutor, could decide upon the pace in which content and context were dealt with. No obligatory meetings were scheduled. The results of a summative test combined with graded participation in the group were used to make a pass-fail decision at the end.

3.2 Participants

The present study took place in an International Business degree programme for bachelor students at Maastricht University in the Netherlands. In order to assess who needed remedial education before the start of the curriculum, prospective students were able to make an online

diagnostic test to assess their prior knowledge in the summer of 2005. In mathematics, 230 prospective students took the test and 83% scored below the threshold. In total 211 prospective students took an economics test of which 75% scored below the threshold (based on secondary education, A-level). Students who were willing to invest 60 to 80 hours were invited to participate in one or both of the courses. In total 50 students registered for economics and 55 for mathematics, of whom mostly German students with the basic level mathematics and no economics[†] participated. Participation was fully voluntary and free of charge, which could have led to a selection bias. As the courses were experimental in design and all students that were willing to join were granted access, only ex-post a potential selection bias can be investigated in a quasi-experimental setting.

Table 3.1 Descriptive statistics of cohort based on prior knowledge

	Total	QM1	ECBUS	Study- success
Dutch	304			
German Basic Math (GK)	230	134		
German Advanced Math (LK)	91	50		
Other Foreign Math	83	28		
EconPrior			18	
NoEconPrior			190	
Summercourse Pass	41	18	20	29
Summercourse Fail	38	10	14	16
No Summercourse	629	184	174	167

In order to measure any longitudinal effects, the summer course participants were compared to other students that have similar characteristics (demographics, prior education, prior knowledge) for possible learning effects over a longer time-span. Therefore, we used a cohort of 850 first year bachelor economics at University Maastricht in the study-year 2005-2006 from which prior knowledge data of 709 (83%) students is available. In total 629 students of whom we have prior-knowledge data did not take part in any of the summer course programmes. As most students participating in the online remedial programme were foreign and our primary focus is on transitional problems of foreign students, we removed the Dutch students from our inquiry. In addition, in order to measure long-term longitudinal effects, we selected the largest of

[†] As most German students had to participate in a one-year military/community service programme after graduating from secondary school or decided to take an internship, the actual mastery of mathematics and economics is probably lower compared to students who just recently graduated from secondary school.

three bachelor programmes in business, namely International Business. In other words, in total 28 summer course mathematics students are left for comparison of study performance in Quantitative Methods I (QMI), 34 summer course economics participants for Economics and Business (ECBUS) and 45 summer students for the entire first year (Study success). In Table 3.1, the detailed descriptive figures of the used cohorts are listed.

3.3 Instruments

Two measures are used to determine any longitudinal effects of online remedial education. First of all, the short-term (study performance) effect of the remedial course is tested by comparing the pass rate, as well as average grade of the relevant module with the particular domain knowledge that the remedial course aims to bridge. For the online remedial course mathematics, the relevant course to assess knowledge retention in the regular bachelor curriculum is *Quantitative Methods I* (QMI). QMI is an introduction into mathematics and statistics and repeats parts of secondary school math programmes. For the online remedial course economics, the relevant course to assess knowledge retention in the regular curriculum is *Economics and Business* (Ecbus). This course prepares future managers to use economic theory and extends the economics taught at Dutch secondary education.

Second, the long-term (study success) effect of remedial education is assessed by comparing the pass rate as well as GPA of the entire first year of the bachelor programme. The metric that we used to estimate and describe the longitudinal effect is by taking the standardised difference of two means (Cohen's d) effect size. This metric is appropriate when 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 (1988) recommend that $d=0.20$ (small effect), $d=0.50$ (moderate effect) and $d=0.80$ (large effect) serve as general guidelines across disciplines.

4. RESULTS

4.1 Study performance in Quantitative Methods

In Figure 3.1, we have distinguished the performance of the *Quantitative Methods I* (QMI) exam based on the different prior education groups, namely German basic mathematics (GK), German advanced mathematics (LK) and other students (Other_Foreign). There are large differences in pass rates of QMI based on differences in prior knowledge. The remedial course mathematics has been offered to the target group of German students with lowest level of math prior education (GK). In comparison to the QMI course performances of both successful summer course participants (SC-pass) and non-successful summer course participants (SC-fail) within their reference group, the GK group, it is striking that both types of summer course participants manage to achieve a major improvement in their performance. Roughly, although summer course participants have only basic math prior education, they show similar QMI course pass rates compared to students with advanced math prior education (LK).

Figure 3.1 Pass rates Quantitative Methods I (in %)

Somewhat puzzling is the fact that students participating but failing the summer course seem to do relatively well in the QMI course compared to their peers. However, further analysis of course data provides an explanation of this phenomenon. Pass rates are only determined for students who showed up at the final exam; however, not all students who participated in the course ultimately show up at the exam. Taking non-

attendance of the final exam into account, students participating but failing the summer course appear to be overrepresented in the group of students that participated in the course but did not show up at the exam.

Taking both attendance and performance in the exam into account, students passing the remedial course stand out with a success rate of 75%, compared to success rates of 50% or less for students not participating the summer course, or failing the summer course. An independent sample T-test indicates that SC-pass students are more successful than their peers, although the p-value is no longer statistically significant at 5% ($F = 60.253$, $t = 1.917$, $p\text{-value} = 0.057$, $d\text{-value} = 0.68$), probably due to a smaller population size. In fact, if we take the entire foreign population of all bachelor programmes in business/economics, SC-pass students are more successful than their peers on 1%.

Figure 3.2 Partial scores in QMI final exam (1-20)

The finding that participants of the remedial course outperform non-participants is in itself no proof of the successfulness of the remedial course: again, there might be a selection bias. If the summer course attracts a non-representative group of students, such as highly motivated students, the effect of participation in the summer course might be explained due to motivation. To investigate the extent to which the increased success rate in the exam can be attributed to a selection bias component on the one hand, and a real learning effect by the summer course on the other hand, the partial math and statistics scores in the final QMI exam of Summer course participants and non-participants are compared.

Summer course participants indeed do better than non-participants (No-SC) in both math and statistics, but their advantage in math is much larger than their advantage in statistics, as can be seen in Figure 3.2. In fact, the only statistically significant difference in partial exam scores is the math score of student passing the summer course compared to the math score of non-participants. So if any selection bias is present, the effect it causes is small, statistically insignificant and surpassed in size by a true learning effect.

A second check for the presence of a selection bias caused by motivational differences is provided by log data of students working in the ALEKS Business Statistics module during the course QMI. Whereas a small group of students used the ALEKS College Algebra module during the summer course on a voluntary basis, all students used the ALEKS Business Statistics module in the QMI course in order to practice and prepare for their statistics quizzes. Study time (logon time) in ALEKS Business Statistics can be used as a proxy for student motivation. As is clear from Figure 3.3, summer course participants study slightly less than students in their reference group, the students with a GK prior education. In other words, it seems that the summer course participants are not more motivated than their peer group (GK). Neither partial scores nor study time suggest the existence of a selection effect. This suggests that the increased course performances of the successful mathematics summer course participants can indeed be attributed to a true learning effect.

Figure 3.3 Hours studied with ALEKS during QMI

4.2 Study performance in Economics and Business

In the second period, students follow an introductory economics course called *Economics and Business* (EcBus). Most foreign students had no economics in secondary education (NoEconPrior). A small group of foreign students indicated that they already had some prior education in economics (EconPrior). What is clear from Figure 3.4 is that SC-pass students outperform their peers of the NoEconPrior group and even those who had Economics before. All except one SC-pass participant passed the final exam, whereas 72% of their peers (NoEconPrior) passed. An independent sample T-test confirms that SC-pass participants outperform NoEconPrior students ($F = 44.202$, $t = 2.191$, $p\text{-value} = 0.030$, $d\text{-value} = 0.65$) and the size-effect is moderate.

Figure 3.4 Passing rates Economics & Business (%)

Besides improved pass rates, SC-pass participants outperform other foreign students with respect to the final grade on the EcBus exam in Figure 3.5. In other words, students who passed the summer course on average score almost one point (on a scale from 1 to 10) more than students in the NoEconPrior-group. This difference is statistically significant and the effect size is moderate ($F = 2.546$, $t = 2.606$, $p\text{-value} = 0.010$, $d\text{-value} = 0.71$). SC-fail participants score between these two extremes, but an independent sample T-test confirms that SC-fail participants do not perform significantly better than NoEconPrior. In other words, we can conclude that participants who successfully completed the online remedial course economics perform better in the relevant course economics in the academic curriculum. Students who participated in the remedial course but failed to meet the end

terms do not differ from students who did not participate in this remedial course.

Figure 3.5 Average grades final exam Economics & Business (0-10)

4.3 Long-term study success in first year

In order to measure the long-term effects of the online remedial courses, the study success of all foreign International Business students in their first year is analysed. The first year International Business consists of in total nine courses. Students have two chances to pass an exam, the first sit and a re-sit. Therefore, we distinguish “Exams Passed 1st time” from “Exams Passed”, which includes the re-sit. Finally, GPA measures the average grade on these nine exams. In Table 3.2, we compare three groups of students: students who did not take part in any summer course (No-SC), students who passed at least one summer course (SC-pass), and students who joined at least one summer course but failed to pass (SC-fail).

As expected, students who successfully participated in at least one of the summer courses passed on average 7.8 out of 9 exams at the end of year one. This is one exam more compared to students who did not join any summer course. When we include the re-sit possibility, the gap in study success between SC-pass and others remains. Finally, when comparing GPAs, it is clear that SC-pass participants outperform other students throughout the curriculum. All three long-term measures of study success are significantly different, which given the relatively small sample size of online summer course participants is remarkable. In addition, the size effect of Cohen d-value is moderate. The lack of perseverance of SC-fail students resemble the results obtained in the first year of the academic curriculum.

Table 3.2 Longitudinal effects of online remedial education after one year

	No-SC		SC-pass		SC-fail		t-test	d-value
	M	SD	M	SD	M	SD	difference	
Exams passed 1st time	6.46	2.72	7.76	2.08	6.88	3.28	2.44*	0.54
Exams passed (including resit)	7.31	2.45	8.38	1.35	7.25	3.21	2.30*	0.54
GPA	6.27	1.32	6.95	1.04	6.39	1.67	2.60**	0.57

Independent sample T-test (2-sided) and Cohen d-value of SC-pass vs.NoSC

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

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

5. DISCUSSION

In chapter 3, we focussed on longitudinal effects of offering online remedial courses. In contrast to offering a physical summer course, which requires attendance at a fixed time at a particular place, we explored the short- and long-term effects of offering an online remedial course in foreign students. In order to strengthen the analysis, two distinctively different pedagogical scenarios were used. The online remedial course mathematics used an individual learning philosophy based on cognitive learning theory, in particular Knowledge Space Theorem. Students worked on individually-tailored (adaptive) exercises with a computer and limited (online) contact with a teacher. The reason was to maximise flexibility to study when and wherever students wanted. In contrast, the online remedial course economics was based on the idea that the ability to work together in groups in an online environment might be stimulating for the learning process. Therefore, this course used social collaboration with other students in an electronic problem-based learning format (e-PBL) in order to achieve higher levels of student motivation.

In order to assess whether the two remedial courses led to improved study performance and study success, a longitudinal study was conducted on the basis of a quasi-experimental design. The participants of the online remedial course mathematics outperformed their peers on the first mathematics exam (Quantitative Methods I) in the regular bachelor curriculum in both pass rate as well as average exam grade. The expected selection bias that might occur when students voluntarily join an experiment was neither supported by the analyses of the hours worked in ALEKS nor by the partial scores on the QMI exam. Therefore, it can be argued that

students with a mathematics deficiency, who participated in the summer course, bridged the knowledge gap between them and their peers. In addition, the mastery of mathematical knowledge of successful summer course participants was raised to a level of students who were educated in advanced mathematics.

Despite an entirely different pedagogical framework, the economics summer course also contributed to the study success in the relevant bachelor course. The results in the course Economics and Business indicate that students following the online remedial course economics outperformed their peers with respect to pass rates as well as average exam grade. Thus, it can be concluded that the summer course economics has a positive short-term effect on study performance.

Finally, when looking at the long-term impact of the summer course programme, students who passed at least one summer course also pass more exams in the first year than their peers. Even if we take into account the re-sit of these exams, the size-effect remains strong. In addition, the GPA obtained in those nine exams is more than half a point higher than their peers. In other words, there seems some evidence that successful participation in this online remedial programme improves the long-term study success of foreign students.

The implementation of both summer courses was mainly focused on pedagogical and organisational aspects, since the technical infrastructure was already in place. Both courses are implemented using existing IT-infrastructures, comparable to other Higher Education Institutes. As long as sufficient expertise and resources are invested, the problems accompanying the increasing internationalization of students can be tackled.

Future research is intended to enlarge the subgroups of participants of the summer courses and to get more specified and detailed information about the characteristics of the subgroups. In this way the statistical power of the research will be enlarged and we will be able to elaborate our analysis on possible selection-effects. In this way, we will be able to assess which pedagogical framework is more appropriate for online remedial education. In addition, more research is needed on motivation and learning-styles of students, which will help to identify a possibly preferred mode of learning. Finally, qualitative analysis will be necessary in order to assess whether online remedial education leads to increased academic integration.

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Chapter 4

THE ROLE OF ACADEMIC MOTIVATION IN COMPUTER-SUPPORTED COLLABORATIVE LEARNING *

Increasing attention has been devoted to virtual learning. In the last decade, a large number of studies in CSCL have assessed how social interaction, learning processes and outcomes in virtual settings are intertwined. Although recent research findings indicate that learners differ with respect to the amount and type of discourse contributed in virtual settings, little is known about the causes of these differences. The research presented here looks into the effects of motivation of learners on their contribution to discourse. This study of 100 participants who were randomly distributed in six groups collaborated in a virtual setting to remediate deficiencies in economics indicates that individuals differed with respect to the amount of discourse activity. Furthermore, an integrated multi-method approach was used in order to examine the impact of academic motivation on the type of discourse activity contributed and on the position of the learner in the social network. The results indicate that highly intrinsically motivated learners become central and prominent contributors to cognitive discourse. In contrast, extrinsically motivated learners contribute on average and are positioned throughout the social network.

1. INTRODUCTION

Recent findings in Computer-Supported Collaborative Learning (CSCL) indicate that learners contribute differently to discourse (Caspi, Chajut, Saporta, & Beyth-Marom, 2006; De Laat & Lally, 2003; Häkkinen & Järvelä, 2006). For example, Caspi, Gosky and Chajut (2003) analysed a total of 7706 messages of 47 courses at various faculties of the Open University in Israel and found that the majority (80%) of students contributed only a small

* Based upon:

Rienties, B., Tempelaar, D. T., Van den Bossche, P., Gijselaers, W. H., & Segers, M. (2009). The role of academic motivation in Computer-Supported Collaborative Learning. *Computers in Human Behavior*, 25(6), 1195-1206.

amount (20%) of messages. But not only differences in the amount of contributions by students have been found. For example, De Laat and Lally (2003) showed that students in an online E-learning Master's programme also differed with respect to the type (cognitive, affective, metacognitive) of contributions. In a Bachelor's freshman course of educational science, Schellens and Valcke (2005) found significant differences with respect to both amount and type (social, cognitive) of discourse.

Although recent research findings indicate that learners differ with respect to the amount and type of discourse contributed, little is known about what the causes of these differences are. Within the field of Computer-Supported Collaborative Learning, researchers try to understand what the underlying reasons for a lack of contributions to cognitive discourse are and how to solve them. For example, Lowry and colleagues (2006) found that informatics learners who in an experimental design collaborated in class and were complemented with ICT established higher levels of communication quality than learners who collaborated only virtually. Hurme and colleagues (2007) analysed the interaction patterns among secondary school children who worked online in pairs on mathematical problems. Metacognitive activity varied among participants, which subsequently influenced the interaction among pairs of learners. Furthermore, by using Social Network Analysis some pairs became central contributors to discourse, while others were less active and were positioned on the outer fringe of the social network (Hurme et al., 2007).

Recently several researchers have investigated the role of motivation in CSCL. For example, by measuring goal-oriented motivation (Pintrich & De Groot, 1990), Yang and colleagues (2006) found evidence that motivation is positively related with how learners perceive each other's presence in online courses. Järvelä and colleagues (2008) found that students who were working together in groups of 3-5 students reported more (favourable) learning goals and fewer performance goals in the face-to-face setting than students in virtual groups. Besides goal-oriented motivation, several other factors might influence motivation like the degree of self-determination of learners (Ryan & Deci, 2000a, 2000b). For example, in an online setting learners have a large autonomous freedom and can decide their own learning path, which might be beneficial for learners with intrinsic motivation (Ryan & Deci, 2000b; Vallerand & Bissonnette, 1992). In addition, the limited role of the teacher in a distance learning constellation (Kirschner, Strijbos, Kreijns, & Beers, 2004; Vonderwell, 2003) refrains the teacher to interact in a similar manner as in a face-to-face setting. A teacher can directly provide instruction, feedback and coaching in a face-to-face setting, which should help learners who are in need for external regulation (Roth, Assor, Kanat-Maymon, & Kaplan, 2007). In an online setting, the lack of regulation might limit the responses from extrinsically motivated learners.

The research presented here looks into the effects of differences in academic motivation (i.e. intrinsic/extrinsic/a-motivation) of learners on their contribution to discourse. Although recently an increasing number of researchers have analysed the role of motivation in CSCL settings in a qualitative manner, to our knowledge no quantitative study exists that analyses how differently motivated learners behave in an online learning environment. Therefore, we will investigate to what extent differences in individual contributions to discourse are explained by differences in academic motivation. As recommended by recent research (De Laat, Lally, Lipponen, & Simons, 2007; De Wever, Schellens, Valcke, & Van Keer, 2006), we will use a multi-method approach composed of Content Analysis, which measures the type of discourse activity, and Social Network Analysis, which measures the interaction processes among learners. Afterwards, we will integrate the type of contributions to discourse with the position of each individual learner in the social network and finally link this to his/her type of motivation. In this way, we attempt to assess to what extent differently motivated learners vary in the type of discourse contributed in online settings.

2. IMPORTANCE OF MOTIVATION FOR LEARNING

Motivation has an important influence on a learner's attitude and learning behaviour (Deci & Ryan, 1985; Fairchild, Jeanne Horst, Finney, & Barron, 2005; Ryan & Deci, 2000a; Vallerand et al., 1992). "Motivation has been a central and perennial issue in the field of psychology, for it is at the core of biological, cognitive and social regulation" (Ryan & Deci, 2000b, p. 69). As motivation is a multidimensional and multilevel construct (Boekaerts, 1997), a wide variety of definitions and instruments are discussed and used in educational psychology research. We adopt the concept of motivation developed by Deci and Ryan (1985), where "[t]o be motivated means to be moved to do something", as the degree of self-determination of learners might explain why some learners contribute more to discourse in CSCL than others. According to Ryan and Deci (2000a, 2000b), most theories of motivation regard motivation as a unitary phenomenon, implying that a learner has either a lot or little motivation, also referred to as motivation versus a-motivation. To be motivated means to be moved to do something, while a-motivation is a state of lacking any intention to act (Ryan & Deci, 2000a). However, focusing only on the level of motivation ignores the underlying attitudes and goals the learner has in order to pursue an action or goal (Deci & Ryan, 1985). In Self-Determination Theory (SDT), Ryan and Deci (2000a, 2000b) distinguish between intrinsic motivation, extrinsic motivation and a-motivation.

In intrinsically motivated learning, the drive to learn is derived from the satisfaction and pleasure of the activity of learning itself; no external rewards come in play. According to Ryan and Deci (2000a, p. 56), intrinsic motivation is “... a critical element in cognitive, social, and physical development because it is through acting on one’s inherent interests that one grows in knowledge and skills”. In a subtheory of SDT, Cognitive Evaluation Theory (CET), social and environmental factors play an important role in determining what facilitates and what hinders intrinsic motivation. More specific, in SDT feelings of competence and social relatedness in combination with a sense of autonomy (defined as basic psychological needs) are important facilitators for intrinsic motivation to occur, to maintain and to enhance.

Externally motivated learning refers to learning that is a means to an end, and not engaged for its own sake. In contrast to classical theories of motivation that regard extrinsic motivation as a single construct, SDT proposes that extrinsic motivation is a construct with different facets that vary greatly with the degree to which the learner is autonomous (Deci & Ryan, 1985; Ryan & Deci, 2000a). That is, besides intrinsic motivation and a-motivation, SDT distinguishes four different forms of extrinsic motivation that constitute a motivational continuum reflecting an increasing degree of self-determined behaviour, namely external regulation, introjection, identification and integration (Ryan & Deci, 2000a).

As most educational learning settings are externally regulated, a crucial question is how to internalise and to integrate educational activities for learners (Deci & Ryan, 1985). “Internalisation is the process of taking in a value or regulation, and integration is the process by which individuals more fully transform the regulation into their own so that it will emanate from their sense of self” (Ryan & Deci, 2000a, p. 60). When learners internalise their reasons for showing a given behaviour, learners become more self-determined (Legault, Green-Demers, & Pelletier, 2006). Three factors in SDT enhance the internalisation of regulation, namely relatedness, perceived competence and autonomy (Deci & Ryan, 1985). The more a learner perceives a sense of belonging and connectivity to other learners (relatedness), the more willing learners are to show the behaviours that are externally regulated (Legault et al., 2006). In addition, a learner can only adopt an extrinsic goal when the learner feels he or she is competent to achieve this goal. Finally, in order to fully internalise a regulation, a learner must autonomously value its meaning and worth (Ryan & Deci, 2000a).

In a long series of over 700 studies in classroom settings, the model of Deci and Ryan (1985) has been empirically verified (Ryan & Deci, 2000a, 2000b). For example, more autonomous extrinsic motivation has been found to lead to greater engagement, less dropping out (Legault et al., 2006), higher quality learning and greater psychological well-being (Ratelle, Guay, Vallerand, Larose, & Senécal, 2007; Ryan & Deci, 2000a). Greater

internalisation yields more behavioural effectiveness as well as greater experienced well-being (Ryan & Deci, 2000a).

Vallerand and colleagues have added further theoretical concepts to the model of Deci and Ryan (1985) by acknowledging that the attitudes, values and goals that trigger a learner to become intrinsically motivated can differ when a learner enters into college or university and voluntarily chooses a study. For example, some students might choose to study economics as they enjoy learning a new science, some might choose economics in order to understand the underlying reasons of an economic crisis, while others might choose economics as playing a manager in a virtual game during a management course seems exciting. Therefore, Vallerand et al. (1992) distinguish between three intrinsic motivation types: intrinsic motivation to know or learning for the satisfaction and pleasure to understand something new; intrinsic motivation to accomplish or learning for experiencing satisfaction and pleasure to accomplish something; and intrinsic motivation to experience stimulation or learning to experience stimulating sensations.

2.1 Role of motivation in CSCL

Several researchers have found that learning in CSCL settings is more complex than in face-to-face settings. For example, Schellens and Valcke (2005) found that educational psychologists who worked together online in groups of ten contribute mainly lower level cognitive discourse. Järvelä et al. (2008) found that learners who collaborated online produced less (favourable) learning goals and more performance goals than learners who collaborated in a face-to-face setting. Bromme et al. (2005, p. 5) argue that meaning barriers that obstruct the mutual construction of meaning of information from sender to receiver might hinder effective communication among learners in CSCL settings. For example, the intention of one learner posting a message in a discussion-board might be interpreted differently by another learner due to a lack of context, body-language or writing-style. This might reduce the connectivity and sense of belonging (relatedness) of a learner as well as reduce the perceived competences due to the occurring miscommunications, which in turn might reduce social interaction. According to Williams et al. (2006), working and learning online can be a lonely and frustrating experience, in particular when the social interaction is limited.

Tai (2008) argues that strong motivation is a prerequisite for online learning. Yang et al. (2006) found that the way learners experience and perceive social interaction depends on social presence of peers (i.e. ability of peers to express themselves socially and emotionally in the group) as well as written communication skills. If social interaction is difficult to achieve and maintain in online learning settings, this might have a negative impact on the motivation of learners. In an extreme case, a learner might

become amotivated due to the meaning barriers, lack of relatedness and lack of perceived competence and will therefore refrain from contributing to social interaction (Legault et al., 2006; Ratelle et al., 2007).

Recent research in face-to-face settings by Roth, Assor, Kanat-Maymon and Kaplan (2007) and Legault et al. (2006) indicates that the teacher has a strong influence on the type of motivation of students. In online settings, the role of the teacher seems to be more complex (De Laat et al., 2007; Vonderwell, 2003), whereby providing accurate and timely instruction and feedback is notoriously difficult due to barriers in space and time (Bromme et al., 2005; De Wever et al., 2006). The limited role of teacher might hamper learners who are triggered mainly by external regulation as the teacher can only provide immediate instruction and feedback when both teacher and student are online simultaneously. At the same time, two potentially opposite effects might occur for intrinsically motivated students. As teacher regulation is limited, this may leave more room for self-directed learning, which is assumed by SDT to be beneficial for intrinsic motivation (Roth et al., 2007). In contrast, the lack of timely positive feedback might hamper intrinsic motivation to be sustained during the entire duration of a course (Ryan & Deci, 2000b).

Three recent studies have analysed the role of motivation in the context of CSCL. Yang et al. (2006) conducted a survey among 250 respondents of eleven online educational psychology courses and found that goal-oriented motivation measured by the Motivated Strategies for Learning Questionnaire (MSLQ) of Pintrich & De Groot (1990) positively influences social presence among peers, that is the perception that emotions can be shared using CSCL. Although the finding that motivation influences perceived social presence among peers is important, the lack of measurement of actual learning processes and learning outcomes and lack of control of 51% non-response requires further research. Therefore, Veermans and Lallimo (2007) used a cluster analysis on eight scales (collaborative learning, interest in learning and technology, controls of learning beliefs and self-efficacy) in an online class of 50 psychology students and conducted a content analysis of discourse activity of three students, each from one of the three identified cluster profiles. The student with the combined highest values on the eight scales produced messages that had more variety of categories within each message, which according to Veermans and Lallimo (2007) is a necessity for genuine knowledge building.

To capture how motivation influences the learning process, Järvelä et al. (2008) have analysed how motivation in collaborative learning settings changed over time (again) using MSLQ (Pintrich & De Groot, 1990). Educational psychology students in groups of 3-5 worked together on three collaborative learning tasks in either face-to-face or virtual settings. Students in the face-to-face setting reported more (favourable) learning

goals and less performance goals relative to students in virtual settings. Afterwards, Järvelä et al. (2008) described the relation with motivation and behaviour for two face-to-face groups. Although the two studies of Järvelä et al. (2008) and Veermans and Lallimo (2007) provide important insights in how motivation influences behaviour of learners in CSCL using a qualitative perspective, a quantitative analysis to assess the role of motivation on behaviour of learners in CSCL might increase our understanding why some learners contribute more actively to discourse than others. In addition, by using self-determined motivation rather than goal-oriented motivation, a different perspective on the role of motivation in CSCL is taken.

In this article, we try to unravel the complex dynamics of contributions to discourse in online settings. As some learners are more active than others to contribute to discourse, we need to understand why contributions to discourse and interaction patterns among learners vary. Furthermore, we need to distinguish contributions made by learners solely in cognitive discourse communication, as task-related communication has been found to be positively related to individual knowledge acquisition (Schellens & Valcke, 2005; Weinberger & Fischer, 2006). Therefore, recent research (De Laat et al., 2007; Hurme et al., 2007) has suggested that using a combination of content analysis (type of discourse) with Social Network Analysis (position of learner relative to others) leads to a clearer understanding of interaction patterns in CSCL. Social Network Analysis (SNA) can be considered as a wide-ranging strategy to explore social structures to uncover the existence of social positions of individuals within the network (Aviv, Erlich, Ravid, & Geva, 2003). In SNA, one can determine the position of a learner within a group relative to other learners. Network centrality, that is the degree to which a learner has a central position in the social network, and ego-density, that is the number of other learners a learner is connected with also called neighbourhood size, are core-concepts within SNA (Hurme et al., 2007; Wassermann & Faust, 1994). For example, in a group of 21 students in a graduate online course genetics regression analysis revealed that network centrality among students who worked in collaborative groups was a robust predictor of cognitive learning outcomes (Russo & Koesten, 2005). Hurme et al. (2007) found that the neighbourhood size was positively related with the number of contributions from and to others.

In particular when SNA is combined with other instruments, SNA provides an powerful instrument to measure dynamics of learning processes (De Laat et al., 2007; Martinez, Dimitriadis, Rubia, Gomez, & de la Fuente, 2003). For example, Martinez et al. (2003) found that by using log data of users and SNA the dominant central role of the teacher in discussion forums could be identified. De Laat et al. (2007) measured the centrality of learners at three distinct phases using SNA in combination with

CA, which was afterwards used to as primary input for a critical event recall by the teachers. In this way, the teachers were able to link their own behaviour to the dynamics of the learning processes of the group. Although De Laat et al. (2007) and Hurme et al. (2007) used both Content Analysis (CA) and SNA, they only qualitatively link the methods together. To our knowledge not a single study has (quantitatively) integrated the results of CA into SNA. Our integrated approach distinguishes the various interaction patterns among learners based upon the type of discourse by combining the type of discourse contributed by a learner (e.g. learner 1 has contributed ten messages, of which six that were task-related and four were non-task related) with his/her position relative to others in the social network (e.g. learner 1 has two connections to learner 2 and 5 who also contributed to task-related discourse and three connections to learner 2, 6 and 8 who contributed to non-task related discourse). As a learner can become a central contributor to discourse because of having actively participated in non-task related contributions rather than task-related discourse, distinguishing the type of discourse when using SNA will further improve our understandings of the complex dynamics of discourse within CSCL. Furthermore, by distinguishing the type of task-related discourse contributed by a learner (Schellens & Valcke, 2005; Veerman & Veldhuis-Diermanse, 2001), our integrated approach allows us to distinguish the position of learners within the social network based upon their contributions to cognitive discourse. Schellens and Valcke (2005) argue that learners who contribute mainly to reporting facts or own opinions are primarily contributing to lower cognitive discourse. Learners who mainly contribute to theoretical ideas, elaborate on argumentation of others, or evaluate the argumentations put forward by others are contributing to higher cognitive discourse.

2.2 Research questions

We expect that learners who are highly intrinsically motivated to learn contribute more actively to (cognitive) discourse than learners who are low on intrinsic motivation and who may require additional teacher support to participate at levels comparable to intrinsically motivated learners. As a result, learners high on intrinsic motivation will take a more central position relative to other learners, in particular when looking at the (higher) cognitive discourse. In contrast, highly extrinsically motivated learners are expected to contribute less to (cognitive) discourse and will be positioned on the outer fringe of the network. Therefore, we will investigate the following three research questions:

- To what extent do differently motivated students show different non-task related and task-related discourse activity?

- To what extent are differently motivated students different in the degree of centrality in the social network?
- To what extent are differently motivated students different in the degree of centrality in the (higher) cognitive discourse network?

3. METHODOLOGY AND RESEARCH DESIGN

3.1 Setting

The present study took place in an online summer course for prospective bachelor students of an International Business degree programme in the Netherlands. The aim of this course was to bridge the gap in economics prior knowledge for students starting a bachelor (Rienties, Tempelaar, Waterval, Rehm, & Gijssels, 2006). The online course was given over a period of six weeks in which students were assumed to work for 10-15 hours per week. The participants never met face-to-face before or during the course and had to learn using the virtual learning environment “on-the-fly”. The course was based upon principles of Problem-based learning (PBL), which is an educational method that fosters socio-constructivist learning. PBL focuses student learning on complex situations and on a variety of realistic information (Dochy, Segers, Van den Bossche, & Gijssels, 2003; Van den Bossche, Gijssels, Segers, & Kirschner, 2006). One of the key issues in PBL is that students are actively constructing knowledge together in collaborative groups (Hmelo-Silver, 2004). Students participated in groups within a collaborative learning environment using discussion forums and announcement boards. Within six weeks, students had to collaborate together on solving six tasks through a problem-based learning method. The group, together with the tutor, could decide upon the pace in which content and context were dealt with. No obligatory meetings were scheduled. At the end of each week, the tutor made a suggestion on how to proceed with the next task, thereby focusing on process rather than on content. The results of three interim-tests and a final summative test combined with graded participation in the discussion forums were used to make a pass-fail decision. Students who passed the course received a certificate. Hence, this setting provides a unique opportunity to assess the role of motivation on behaviour of learners in virtual settings as the learners never met each other before and collaborated exclusively in the virtual learning environment.

3.2 Participants

In total 100 participants were randomly assigned in six groups. Data were analysed for those individuals who actually posted at least once a reaction in the discussion forum. This resulted in a total of 82 participants that were selected for analysis. The six groups had an average of 13.66 members ($SD = 2.16$, range = 11-17) per team. The average age was 19 years and 45% of the learners were female.

3.3 Instruments

3.3.1 Individual contribution to discourse using Content Analysis

According to two reviews of CSCL-literature (De Wever et al., 2006; Rourke, Anderson, Garrison, & Archer, 2001), most researchers use Content Analysis (CA) schemes to analyse discourse in CSCL. The aim of content analysis techniques is to reveal evidence about learning and knowledge construction from online discussions. Content analysis for evaluating discourse activities was based on the instrument of Veerman and Veldhuis-Diermanse (2001) that has been used and validated by other researchers (e.g. Schellens & Valcke, 2005). When comparing various content analysis schemes, Schellens and Valcke (2005) conclude that the Veerman and Veldhuis-Diermanse (2001) scheme is particularly suited for analysing knowledge construction among novice students. Veerman and Veldhuis-Diermanse (2001) make a distinction between non-task related (1 planning; 2 technical; 3 social; 4 non-sense) and task-related discourse activity (5 facts; 6 experience/opinion; 7 theoretical ideas; 8 explication; 9 evaluation). Examples of each of the nine discourse activities are provided in Appendix A. Three independent coders (two economists, one educational psychologist) were trained to use the CA instrument and independently coded all messages. A random sample of 100 messages was used as a test case but the Cronbach alpha was rather low (0.6). Therefore, an additional meeting with the three coders was established and the diverging results were discussed and consensus on the method was arranged. The coding took 80-100 hours per coder, who received a financial compensation in return.

As a unit of analysis, the complete message was chosen, unless the coders considered a message to consist of multiple elements. The message was split when two or more coders thought that a message consisted of multiple elements (see two examples in Appendix B), which occurred for 42 messages. In addition, a message was "codeable" when two or more coders used the same category. When a message was "uncodeable", the message was removed from the analysis (see two

examples in Appendix C). Students posted 2307 messages of which 2075 were considered as codeable (90%). The Cronbach alpha (α) for these 2075 messages was 0.928. Most studies have set the minimum α at 0.7 and recommend setting $\alpha > 0.8$. The Cohen's kappa of the coder inter-reliability (coders agreeing with each other) between Coder 1 - 2, 2 - 3 and 1 - 3 was 0.71, 0.71 and 0.68 respectively and Fleiss' kappa of the three coders is 0.66. De Wever et al. (2006) argue that Cohen's kappa values between 0.4 and 0.75 represent fair to good agreement beyond chance, while the Fleiss' kappa indicates substantial agreement among the coders (Lombard, Snyder-Duch, & Campanella Bracken, 2002).

3.3.2 Positioning of individuals within social network using Social Network Analysis

While Content Analysis methods are frequently used in CSCL, focusing on content analysis alone, without taking into consideration interaction processes, restricts our understanding of learning processes in online settings (De Laat et al., 2007; Hurme et al., 2007). While Weinberger & Fischer (2006) solved (part of) this problem by using four separate CA measures for participation, epistemic dimension, argument dimension and social modes of dimension, the "application of the framework is still a challenge due to the enormous work load of analysing discourse corpora on multiple dimensions..." (Weinberger & Fischer, 2006, p. 90). To avoid this, we integrated the results of the content analysis into our Social Network Analysis (SNA) in order to measure participation, argumentation and social interaction patterns (De Laat et al., 2007; Hurme et al., 2007; Wassermann & Faust, 1994).

Social Network Analysis provides us with several tools to analyse interaction patterns among individual learners. Two frequently used measures were employed in order to determine the position of individuals in the overall, task-related, and higher cognitive social structures, namely centrality and ego network density. First, Freeman's degree of Centrality (Freeman, 2000; Wassermann & Faust, 1994) measures whether learners were central in the social network or not. If a learner contributed actively to discourse and most other learners responded to the activities of this learner, he/she became a central learner in the network and therefore had a high degree of centrality (Reply Degree). Afterwards, all communication identified by CA as facts, experience, theoretical ideas, explication and evaluation was integrated in the SNA in order to measure the degree of centrality of only task-related communication (Reply TR Degree). In this way, we were able to distinguish contributions made by learners solely in task-related communication, as task-related communication has been found to be positively related to individual knowledge acquisition (Schellens & Valcke, 2005; Weinberger & Fischer, 2006). Finally, the degree of centrality

with communication restricted to only higher cognitive discourse (Reply HC Degree) was measured, which implies communication labelled by CA as theoretical ideas, explication or evaluation. By building upon theoretical ideas, elaborating on argumentations of others and finally evaluating the arguments raised, learners construct their own mental model about complex problems (Alexander, 2006; Schellens & Valcke, 2005; Weinberger & Fischer, 2006). Second, the ego network density of each individual within the network (Size) was used, which measures to how many other learners a learner is directly connected. As with the centrality measures, we also included a separate measure for task-related discourse (TR Size) and higher cognitive discourse (HC Size).

3.3.3 Individual motivation

Individual motivation was measured by the Academic Motivation Scale (AMS), which was developed by Vallerand et al. (1992) for college/university students and measures the contextual motivation for education. The instrument consists of 28 items, to which students respond to the question stem "Why are you going to college?". There are seven subscales on the AMS, of which three belong to intrinsic motivation scale, three to extrinsic motivation scale and one for a-motivation. Intrinsic motivation subscales are intrinsic motivation to know (IMTK): learning for the satisfaction and pleasure to understand something new; intrinsic motivation to accomplish (IMTA): learning for experiencing satisfaction and pleasure to accomplish something; and intrinsic motivation to experience stimulation (IMES): learning to experience stimulating sensations. The three extrinsic motivation subscales are identified regulation (EMID), introjected regulation (EMIN), and external regulation (EMER). The three 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 last scale, a-motivation (AMOT), constitutes the very extreme of the continuum: the absence of regulation, either externally directed or internally. The reliability and validity of the AMS scale has been established in a variety of studies (Cokley, Bernard, Cunningham, & Motoike, 2001; Fairchild et al., 2005; Vallerand & Bissonnette, 1992; Vallerand & Pelletier, 1993; Vallerand et al., 1992). The temporal stability of the AMS construct was confirmed by Vallerand and Bissonnette (1992) and Vallerand and Pelletier (1993) with a mean test-retest correlation of .75 and .79 respectively. In addition, the stability of the AMS-instrument after one year (mean test-retest correlation) was .68 and .29 after five years (Guay, Mageau, & Vallerand, 2003). In other words, the AMS instrument measures a relatively stable construct of motivation towards education amongst college and university students.

The AMS questionnaire was distributed one month after the end of the summer course in the regular bachelor programme. The learners were asked to fill in the AMS-questionnaire without taking into consideration a particular course. The response-rate on AMS-questionnaire was 93% and the Cronbach alpha for the seven items ranged from .760 to .856, which is in line with previous studies (Fairchild et al., 2005; Legault et al., 2006; Vallerand et al., 1992).

3.4 Analysis

We used a methodology of an integrated multi-method approach to identify the effects of differences in academic motivation on the type of discourse as well as on the position of the learner in the social network. Data were gathered on the individual level as well by means of the relative position of each learner within the overall network using UCINET version 6.158. Afterwards, the results of the content analysis were integrated into the Social Network Analysis, whereby we further distinguished the task-related discourse network (cat. 5-9) and the higher cognitive discourse network (cat. 7-9). The interrelationships between all measures were assessed through correlation and MANOVA analyses using SPSS 15.0.1.

4. RESULTS

4.1 Individual contributions to discourse

On average, the learners contributed 25.64 (SD= 28.07) messages and there are substantial differences amongst individuals with respect to the amount of discourse as assessed by a Chi-Square test (χ^2 (df= 81 N=82) 2258.17, $p < .001$). In addition, if we distinguish between task- and non-task related discourse, again significant differences are found (see Table 4.1). If we look beyond mean values and take into account standard deviation, Skewness and Kurtosis values, we find strong variation in discourse activities. Standard deviations are in all content analysis categories larger than their mean values. In addition, the Skewness in all content analysis categories are positive and around two or higher, implying a distribution with a right-hand tail. Also the Kurtosis values indicate that observations are clustered more and have longer positive tails than the normal distribution, with the exception of the number of ties to others (Size, TR Size, HC Size). Standard errors in Skewness (.267) and Kurtosis (.529) are smaller than two, which implies that normality conditions still satisfy. If we look into the different categories that are discerned by Veerman and Veldhuis-Diermanse (2001), we find evidence of differences in individual

contributions to knowledge construction with the exception of categories 3 (social) and 9 (evaluation).

The distribution of the degree of centrality of our social network indicators follows a similar pattern as those of content analysis, although the tail is slightly shorter. When discourse becomes more (higher) cognitive, the number of central contributors decreases. With respect to the number of connections (Size) each individual learner has, the differences amongst individuals are significant except for higher cognitive discourse (HC Size). The number of learners that a learner is connected to decreases as we move to (higher) cognitive discourse. In sum, we find large differences among individuals with respect to the amount and type of discourse as well as significant differences among individuals with respect to their position in the social network.

Table 4.1 Contributions to discourse and integrated Social Network position

	M	SD	Skewness	Kurtosis	Chi-square
<i>Content Analysis</i>					
<i>Non-task related</i>	12.88	15.04	2.77	10.68	1404.63
Planning (Cat. 1)	1.37	2.03	2.09	4.53	75.33
Technical (Cat. 2)	1.11	2.12	2.42	6.27	58.22
Social (Cat. 3)	0.84	1.55	2.51	7.06	38.62
Nonsense (Cat. 4)	9.53	11.39	3.31	15.58	1065.93
<i>Task-related</i>	12.77	14.94	2.50	8.25	1037.74
Facts (Cat. 5)	4.63	5.57	2.36	7.96	355.95
Experience (Cat. 6)	1.28	2.18	2.52	6.81	88.75
Theoretical Ideas (Cat. 7)	2.04	2.74	1.91	4.33	101.90
Explication (Cat. 8)	4.58	5.89	2.29	6.40	376.84
Evaluation (Cat. 9)	0.22	0.50	2.23	4.33	2.00
<i>Social Network Analysis</i>					
Reply Degree	26.26	24.30	1.35	1.46	1772.73
Reply TR Degree	13.36	13.49	1.60	2.72	755.52
Reply HC Degree	6.82	7.53	1.58	2.56	402.60
Size	6.44	4.03	0.08	-0.97	159.46
TR Size	3.73	3.03	0.63	-0.34	113.11
HC Size	2.38	2.34	0.88	0.08	74.77

n = 82

TR = Task-Related communion (Content Analysis cat.5-9)

HC = Higher Cognitive communion (Content Analysis cat.7-9)

To illustrate the power of SNA in understanding the interaction of contributions of individuals, the social network of all discourse activity (Figure 4.1) as well as only higher cognitive discourse (Figure 4.2) of the virtual team with the highest average posts per learner ($M=40.41$, $SD=35.04$) is presentedⁱ. Four aspects can be distinguished from these figures. First of all, the social networks illustrate to whom a learner is communicating with and what the direction of communication is (Freeman, 2000). For example, in Figure 4.1, Tutor 4 replied to a comment of Irine, which is indicated by the direction of the arrow (Wassermann & Faust, 1994). In addition, John and Catherina have a so-called “reciprocal link” when looking at all discourse activities, as they reacted both to each other’s contribution and the arrow goes in both directions. However, John and Catherina do not have any direct link when looking at higher cognitive discourse in Figure 4.2.

Second, some individuals within the network are more central than others (Russo & Koesten, 2005; Wassermann & Faust, 1994). For example, Andre, Mark, Rick, Brigit and Judith are central members in the overall network, while Rick, Maria and Tiffany are central in the higher cognitive network. In other words, not every learner who is central in the overall network (e.g. Andre, Judith) is also central in the higher cognitive network. Other learners who are not central in the overall network might become central contributors to higher cognitive discourse (e.g. Maria and Tiffany). Hence, by integrating CA with SNA, we are able to distinguish dynamic interaction patterns among learners based upon the type of discourse.

Third, some learners are on the outer fringe of the network and are not well-connected. For example, Don, Sandra and Irine are connected with less than four ties in the overall network, while they are not taking part in the higher cognitive discourse network.

Finally, there are some learners who are connected with most learners but who are still on the outer fringe. For example, Joe, John, Jonathan and Brenda have more than 15 contributions but are still on the outer fringe of the overall network. This means that despite the fact that their ego-density (i.e. number of links to others) is large, they do not occupy a central position in the network as the average number of contributions in this team was 40 contributions. In the other five teams similar patterns are found, although the number of messages is lower.

In sum, individuals differ with respect to the number of ties as well as with respect to the position in the network, which has also been found in other research (De Laat et al., 2007; Russo & Koesten, 2005). An innovative feature is that by combining the results of the Social network analysis and the content analysis, we are able to distinguish dynamic interaction patterns at different levels of discourse.

Figure 4.1 Social Network of all discourse activity

Figure 4.2 Social Network of higher cognitive discourse

4.2 Relating students' motivations and contributions

Table 4.2 contains correlations between our selected learning indicators of content analysis with the seven motivations scales from the AMS instrument. Focussing first on correlations between the several content analysis categories scores and the scores for the three types of intrinsic motivation, it is evident that being highly intrinsically motivated positively correlates with discourse activity in all categories: all correlations are positive. However, the strongest contribution of being highly intrinsically motivated is in the categories of task-related discourse: correlations in this category are generally higher in value than correlations with non-task related discourse. In order to assess whether the type of motivation has an influence on non-task related as well as task-related discourse, a MANOVA analysis was used. However, a one-way MANOVA results in an insignificant effect ($\text{Lambda}(2, 72) = 1.560, p > .10$). Although the coefficient of non-task related discourse is positive, it is not significant at 5% confidence interval. For the aggregate category of all task-related activities, correlations with all three intrinsic motivation scales are moderate in size and statistically significant at the 5% confidence level (IMTK $r=0.27$; IMTA $r=0.24$; IMES $r=0.23$, with $p < .05$). In other words, students high on intrinsic motivation contribute actively to all types of discourse, but most strongly in task-related discourse. Within the categories of non-task related discourse, highly intrinsically motivated students have an above-average interest in organisational matters, like planning (IMTA $r=0.24$; IMES $r=0.24$, $p < .05$) and technical issues (IMES $r=0.26$, $p < .05$).

Within the task-related issues, highly intrinsically motivated learners excel most in contributing own experiences, theoretical ideas and explications. The highest correlations are found for experience (IMTK $r=0.29$; IMTA $r=0.28$; IMES $r=0.28$, $p < .05$). The category 'new theoretical ideas' is positively related to intrinsic motivation (IMTA $r=0.23$; IMES $r=0.26$, $p < .05$). Finally, a positive correlation with explication has been found for two of the three types of intrinsic motivation (IMTK $r=0.26$; IMTA $r=0.25$, $p < .05$). A MANOVA, with three sub-groups of students based on median-splits of intrinsic and extrinsic motivation scores, rendering high-high, high-low and low-high scoring sub-groups, confirms the results and a significant effect ($\text{Lambda}(2, 69) = 2.783, p < .05$) was found. Follow-up univariate ANOVAs indicated that learners high on intrinsic motivation did not contribute more theoretical ideas ($F(2, 69) = 3.096, p > .05$). However, highly intrinsically motivated learners contributed more Experience ($F(2, 69) = 5.273, p < .05$) and Explication ($F(2, 69) = 3.859, p < .05$). The fact that no relationship has been found with respect to evaluation may be caused by the limited number of messages that have been categorised as evaluation.

Table 4.2 Learning indicators and student motivation

	IMTK	IMTA	IMES	EMID	EMIN	EMER	AMOT
<i>Content Analysis</i>							
<i>Non-task related</i>	0.14	0.17	0.18	-0.02	0.03	0.01	0.17
Planning (Cat. 1)	0.21	0.24*	0.24*	0.07	0.07	0.04	0.06
Technical (Cat. 2)	0.22	0.21	0.26*	-0.06	0.07	-0.05	0.07
Social (Cat. 3)	0.17	0.10	0.12	-0.28*	-0.03	-0.29*	-0.13
Nonsense (Cat. 4)	0.08	0.12	0.12	0.02	0.02	0.06	0.21
<i>Task-related</i>							
Facts (Cat. 5)	0.23*	0.18	0.18	-0.05	-0.10	-0.13	0.00
Experience (Cat. 6)	0.29*	0.28*	0.28*	0.10	0.03	-0.02	-0.14
Theoretical Ideas (Cat. 7)	0.22	0.23*	0.26*	0.01	0.11	0.03	-0.05
Explication (Cat. 8)	0.26*	0.25*	0.20	0.07	0.04	-0.01	-0.14
Evaluation (Cat. 9)	-0.10	-0.08	-0.20	0.03	0.01	0.09	-0.08

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

While learners high on intrinsic motivation contribute actively and above average to the various types of discourse, highly extrinsically motivated learners contribute on average. Interestingly, there is one exception to this finding: the extrinsically motivated learner who scores high on identified regulation (EMID) and external regulation (EMER) adds on average significantly less contributions labelled as social (category 3) in our online settings (EMID $r=-0.28$; EMER $r=-0.29$, $p < .05$). Learners with high levels of a-motivation (AMOT) do not distinguish themselves, except on nonsense contributions (AMOT $r=0.21$, $p > .05$), be it marginally significant. In sum, students who are highly intrinsically motivated contribute more to cognitive discourse, in particular experience, theoretical ideas and explication.

4.3 Relating students' motivation to position in social network

While the above analysis captures how differences in levels of the several facets of motivation are related to differences in the intensity to contribute in the different types of discourse, the analysis does not allow us to investigate with whom a learner has interaction. By using an integrated social network analysis, a detailed picture of the role of motivation on learning interaction processes can be established. All three aspects of intrinsic motivation are positively correlated with the three centrality measures from our social network analysis: see Table 4.3. This implies that

highly intrinsically motivated students distinguish themselves (much stronger) from extrinsically and amotivated students also with respect to their position in the network. Especially students with high levels of intrinsic motivation to know are central contributors to overall discourse (Reply Degree) (IMTK $r=0.24$, $p < .05$). Those students are also more central in task-related discourse (IMTK $r=0.27$, $p < .05$) and in contributions of higher cognitive discourse (IMTK $r=0.27$; IMTA $r=0.24$, $p < .05$).

Table 4.3 Centrality, ego-density and academic motivation

	IMTK	IMTA	IMES	EMID	EMIN	EMER	AMOT
<i>Social Network</i>							
<i>Analysis</i>							
Reply Degree	0.23*	0.21	0.18	0.00	0.00	-0.03	0.05
Reply TR Degree	0.27*	0.21	0.18	0.01	-0.04	-0.07	-0.12
Reply HC Degree	0.27*	0.24*	0.20	0.11	0.06	0.05	-0.16
Size	0.24*	0.21	0.22	-0.01	0.04	0.05	-0.02
TR Size	0.29*	0.26*	0.23*	-0.02	0.05	-0.03	-0.08
HC Size	0.29*	0.29*	0.24*	0.13	0.05	0.04	-0.12

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

If we also take into consideration the number of other learners an individual learner is connected to (Size), again a positive relationship is found for the three types of intrinsic motivation. In addition, when only taking into consideration discourse activity of (higher) cognitive discourse, all intrinsic motivation types are significantly correlated (IMTK $r=0.29$; IMTA $r=0.29$; IMES $r=0.24$, $p < .05$). This implies that highly intrinsically motivated learners both show up in the centre of the network but also on the outer fringe, but then as learners who have above average connections to other learners. Students who are highly extrinsically motivated do not distinguish from the average student in our online setting. The number of links of highly extrinsically motivated learners is on average. A-motivation demonstrates a negative but non-significant relationship with higher cognitive centrality ($r=-0.16$, n.s.) and higher cognitive size ($r=-0.12$, n.s.).

5. DISCUSSION

The results of the present study indicate that individuals contribute differently to discourse in online settings, depending on their type of motivation. Significant differences are found amongst individuals with respect to the amount and type of discourse activity. Some learners are active contributors to discourse, while other learners contribute only a limited amount to discourse. Although these results have already been found in other studies (e.g. Caspi et al., 2003; De Laat et al., 2007; Järvelä et al., 2008; Schellens & Valcke, 2005; Veermans & Lallimo, 2007), this study is the first to empirically demonstrate that motivation is one of the determinants explaining the differences in the amount and quality of contributions to discourse in online settings. We find that highly intrinsically motivated learners contribute more task-related discourse than other types of learners. In addition, highly intrinsically motivated learners do not contribute more non-task related messages per se, but differ with respect to contributing to planning and technical issues. We find that highly extrinsically motivated students contribute less actively to non-task related issues. In particular, they contribute significantly less to discourse labelled by Veerman and Veldhuis-Diermanse (2001) as social contributions.

The contribution to cognitive discourse in our setting is positively related to students with the level of intrinsic motivation. Learners high on intrinsic motivation contribute more task-related discourse than other types of learners. In particular, highly intrinsically motivated students contribute more own experience, new theoretical ideas and explication. Extrinsically motivated students “underperform” relative to intrinsically motivated students on all task-related categories. Learners high on a-motivation do not contribute less to discourse, which is contrary to prior expectations. With respect to our first research question, the results indicate that differently motivated student do show different non-task related and task-related discourse activity.

With respect to our second research question, large differences are found amongst learners with respect to their position in the social network, which is in line with previous findings (De Laat et al., 2007; Hurme et al., 2007; Russo & Koesten, 2005). A new feature in this article is that we are able to link the position of the learner in the social network to the type of motivation. Central learners in the social network appear to be highly intrinsically motivated students. In addition, learners who have more connections seem to be highly intrinsically motivated learners. Based upon our correlational analysis, learners with high levels of extrinsic motivation do not differ from average learners in their position in the network.

In order to answer our third research question, we have integrated the results of content analysis with social network analysis, which improves our

insights of dynamic interaction processes in CSCL. Centrality within the network decreases as we move to (higher) cognitive discourse. In addition, the number of learners an average learner is connected to (ego-density) decreases when discourse becomes more (higher) cognitive. As is shown by the two visualisations of the social networks, distinguishing the type of discourse leads to additional insights in interactive learning processes. Learners who are central in the overall network are not automatically central in the (higher) cognitive network. When we take only higher cognitive discourse activities into consideration, central contributors seem to be highly intrinsically motivated learners. Quite interestingly, when looking at (higher) cognitive communication, having more ties to others is an important merit for learning. The correlation coefficients of ego-density and scores for intrinsic motivation are somewhat larger than those coefficients of centrality and scores for intrinsic motivation, implying that having more ties might be more important than being in the centre of the social network. In other words, learners who are in between the centre and the outer fringe of the network might also play an important role in contributions to (higher) cognitive discourse. In sum, learners high on intrinsic motivation are more central in social networks of (cognitive) discourse and have more connections to other learners, while highly extrinsically motivated learners and a-motivated learners show no tendency to occupy certain positions in the network more often than other positions.

By distinguishing the type of motivation, we have shown that having strong motivation is not sufficient for contributing to cognitive discourse, it is strong intrinsic motivation that matters. These findings might have important consequences on how we integrate the various motivational types into our learning environment. Students who are extrinsically motivated like Don, Sandra and Irine, appear to be poorly connected in the higher cognitive network (Figure 4.2). Measures should be taken to let them not be excluded from participating in higher cognitive discourse in groups, as co-construction of knowledge has been shown to be a driving factor for learning. On a positive note, most highly extrinsically motivated students perform on average despite the lack of external teacher regulation in our distance learning setting. We had expected that strongly externally regulated students would find the design of the open collaboration setting less suitable for their motivational type. On a negative note, the fact that there are large differences between (higher) cognitive discourse activities among intrinsic vs. extrinsic students might imply that highly extrinsically motivated students might be difficult to externally regulate to participate in online settings.

Social Network Analysis (SNA) techniques provide a powerful tool to measure the dynamic interaction of learning processes within CSCL. By measuring interactivity of discourse activities at three levels of (cognitive) discourse, we find that individuals take different positions in social

networks. In particular, integrating the results of the content analysis with social network analysis, we are able to demonstrate that different patterns of interactivity exist in different types of discourse. Finally, the correlations of the Academic Motivation Scale with the results of the content analysis and social network analysis indicate that the degree and type of activity in online learning depends on the type of motivation.

5.1 Limitations

The results of this study are based on a multi-method approach, whereby Content Analysis is used to analyse what learners are contributing, Social Network Analysis is used to determine who is contributing, and finally Academic Motivation Scale for analysing how motivation influences the learner's behaviour. This can be viewed as a potential limitation to this study in that the (long-term) consequences on learning outcomes have not been demonstrated. Russo and Koesten (2005) have found that central contributors to discourse also perform better on learning outcomes. In addition, preliminary findings indicate that active summer course participants outperform others in the first year of the bachelor programme (Rienties, Tempelaar, Dijkstra, Rehm, & Gijselaers, 2008). In a range of studies focussing on learning in a face-to-face problem-based learning programmes in the Netherlands, correlations between these motivational scales and indicators describing learning process and learning outcome aspects typically range between 0.10 and 0.20 (Tempelaar, 2006; Tempelaar, Gijselaers, Schim van der Loeff, & Nijhuis, 2007). Given that the correlations of motivation on discourse activity and position in the social network in our study are larger than in face-to-face settings, we might expect that the type of motivation has an even stronger influence on learning outcomes in online settings. Besides the quantitative measures of learning, implementing qualitative measures of learning like critical event recall (e.g. De Laat et al., 2007; Veermans & Lallimo, 2007) might provide further evidence of how motivation influences learning in online settings. We encourage researchers to assess the role of motivation on type of discourse and position in the network in other settings in order to verify our findings.

A second limitation of this study is that no measures were taken to prevent self-selection in the summer course programme or to introduce a control condition. Selecting or rejecting students based on types of motivation rather than prior knowledge leads to ethical issues. Alternatively, rearranging learners in other groups based on their type of motivation might also lead to ethical dilemmas. In our setting, which matches the practice teachers in online settings are confronted with (i.e. groups with a mix of

various types of motivated students), we did not balance groups based on a pre-determined mix of motivational types. Furthermore, we did not introduce a control condition as our primary research aim was to measure in a real-life realistic CSCL environment how learning processes were influenced by motivation.

Based on our theoretical conceptions, we expected that the more externally regulated a learner was, the less he/she would contribute to discourse given the limited possibilities of teachers to impose external regulation in online settings. Furthermore, we expected that learners high on a-motivation would contribute less to discourse due to their lack of motivation. Although the correlations for extrinsically regulated and a-motivated learners have the expected sign, the coefficients are not significant. Further research should assess whether specific groups of learners can be identified using cluster analysis or by identifying extreme groups in order to assess why no significant negative relationship was found between contributions to discourse and a-motivation. Additionally, the lack of internalisation of the regulation to the self might be explained the short duration of the course. Learners with strong external motivation to education might need more time to internalise the regulation into the self (Guay et al., 2003). Another explanation might be that the limited external benefits in our setting (i.e. credits) might lead extrinsically motivated students to put less effort into the course than others. By increasing the cohorts in the future, we expect that the coefficients will become significant as the sample size increases.

A final limitation was that we did not measure the mutual conception among participants. In groups that have more highly intrinsically motivated learners, one might expect that more (higher) cognitive discourse activities are present than groups with low intrinsically motivated learners. However, as the number of groups (six) was rather small to conduct a group-level analysis and the fact that it is difficult to measure interaction patterns on group level when CA and SNA-measures are combined, further research should assess whether group-level effects also influence behaviour of individual learners in CSCL settings.

5.2 Future research and implications for education

Future research should investigate the impact of learner profiles on the behaviours of learners in CSCL, for example by distinguishing various types of learners using cluster analytic methods (Veermans & Lallimo, 2007). In addition, by analysing how learners mutually influence each other in collaborative learning, future research should assess how the type of motivation of one learner influences the behaviour of others in virtual teams. Based on our findings, we will redesign the learning environment to capitalise on the merits of social interaction, peer-support and planning of

learning processes. By increasing social presence in our virtual learning environment by using Web 2.0 tools like blogs, wiki's and webconference, we hope to increase the relatedness among learners. These findings are relevant for teachers, managers, admission officers and schedulers as the results imply the type of motivation has a moderately strong influence on the type of discourse and position within the social network. Appropriate strategies to deal with various types of motivation should be designed to assist each type of learner.

6. APPENDIX

6.1 Appendix A: Content Analysis scheme social and cognitive discourse

Veerman and Veldhuis-Diermanse (2001) distinguish four activities of non-task-related discourse, whereby the examples are taken from the online course economics:

1. Planning: "Shall we first complete Task 1, before we go on with the next one?"
2. Technical: "Does anybody know how to add a graph to my thread?"
3. Social: "I think that a lot of people are very motivated here, which is good"
4. Nonsense: "Have you all made up your mind to start studying at UM in September?"

In the original coding scheme of Veerman and Veldhuis-Diermanse (2001), they consider three basic cognitive processing activities, namely new information (facts, experience, theoretical ideas), explication and evaluation. However, Schellens and Valcke (2005) found that the three new information activities should be distinguished in separate activities. Furthermore, Schellens and Valcke (2005, p. 961) argue that the five task-related discourse activities should be ordered in a hierarchical structure, whereby "[c]onsecutive types of communication represent higher levels of knowledge construction":

5. New fact, that is learners present information that is new in the context of the discussion: "The average rate of inflation in the U.S. for 2004 is 2.7 %."
6. Own Experience/opinions: "I think that VAT-taxes should be reduced to increase demand".

7. Theoretical ideas: “If we take the Circular Flow Model from the book (Parkin/Bade) you are right, because it only takes households into account”.
8. Explication. This is a type of communication that reflects a further refining and/or elaboration of earlier ideas: “There are actually quite a lot of different, more specific market forms, the ones you mentioned are the three big ones (monopoly, oligopoly and perfect competition), but some rare ones exist as well. For example a monopsony exists”.
9. Evaluation. This type of written messages corresponds to a critical discussion of earlier information or ideas. It goes beyond a simple confirmation or negation and reflects argumentations, reasonings, justifications.

6.2 Appendix B: Two examples of messages consisting of multiple elements

The following message was posted by Maria, after a discussion along seven messages on which market types exist. Tiffany had previously explained that there are three market forms (i.e. monopoly, oligopoly and perfect competition). Coders 1-3 coded the first paragraph as an elaboration (category 8), while they coded the second paragraph as social (category 3). Therefore, the message was split.

“Hey Tiffany!

I would like to add the market of a cartel: a small group of large firms who may agree to work together (there are a type of monopoly), trying to keep their prices and profits high. They only compete on a non-price basis...

I think that a lot of people are very motivated here, which is good. I am of course motivated too but in a little time conflict, but quite confident that I will manage. I don't know how far we are meant to, perhaps the tutors can answer these questions, but I think they just want us to write :-)”

Afterwards, Andre responded to the above message of Maria, whereby coders 1-3 code the first paragraph as social (category 3), while they code the second paragraph as an elaboration (category 8).

“Hi Maria,

I think it is good as well that we are all that over motivated, because we will get a lot more information if everyone actively contributes something. I don't know if there are any restrictions about how far we want to go, are there?

@ Tiffany

There are actually quite a lot of different, more specific market forms, the ones you mentioned are the three big ones (monopoly, oligopoly and perfect competition), but some rare ones exist as well. For example a monopsony exists, this means there is only one buyer in the market and more than one seller (for example

weapons which are only bought by one certain government but could be produced by different companies).”

6.3 Appendix C: Two examples of uncodeable messages

The message posted by Rick only includes a reference to a discussion on the difference between nominal Gross Domestic Product (GDP) and real GDP. Coder 1 coded this message as uncodeable, coder 2 as a new fact (category 5), and coder 3 as a new theoretical idea (category 7).

“Reference: http://en.wikipedia.org/wiki/aggregate_expenditure”

The message posted by Maria after a series of messages discussing the difference between nominal GDP and real GDP was coded by coder 1 as an elaboration (category 8), as it elaborated previous discussions. Coder 2 coded it as a new fact (category 5), since the GINI coefficient was introduced as new fact without reference to previous ones. Finally, coder 3 coded it as an evaluation (category 9), as the measurement of GDP leads to several problems and Maria provided a possible solution by using the GINI coefficient.

“I think it is totally true what you said. A big weakness of the GDP is that it does not show the distribution of wealth, but none of you has come up with a solution...

I remember from my geography lessons that there is a gini index (also included in data from CIA worldfact book) that shows the distribution of wealth. As ia wasnt able so far to get this library thing started, I can only give a link ti wikepedia, but perhaps someone else find something...

Another thing I remember from school when talking about development and inequality is that we had data that showed the share of the GDP for the poorest and fro the richest 10% of the population. So if there was a big difference (eg poor 4%, rich 40%) one can assume that there s a very unfais distribution of wealth.

Any additional info?

Has anybody heard of it, too?

Reference: http://en.wikipedia.org/wiki/Gini_index”

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ⁱ The names of the participants are replaced by fictitious names in order to guarantee privacy of the participants.

Chapter 5

SOCIAL INTERACTION IN VIRTUAL NETWORKS, A PREFERENCE FOR INTRINSIC MOTIVATION*

A large number of studies in Computer-Supported Collaborative Learning (CSCL) have assessed how social interaction, learning processes and outcomes in virtual settings are intertwined. Although recent research findings indicate that learners differ with respect to the amount and type of discourse contributed in virtual settings, little is known about the underlying causes and its consequences explaining differences between participants' contributions to discourse. The present research investigates how motivational orientation (intrinsic/extrinsic) of a learner influences the interaction patterns with other learners in a virtual network. We gathered data about 100 participants who collaborated together in six virtual networks. Our research indicates that three (self-directed) sub-groups were formed within each virtual network. These subgroups were generated by a K-means cluster analysis of academic motivation measured by the Academic Motivation Scale instrument (AMS). Afterwards, the different motivational profiles were added as attributes to each virtual network. The research results reveal that the motivational profile predicts with whom a learner is interacting. Extrinsically motivated learners have a preference to connect to intrinsically motivated learners. However, intrinsically motivated learners prefer to discuss mainly among themselves, implying that extrinsically motivated learners will receive less feedback and discourse possibilities from other members within the virtual network. Our findings further our understanding about differences found in distance learning courses about participation and drop-out in class.

1. INTRODUCTION

In recent years, the attention for virtual collaborative learning seems to be fuelled by two separate, yet mutually enforcing developments: First, the availability of increasing possibilities of Information Communication Technologies (ICT) provide enhanced support for collaboration (Bromme,

* Based upon:

Rienties, B., Tempelaar, D. T., Giesbers, B., Segers, M., & Gijssels, W. H. (Submitted). Social interaction in virtual networks, a preference for intrinsic motivation.

Hesse, & Spada, 2005; Resta & Laferrière, 2007; Schellens & Valcke, 2005). Second, growing amounts of evidence have become available showing that collaboration can enrich student learning through interaction (Jonassen & Kwon, 2001; Lindblom-Ylänne, Pihlajamäki, & Kotkas, 2003; Van den Bossche, Gijsselaers, Segers, & Kirschner, 2006). In general, it can be said that virtual collaborative learning is built on the assumption that ICT has the power to provide a rich learning experience by using a variety of learning methods (Beers, Boshuizen, Kirschner, & Gijsselaers, 2007; Giesbers, Rienties, Gijsselaers, Segers, & Tempelaar, 2009; Jonassen & Kwon, 2001; Resta & Laferrière, 2007).

Despite the learning possibilities created by ICT-tools, recent findings in research on Computer-Supported Collaborative Learning (CSCL) indicate that interaction and contributions made to interaction depend on a variety of factors. Not every learner contributes equally to others. It has been found that learners who are similar with respect to educational background and prior knowledge nevertheless contribute differently to discourse (Caspi, Chajut, Saporta, & Beyth-Marom, 2006; De Laat, Lally, Lipponen, & Simons, 2007; Rienties, Tempelaar, Van den Bossche, Gijsselaers, & Segers, 2009). For example, Caspi, Gosky and Chajut (2003) analysed a total of 7706 messages of 47 courses at various faculties of the Open University in Israel and found that the majority (80%) of students contributed only a small amount of messages. A small minority contributed the bulk of the messages. Similar differences between learners have been found with respect to the type (cognitive, affective, metacognitive) of contributions (De Laat et al., 2007; Schellens & Valcke, 2005). It can be said that participation in distance e-learning courses is unequivocally divided among its participants. An overall finding in research is that the majority of interactions and contributions within online courses can be attributed to a small number of learners. While this research has demonstrated the existence of this phenomenon, the obvious question is how these differential patterns between learners can be explained.

Several studies have examined this phenomenon by using social network analysis to explain interaction patterns in CSCL. Social network analysis (SNA) provides powerful tools to analyze how people interact over a given period of time (Hurme, Palonen, & Järvelä, 2007; Martinez, Dimitriadis, Rubia, Gomez, & de la Fuente, 2003; Rienties et al., 2009). It considers whether certain individuals are central in networks or at the peripheries, and how interactions between individuals may change over time. Research findings have indeed revealed that some learners are more central in the social network than other learners (Hurme et al., 2007; Russo & Koesten, 2005). It has been found that learners who were central in a social network received and also contributed more messages than other

learners. In addition, Russo and Koesten (2005) found that learners who were central in the social network had better cognitive learning outcomes.

Although recently several researchers have identified that some participants are more likely than others to be in the centre of networks, they could not explain the underlying mechanisms of these social interaction patterns. The present study aims to fill in this gap, by examining the underlying causes that explain differential contributions to social networks. We address the question why some learners receive relatively more replies to their contributions in discourse while others do contribute but get only limited response from others. So the issue is to what extent is it a coincidence that some learners become central contributors? In this article, we will investigate what the “invisible” mechanisms in social interaction are that result in learners of virtual networks being central or learners being on the outer fringe of a social network.

2. AN INVISIBLE HAND IN SOCIAL INTERACTION IN CSCL: MOTIVATION

In most virtual networks learners are geographically separated and dispersed over many settings. They have to construct meaning and co-construct knowledge in a virtual setting. However, participation and making contributions to discourse in virtual networks cannot be taken for granted (Bromme et al., 2005; Kirschner, Beers, Boshuizen, & Gijssels, 2008). In particular when learners are interacting using lean ICT-tools like discussion forums or WIKIs, establishing a critical mass of interaction whereby participants contribute actively to cognitive discourse is troublesome (Caspi et al., 2003; Schellens & Valcke, 2005). Some learners are more inclined to start and actively contribute to a discussion than others. Other learners might prefer to wait for a while before contributing to a discussion, in particular when the members of the virtual network are seeking for effective working and learning strategies (Beers et al., 2007; Kirschner et al., 2008).

Within CSCL, several researchers have tried to influence the interaction patterns among learners by (re-)scaffolding the learning process by designing scripts (Weinberger & Fischer, 2006), adjusting the degree of social presence of ICT tools (Giesbers et al., 2009; Jonassen & Kwon, 2001; Tu & McIsaac, 2002) or regulating the interaction processes (Beers et al., 2007; Kirschner et al., 2008). For example, by increasing the regulation of interaction processes, Beers et al. (2005) found that interaction among participants could be enhanced. By establishing argumentative scripts, learners contributed more argumentative discourse than when other scripts were used (Weinberger & Fischer, 2006). Nonetheless, individual

differences to contributions to discourse still persist when redesigning the learning environment. Limited research has been conducted how differences in individual traits influence the interaction patterns of learners in networks.

One of the explanations for these individual differences lies in the motivation of learners to contribute to the virtual network. Recent research highlights indeed that motivation has a strong influence on how learners contribute to discourse in online settings (Järvelä, Järvenoja, & Veermans, 2008; Rienties et al., 2009; Veermans & Lallimo, 2007; Yang, Tsai, Kim, Cho, & Laffey, 2006). For example, Yang et al. (2006) conducted a survey among 250 respondents of eleven online educational psychology courses and found that goal-oriented motivation measured by MSLQ (Pintrich & De Groot, 1990) positively influences social presence among peers, that is the perception that emotions can be shared using CSCL. This finding has been replicated in various ways. Using a cluster analysis among a cohort of 50 psychology students following an online course, Veermans and Lallimo (2007) found that messages contributed by motivated students demonstrate a richer variety of topics. Järvelä et al. (2008) found that students in the face-to-face setting reported more (favourable) learning goals and less performance goals (Pintrich & De Groot, 1990) relative to students in virtual settings.

Although the two studies of Järvelä et al. (2008) and Veermans and Lallimo (2007) provide important insights in how motivation influences behaviour of learners in CSCL using a qualitative perspective, in our own research we use a more quantitative analysis to assess the role of motivation on social interaction in virtual teams. Previously, we found that intrinsically motivated learners are more inclined to contribute to cognitive discourse than extrinsically motivated learners (Rienties et al., 2009). The present research builds further on these findings by examining how motivation affects the creation, development and evolution of links between learners in virtual networks. As motivation is a multidimensional and multilevel construct (Boekaerts, 1997), a wide variety of definitions and instruments are discussed and used in educational psychology research. We adopt the concept of motivation developed by Deci and Ryan (1985), where to be motivated means to be moved to do something. The degree of self-determination of learners might explain why some learners contribute more to discourse in CSCL than others. As a consequence, it is expected that some learners contribute more to discourse in CSCL than others, given their motivation. However, focusing only on the level of motivation ignores the underlying attitudes and goals the learner has in order to pursue an action or goal (Deci & Ryan, 1985).

Ryan and Deci's Self-Determination theory (2000) provides a case in point. It distinguishes between intrinsic motivation, extrinsic motivation and amotivation. According to Deci and Ryan (1985), intrinsically motivated learning can be defined as the drive to learn. This drive is based on the satisfaction and pleasure of the activity of learning itself; no external rewards come in play. When an intrinsically motivated learner decides to follow an online course, (s)he is likely to be among the first to contribute to discourse giving the pleasure of learning. In contrast, externally motivated learning refers to learning that is a means to an end, and not engaged for its own sake. SDT proposes that extrinsic motivation is a construct with different facets that vary greatly with the degree to which the learner is autonomous (Deci & Ryan, 1985; Ryan & Deci, 2000). For example, when a learner is forced to join an online course because his parents have told him/her to do so (external regulation), the learner is less likely to be among the first contributors to discourse. Finally, amotivation is a state of lacking any intention to act, which will probably cause an amotivated learner to stop participating in an online course.

Vallerand and colleagues have added further theoretical concepts to the model of SDT as well as adjusting the model for different contexts as SDT was primarily developed to measure motivation among children. Vallerand and Bissonnette (1992) acknowledge that the attitudes, values and goals that trigger a learner to become intrinsically motivated can differ. For example, when a learner enters into college or university and voluntarily chooses to study economics, distinguishing the different intrinsic motives might be important. Some students might choose to study economics as they enjoy learning a new science, some might choose economics in order to understand the underlying reasons of an economic crisis, while others might choose economics as playing a manager in a virtual game during a management course seems exciting. Therefore, Vallerand and Bissonnette (1992) distinguish between three intrinsic motivation types: intrinsic motivation to know or learning for the satisfaction and pleasure to understand something new; intrinsic motivation to accomplish or learning for experiencing satisfaction and pleasure to accomplish something; and intrinsic motivation to experience stimulation or learning to experience stimulating sensations. In sum, the type of motivation of a learner might influence the social interaction with other learners within the virtual network.

Evolution of Social Networks

The present study considers the way learners interact in virtual networks as social network interactions. According to Newman (2003), "[a] social network is a set of people or groups of people with some pattern of contacts or interactions between them". In a review of Social Network Analysis

(SNA) for small groups, Katz et al. (2004) argue that the network perspective can help researchers to identify and explore social network interaction features in groups or networks. For example, SNA can be used to determine why some learners are more active than other learners (Hurme et al., 2007; Martinez et al., 2003), why some experts receive more inquiries for information than others (Borgatti & Cross, 2003), how informal personal networks function (Casciaro, 1998), or why some networks develop into successful and sustainable networks while others fail (De Laat et al., 2007; Newman, 2003).

According to network theorists, there are two important conditions that determine how social networks evolve: 1) the stability of the number of nodes (i.e. participants in virtual network); 2) the (in)equality of characteristics of nodes in the network (Barabási, 2002; Barabási & Albert, 1999; Erdős & Rényi, 1960; Newman, 2003). In case the number of participants in a social network grows continuously (e.g. Wikipedia, Facebook), being among the first participants in the social network might imply that one is more likely to be connected to others than when one has recently joined a social network. In contrast, in an online course (as in most classes), the number of learners is mostly pre-determined and relatively stable. Therefore, a straightforward assumption from network theory would be that the social network of an online course will develop and evolve according to random graph theory (Erdős & Rényi, 1960). In random graph theory, learners connect to other learners in a network with a more or less equal probability.

As an explanation how random networks evolve, Barabási (2002) uses the cocktail party example from Erdős and Rényi (1960). Imagine that you are invited to a party of hundred guests who do not know you or each other. Soon you will start to talk to some guests at the party. After a while you will move on to some other people. If one would construct a social network of all encounters during the party, the interactions at the party would follow a random pattern. The total number of connections to others guests will very similar among all guests. In line with random graph theory, this brings us to our first research hypothesis.

H1: Learners in a virtual network will have an equal amount of connections to all other learners.

If hypothesis 1 has to be rejected in our setting, then learners in virtual networks do not connect to other learners in line with the random graph theory. A crucial assumption of random graph theory is that people in the social network are perceived by others as equal (Erdős & Rényi, 1960; Newman, 2003). However, in line with the second condition when nodes

(i.e. learners) have a specific preference to connect to some type of nodes, the network will not develop according to random graph theory (Barabási & Albert, 1999; Newman, 2003). Several researchers have indicated that learners in online settings differ with respect to prior knowledge, expertise and motivation when they become member of a virtual network (Järvelä et al., 2008; Rienties et al., 2009; Yang et al., 2006). Continuing with the example of the party, when the NBA team winning the finals unexpectedly joins the party it is likely that the basketball players will receive a lot of attention. As a result, when drawing a social network of all social interactions, the basketball players will have a lot of connections with “ordinary” party guests. In contrast, the ordinary party guests will have limited connections to other ordinary party guests. In a similar vein, when learners in a virtual network become aware that interacting with some learners who have a trait (e.g. intrinsic motivation, large knowledge base, expertise) that is (perceived to be) beneficial, these learners might be more interesting to interact with.

As intrinsically motivated learners are more inclined to contribute to discourse than extrinsically motivated learners, in particular with regard to higher cognitive discourse (Rienties et al., 2009), they possess crucial characteristics for distance learning. Superior contributions to discourse at a higher cognitive level might bring them a positive (expert) reputation in the virtual network. Other learners might be more willing to contribute to a learner who is perceived to be motivated and has some expert knowledge. In addition, as extrinsically motivated learners will perceive a lack of external regulation in distance learning, they might direct their attention more towards intrinsically motivated learners. In other words, intrinsically motivated learners lead the discourse development within the virtual network, thereby providing the desired external regulation to extrinsically motivated learners. This will imply that most learners will be connected to intrinsically motivated learners, as phrased in our second and third research hypotheses.

H2: Extrinsically motivated learners are more likely to interact with intrinsically motivated learners than with other extrinsically motivated learners.

H3: Intrinsically motivated learners are more likely to interact with other intrinsically motivated learners than with extrinsically motivated learners.

3. METHOD

3.1 Setting

The present study took place in an online summer course for prospective bachelor students of an International Business degree program at an Institute for Higher Education in the Netherlands. The aim of this course was to bridge the gap in economics prior knowledge with the requirements for the degree program. It was designed for international students who with various backgrounds in diplomas, amount of training in economics, and different contents in economics, started their bachelor (Rienties, Tempelaar, Waterval, Rehm, & Gijsselaers, 2006). This online course was given over a period of six weeks in which learners were assumed to work for 10-15 hours per week. The participants never met face-to-face before or during the course and had to learn using the virtual learning environment “on-the-fly”.

The course was based upon principles of Problem-based learning (PBL). Problem-based learning typically involves learners working on problems and learning tasks in small groups with the assistance of a tutor. Problems serve as the context for new learning. Their analysis and resolution result in the acquisition of knowledge and problem-solving skills. Collaborative learning lies at the heart of PBL (Hmelo-Silver, 2004). In our setting, learners participated in virtual networks within a collaborative learning environment using discussion forums and announcement boards. During six weeks, learners had to collaborate together on solving six tasks through a problem-based learning method.

In virtual networks it is important for tutors to provide rapid feedback on discourse (Anderson, Rourke, Garrison, & Archer, 2001; De Laat et al., 2007; Vonderwell, 2003). For that purpose our PBL design included a lead tutor and back-up tutor. The first was responsible for the instructional design, facilitating discourse and direct instruction, while the backup tutor merely facilitated discourse when the lead tutor was offline during the day. In this manner, the discourse in each virtual network was monitored and facilitated each day. No obligatory meetings were scheduled. At the end of each week, the lead tutor made a suggestion on how to proceed with the next task, thereby focusing on process rather than on content. The results of three interim-tests and a final summative test combined with graded participation in the discussion forums were used to make a pass-fail decision. Learners who passed the course received a certificate.

3.2 Participants

In total 100 non-Dutch participants were randomly assigned in six networks. Data were analysed for those individuals who actually posted at least once a reaction in the discussion forum. We found that 18 learners, although registered for this course, never posted a contribution to the discussion forums. The 82 participants who posted at least once a reaction in the discussion forum were selected for our analysis. The six networks had an average of 13.66 members ($SD = 2.16$, range = 11-17) per network. The average age was 19 years and 45% of the learners were female.

3.3 Academic Motivation Scale (AMS)

Individual motivation was measured by the Academic Motivation Scale (AMS), which was developed by Vallerand et al. (1992) for college/university learners and measures the contextual motivation for education. The instrument consists of 28 items, in all of which learners respond to the question stem "Why are you going to college?". There are seven subscales on the AMS, of which three belong to the intrinsic motivation scale, three to the extrinsic motivation scale and one for amotivation.

Intrinsic motivation subscales are intrinsic motivation to know (IMTK): learning for the satisfaction and pleasure to understand something new; intrinsic motivation to accomplish (IMTA): learning for experiencing satisfaction and pleasure to accomplish something; and intrinsic motivation to experience stimulation (IMES): learning to experience stimulating sensations.

The three extrinsic motivation subscales are identified regulation (EMID), introjected regulation (EMIN), and external regulation (EMER). The three 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 last scale, amotivation (AMOT), constitutes the very extreme of the continuum: the absence of regulation, either externally directed or internally. The reliability and validity of the AMS scale has been established in a variety of studies (Fairchild, Jeanne Horst, Finney, & Barron, 2005; Vallerand & Bissonnette, 1992; Vallerand & Pelletier, 1993). The temporal stability of the AMS construct was confirmed by Vallerand and Bissonnette (1992) and Vallerand and Pelletier (1993) with a mean test-retest correlation of .75 and .79 respectively. In addition, the stability of the AMS-instrument after one year (mean test-retest correlation) was .68 and .29

after five years (Guay, Mageau, & Vallerand, 2003). In other words, the AMS instrument measures a relatively stable construct of motivation towards education amongst college and university students. In total 1445 freshmen including summer course participants filled in the questionnaire during the first few weeks of the first course of the semester. The response-rate on AMS-questionnaire among the summer course participants was 93%. The Cronbach alpha reliability for the seven scales ranged from .760 to .856, which is in line with previous studies (Fairchild et al., 2005; Legault, Green-Demers, & Pelletier, 2006; Vallerand & Pelletier, 1993).

3.4 Statistical analyses

3.4.1 Cluster analysis

Students in the experiment are part of the inflow of 765 international freshmen (out of a total of 1445 freshmen, with the non-international students not participating in the experiment). Motivational profiles were determined of all international students by applying k-means cluster analysis to subscale scores of the AMS-instrument. It was decided to base motivational profiles on the complete sample of international freshmen, and not in the restricted subset of participants of the experiment. First of all, this will lead to a more stable outcome of the cluster analysis. Second, in this way we are able to express the motivational patterns found amongst participants relative to the motivational profiles present amongst all international students. Since participation in the experiment is voluntarily, motivation scores of participating freshmen might be different from motivation scores of all freshmen. In this situation, profiles found amongst all international students were regarded as more relevant benchmarks than profiles found in the restricted group of participants of the experiment.

It was found that a three cluster solution provides an adequate description of different motivation profiles present in these freshmen. Afterwards, data on cluster membership of all participants of the virtual networks were combined with individual data resulting from the social network analysis. The interrelationships between all measures were assessed through standard T-tests analyses using SPSS 15.0.1.

3.4.2 Positioning of individuals within social network using SNA

SNA provides us with several tools to analyse interaction patterns among individual learners. Two frequently used measures were employed in order to determine the position of individuals in social networks, namely centrality and ego network density. First, the ego network density of each individual

within the network was used, which measures to how many other learners a learner is directly connected. Second, Freeman's degree of Centrality (Freeman, 2000; Wassermann & Faust, 1994) measures whether learners were central in the social network or not. If a learner contributed actively to discourse and most other learners responded to the activities of this learner, he/she became a central learner in the network and therefore had a high degree of centrality. Main indicator for this study is the relative position of each learner within the social network, derived by UCINET version 6.158. In order to assess whether learners with different motivational orientations connect equally to each of the clusters, we will use the (absolute/relative) number of send and received messages per learner to members in each of the (send to own/outside) clusters as a measurement for equality of interaction between clusters. An innovative feature of this study is that by combining the results of the SNA and cluster analysis, we were able to distinguish interaction patterns amongst individual learners based upon their motivation profile.

4. RESULTS

4.1 Hypothesis 1

In order to test hypothesis 1, the average number of connections in the cohort of online summer course participants is compared. On average, a learner has 6.43 (SD= 4.03) connections to other learners (ego-density) and there are substantial differences amongst individual learners with respect to the number of connections as assessed by a Chi-Square test (χ^2 (df= 76) 159.458, $p < .001$). Furthermore, significant differences are found using a Chi-Square test in each of the six virtual networks with the exception of network 3. In other words, in contrast to random graph theory the social networks in our setting do not evolve to a random network with an approximately equal amount of connections per learner, with the exception of network 3. Furthermore, some learners are more central than other learners in the network, as is illustrated by the large standard deviation of the Freeman's degree of centrality ($M=26.6$, $SD= 24.29$), as well as by the Chi-Square test for all participants (χ^2 (df= 80) 1772.74, $p < .001$) and the Chi-Square test for participants within each of the networks. As a result, we need to reject hypothesis 1 that social networks develop and evolve in accordance to the model of the random graph theory for five out of six of our networks.

4.2 Clustering learners on Academic Motivation

In order to test hypotheses 2 and 3 and to investigate whether the motivation profile of a learner has an influence on the formation of links to other learners within the social network, a K-means cluster analysis is applied to obtain three different profiles for motivation, which are further labeled according to the final cluster center position (see Table 5.1). As can be seen from Figure 5.1, the three motivation profiles are: cluster 1: low intrinsic motivation (Low In), high extrinsic motivation (High Ex); cluster 2: medium intrinsic motivation (Med In), low to medium extrinsic motivation (Med Ex); cluster 3: high intrinsic motivation (High In), high extrinsic motivation (High Ex).

Table 5.1 Means and standard deviation of classification measures per cluster (K-means)

	Cluster 1 Low In, High Ex (N=182)	Cluster 2 Med In, Med Ex (N=152)	Cluster 3 High In, High Ex (N=415)
Intrinsic motivation to know (IMTK)	4.68 (0.94)	5.38 (1.02)	6.06 (1.10)
Intrinsic motivation to accomplish (IMTA)	3.95 (0.89)	4.09 (0.89)	5.42 (1.06)
Intrinsic motivation to experience stimulation (IMES)	3.17 (0.95)	3.81 (0.99)	4.92 (1.18)
Identified regulation (EMID)	6.04 (1.00)	5.58 (1.20)	6.48 (1.03)
Introjected regulation (EMIN)	4.61 (1.14)	3.24 (1.23)	5.35 (1.22)
External regulation (EMIR)	6.05 (1.03)	4.52 (1.43)	6.12 (1.23)
Amotivation (AMOT)	1.44 (0.73)	1.40 (0.73)	1.32 (0.62)

Figure 5.1 Mean scores of the seven classifications measures per cluster

4.3 Relating learners' motivation to Social Network Analysis

As a third step, the cluster memberships are added as learner attributes to the social networks of each of the six virtual networks. In Table 5.2, the contributions to discourse per cluster within each network are provided. For example, in network 6 three tutors supported the discourse and contributed 64 messages, whereby tutor 3 had the lead role, tutor 4 the supportive role and tutor 1 assisted when tutor 3 and tutor 4 were not available due to taking a day off. Furthermore, one learner in network 6 with no information on academic motivation (Jonathan) has posted 8 messages. The two cluster 1 learners (Bart and Paul) have contributed in total 24 messages. The three cluster 2 learners (Elena, Christina, Bernard) have contributed 22 messages, while the eight cluster 3 learners have contributed 227 messages. A possible explanation why we found a random network for network 3 might be the different division of motivational profiles. There were more cluster 1 learners and less cluster 3 learners in network 3 in comparison to the other networks, which probably resulted in less interaction.

Table 5.2 Contributions to discourse per cluster within each network

	Teacher		No Info		Cluster 1		Cluster 2		Cluster 3		Total	
	P	n	P	n	P	n	P	n	P	n	P	n
Network 1	38	2	26	3	25	2	110	3	81	5	280	15
Network 2	53	3	3	1	55	2	38	2	366	10	515	18
Network 3	34	2	0	0	85	6	5	1	70	4	194	13
Network 4	68	2	0	0	0	0	10	1	677	16	755	19
Network 5	16	3	0	0	52	3	88	2	290	7	446	15
Network 6	64	3	8	1	24	2	22	3	227	8	345	17
Total	273	15	37	5	241	15	273	12	1711	50	2535	97

P= number of posts or messages

Based upon the division of motivational profiles, network 5 (Figure 5.2) and network 6 (Figure 5.3) can be categorised as prototypical networks. Learners for which no motivation attributes are available and teachers are represented by a light-coloured circle, while cluster 1 learners (Low In, High In) are represented by a light-coloured square box, cluster 2 learners (Med In, Med Ex) by a dark triangle, and finally cluster 3 learners (High In, High Ex) by a shaded diamond box[†]. In this way, we are able to visualise the

[†] The names of the participants are replaced by fictitious names in order to guarantee privacy of the participants.

position of each learner in the network as well as to whom each learner is connected to depending on his/her motivational profile. Five aspects can be distinguished from these figures.

First of all, the social networks illustrate who is communicating with whom and what the direction of communication is (Freeman, 2000). For example, in Figure 5.2, Tutor 4 replied to a comment of Kathi, which is indicated by the direction of the arrow (Wassermann & Faust, 1994). In addition, Laura and Charles have a so-called “reciprocal link” as they reacted both to each other’s contribution and the arrow goes in both directions. Second, some individuals within the network are more central than others (Russo & Koesten, 2005; Wassermann & Faust, 1994). For example, Katherina, Martin, Maria, Sylvia and Tutor 4 are central members in network 5, while Jonas, Veronica and Tutor 3 are central in network 6. Third, some learners are on the outer fringe of the network and are not well-connected. For example, Markus, John and Kathi as well as Bernard and Felix are connected with less than four ties in network 5 and network 6 respectively. Fourth, there are some learners who are connected with most learners but who are still on the outer fringe. For example, Laura, Charles and Judith in network 5 and Christina, Sandra and Paul in network 6 have more than 15 contributions but are still on the outer fringe of the overall network. This means that despite the fact that their number of links to others is high, they do not occupy a central position in the network.

Finally, when looking at the three motivation profiles, it appears that learners with high intrinsic motivation are situated closely together. For example, in network 6 most of the connections of Veronica and Jonas (cluster 3) are to learners with the same cluster membership. Learners with low and medium motivation are positioned mostly on the outer fringe of the network and are mainly connected to highly intrinsically motivated learners. Furthermore, learners within cluster 1 (Kathi and Markus of network 5; Paul and Bart of network 6) and learners within cluster 2 (Judith and Laura; Elena, Christina and Bernard) are not well connected to other learners with the same motivation profile. In fact, most cluster 1 and 2 learners are only indirectly linked to each other through cluster 3 learners. For example, in network 6 Bart can only be linked to Paul via Jonas or Caroline. In sum, our learners differ with respect to the number of ties as well as with respect to the position in the network, which has also been found in other research (De Laat et al., 2007; Russo & Koesten, 2005). Furthermore, we find that the position of learners in a social network depends on the type of motivation. Cluster 3 learners form the center core of the network, while the other learners are mostly situated on the outer fringe.

Figure 5.2 Social Network of network 5

Note: Learners for which no motivation attributes are available and teachers are represented by a light-coloured circle. Cluster 1 learners are represented by a light-coloured square box, cluster 2 learners by a dark triangle, and finally cluster 3 learners by a shaded diamond box.

Figure 5.3 Social Network of network 6

Michael

4.4 Hypothesis 2 and 3

In Table 5.3 we compare the average number of internal and external links of each learner within the three clusters, providing mean scores and standard deviations (in brackets). If we look at the (absolute) discourse per learner of each cluster, the amount of discourse is positively related with the cluster type. Cluster 1 learners contribute the least amount of discourse (13.20 messages per learner), cluster 2 form a middle group (17.42), and finally the most active participants are in cluster 3 (26.04). When we distinguish messages send and received from within and outside the own cluster membership, we find that cluster 1 and cluster 2 learners send significantly more messages to learners outside their cluster than to their own cluster type learners.

Table 5.3 Interaction among learners per cluster in absolute numbers

	Cluster 1 Low In, High Ex (N=15)	Cluster 2 Med In, Med Ex (N=12)	Cluster 3 High In, High Ex (N=50)	t-test difference
<i>Sent total</i>	13.20 (12.69)	17.42 (15.22)	26.04 (25.86)	2.048*
Sent to own cluster	2.20 (2.62)	3.17 (4.32)	18.72 (20.92)	3.96***
Sent outside own cluster	11.00 (11.37)	14.25 (11.45)	7.32 (9.36)	-2.13*
Sent difference	-8.80 (10.55)	-11.08 (8.23)	11.40 (19.54)	5.30***
<i>Received total</i>	13.53 (12.94)	18.25 (15.22)	29.82 (25.92)	2.638**
Received from own cluster	2.20 (2.68)	3.00 (3.64)	20.28 (22.02)	4.15***
Received from outside own Cluster	11.33 (11.30)	15.25 (13.23)	9.54 (8.89)	-1.46
Received difference	-9.13 (10.11)	-12.25 (11.66)	10.74 (21.35)	4.84***

Note: Independent sample T-test (2-sided) (Cluster 1 + 2 vs. Cluster 3)

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

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

***Coefficient is significant at the 0.001 level (2-tailed).

For example, Cluster 1 learners send 2.20 messages on average to learners within cluster 1, while they send 11.00 messages to learners in cluster 2 and 3. As a result, the sent difference in Table 5.3 for cluster 1 learners is negative (-8.80), implying that they send more messages to learners outside their own cluster. Furthermore, cluster 1 learners receive more messages from cluster learners outside their own cluster. A similar pattern is found for cluster 2 learners. In contrast, cluster 3 learners send to (18.74) and receive more (20.28) messages from other cluster 3 learners. Both sent difference and received difference for cluster 3 learners is

positive. Using an independent sample T-test, no evidence is found that cluster 1 and 2 differ significantly from each other. In contrast, both cluster 1 and 2 differ significantly from cluster 3. The t-test outcomes of the last column in Table 5.3 illustrate the differences between the combined first two clusters and cluster 3.

In Table 5.4, the relative interactions within and between clusters are illustrated, whereby we correct for the total number of each of the three profiles of motivation within a virtual network. For example, in network 6 there is one learners from cluster 0 (Jonathan), two learners from cluster 1 (Bart and Paul), three from cluster 2 and eight from cluster 3. These 14 learners were supported by three tutors. In order to correct for the difference sizes of each cluster, the size of each cluster within each virtual network is compared to the size of the external cluster. For example, for cluster 1 the number of sent messages to the internal cluster is divided by two, yielding a relative measure for sent to internal cluster for each member within cluster 1. At the same time, the number of sent messages by Bart and Paul to other people is divided by 15. The aggregated results for all clusters in the six networks are illustrated in Table 5.4. Both cluster 1 and 2 differ significantly from cluster 3 using an independent sample T-test with the exception of sent outside own cluster and received from outside own cluster.

Table 5.4 Interaction among learners per cluster corrected by relative cluster size

	Cluster 1 Low In, High Ex (N=15)	Cluster 2 Med In, Med Ex (N=12)	Cluster 3 High In, High Ex (N=50)	t-test difference
<i>Sent total</i>	1.60 (1.50)	2.30 (2.45)	2.74 (2.74)	1.950†
Sent to own cluster	0.62 (0.67)	1.22 (1.54)	1.70 (1.71)	2.790**
Sent outside own cluster	0.97 (0.98)	1.07 (0.95)	1.04 (1.18)	0.518
Sent difference	-0.35 (0.76)	0.15 (0.75)	0.66 (1.08)	3.80***
<i>Received total</i>	1.67 (1.64)	2.32 (2.23)	3.25 (2.57)	2.824**
Received from own cluster	0.62 (0.72)	1.17 (1.34)	1.84 (1.68)	3.356***
Received from outside own				
Cluster	1.04 (1.09)	1.15 (1.07)	1.41 (1.17)	1.660
Received difference	-0.42 (0.86)	0.02 (0.95)	0.42 (1.10)	3.033**

Note: Independent sample T-test (2-sided) (Cluster 1 + 2 vs. Cluster 3)

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

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

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

***Coefficient is significant at the 0.001 level (2-tailed).

For all cluster 1 learners in the six networks, this implies that on average 0.62 messages are sent to each of the cluster 1 learners. At the same time, on average 0.97 messages are sent by cluster 1 learners to each learner outside their own cluster. That is, cluster 1 learners send on average 56% more messages outside their cluster and this difference is significant at 10% ($T = -1.768$, $p < 0.10$) in a paired-samples T-test. At the same time, cluster 1 learners receive 68% more external messages from outside their cluster than from inside their cluster and this difference is again significant at 10% ($T = -1.883$, $p < 0.10$) in a paired-samples T-test. Therefore, both sent to and received from measures indicate that cluster 1 learners are mainly focussed on communication with learners outside their own cluster, implying that the motivation profile has an influence on whom cluster 1 learners are connected to. In other words, we find support for hypothesis 2 that extrinsically motivated learners are more likely to interact with intrinsically motivated learners than with extrinsically motivated learners.

Cluster 2 learners (medium intrinsic, low to medium extrinsic motivation) send about an equal amount of messages to both within and outside their cluster. At the same time, they receive an equal amount of messages from within as well as outside their cluster. This implies that cluster 2 learners do not distinguish with whom they communicate. Thus, cluster 2 learners are connected to other learners within the social network as predicted by random graph theory (Erdős & Rényi, 1960).

Finally, cluster 3 learners contribute most actively to discourse in absolute and relative numbers. More messages are contributed to learners within the same cluster, namely 1.70 messages per learner in cluster 3. In contrast, only 1.04 messages are sent to each learner outside their own cluster. In other words, cluster 3 learners are almost 40% more likely to send a message to their own cluster and this difference is statistically significant at 1% ($T = 4.326$, $p < 0.01$) in a paired samples T-test. In addition, the majority of the messages received by learners in cluster 3 originate from their own cluster ($T = 2.748$, $p < 0.05$). If we subtract the average number of contributions sent to external clusters (1.04) from those received from external clusters (1.40), we find that the communication of cluster 1 and 2 members is more strongly directed to cluster 3 members than vice-versa, and this difference is significant ($T = -3.879$, $p < 0.01$) in a paired-samples T-test. Hence, the stronger extrinsically motivated learners, and the learners with a less outspoken motivational profile, are connecting primarily to the intrinsically motivated learners, which supports hypothesis 2. In addition, intrinsically motivated learners are the most active contributors to discourse, but, in agreement with hypothesis 3, are contributing mostly with learners having similar motivational profile.

5. DISCUSSION

The results of the present study indicate that in our settings learners connect to other learners in their virtual network depending on their motivation profile. We find evidence that learners with high intrinsic motivation receive a relatively large amount of contributions from learners with other motivational profiles. At the same time, intrinsically motivated learners themselves are focussing more on discourse with other intrinsically motivated learners. These findings indicate that in distance learning settings interaction patterns amongst participants and evolutions of social networks of virtual networks do not develop randomly. In fact, we find that highly extrinsically motivated learners are more likely to connect to intrinsically motivated learners than vice versa, which contrasts the random graph theory where learners interact randomly.

With respect to the position of the individual learner in the social network, large differences are found amongst learners, which is in line with previous findings (De Laat et al., 2007; Russo & Koesten, 2005). A new feature is that we are able to link the position of the learner in the virtual network to his/her motivational profile. The social network graphs indicate that learners with certain motivational profiles are more likely to connect to each other than to learners with other profiles. In addition, most extrinsically motivated learners seem to be stronger connected to intrinsically motivated learners than vice versa. In fact, when we analyse the social networks of all six virtual networks as illustrated in Table 5.2 and 5.3, we find strong support for the idea that most learners have a preference to connect to intrinsically motivated learners. This amongst others implies that intrinsically motivated learners rather prefer to discuss with each other than to connect to learners outside their cluster. Learners with medium intrinsic and low to medium extrinsic motivation interact with other learners with a similar probability. The differences we find between internal and external communication in for learners with a less outspoken motivational profile (cluster 2) are not sufficient to produce statistically significant differences, implying that learners' motivation profiles do not play such a crucial role in choosing communication partners than for intrinsically and extrinsically motivated learners. In contrast, extrinsically motivated learners are more externally focussed than internally focussed, although the effects are marginally significant.

These findings might have important consequences as we find support of the idea that in distance learning settings learners prefer to interact with learners who are highly intrinsically motivated. This implies that learners strong in intrinsic motivation, who due to the nature of distance learning

already have an advantage over other learners (Rienties et al., 2009), will in the duration of the course be further stimulated by extrinsically motivated learners as well as other intrinsically motivated learners that are keen to link to them. By receiving more contributions from others to initiated discourse (in particular from intrinsically motivated learners), they can exchange more knowledge and receive more feedback than learners with low intrinsic motivation who receive little contributions from others. In a way, it seems like a self-fulfilling prophecy: active contributors to discourse receive further encouragements from others to continue, while these active contributors at the same time interact mostly with other active contributors rather than learners on the outer fringe of the network. Therefore, intrinsically motivated learners appear “well-suited” for our distance learning setting and continuously receive acknowledgements from other learners. In contrast, extrinsically motivated learners contribute less to the discourse and are less successful in inviting responses from other learners. As a result, extrinsically motivated learners receive less feedback and stimuli from others, which might further decrease their integration within the virtual network.

Research by Russo & Koesten (2005) on the position of learners within the network showed that being central is beneficial for learning outcomes. Furthermore, our own longitudinal research of summer course participants in the first year of their bachelor showed that successful summer course participants, who are mainly intrinsically motivated, outperform their peer on study success and study performance (Rienties, Tempelaar, Dijkstra, Rehm, & Gijssels, 2008). Taking our findings and findings from others together, we find that motivational orientation has a strong influence of the learning interaction processes in collaborative learning, which eventually lead to large differences in learning outcomes. If our findings are replicated in other distance learning settings, this might imply that due to the nature of preferential attachment to intrinsic motivation extrinsically motivated learners will be put at a disadvantage. Given the complex nature of distance learning (Bromme et al., 2005; De Laat et al., 2007; Resta & Laferrière, 2007), this disadvantage might be too large and detrimental for extrinsically motivated learners. This might explain why distance learning courses suffer from large differences in discourse among learners as well as high drop-out rates.

5.1 Limitations

The results of this study were based on a k-means cluster analysis on learner self-scores for a questionnaire on academic motivation, which was afterwards linked to the social network of each virtual network using Social

Network Analysis. This can be viewed as a potential limitation to this study as a self-reported measurement of academic motivation was used with obvious limitations. However, the patterns of interaction among the three identified motivational profiles follow the anticipated direction. In addition, research by Vallerand and colleagues has found that the AMS instrument is a robust predictor of learning outcomes and academic performance. As a second limitation, the long-term consequences on learning outcomes have not been demonstrated. However, our longitudinal analysis of learning outcomes among summer course participants indicate that active summer course participants outperform others in the first year of their bachelor programme (Rienties et al., 2008). Besides the quantitative measures of learning, implementing qualitative measures of learning like critical event recall (e.g. De Laat et al., 2007) might provide further evidence of how motivational orientation influences learning in virtual settings. We encourage researchers to assess the role of motivation on type of discourse and position in the network in other settings in order to verify our findings. A third limitation of this study is that no measures were taken to prevent self-selection in the summer course programme. In our setting, which matches the practice teachers in online settings are confronted with (i.e. networks with a mix of various types of motivated learners), we did not balance networks based on a pre-determined mix of motivational types. Each novice learner who was interested in joining the programme was accepted if his/her prior knowledge was below a pre-defined threshold. Although all students were informed by ordered mail about the opportunities of the summer course, given the voluntary nature of the summer course programme, a reasonable assumption might be that intrinsically motivated learners are more inclined to join than extrinsically motivated learners. We established that the proportion of cluster 3 learners amongst summer course participants is indeed somewhat higher than the proportion in all freshmen, yet cluster 1 and cluster 2 learners are not statistically significantly underrepresented in our subsample. So selection effects, if present, are of limited size.

5.2 Future Research and Implications for Education

Based on our findings, we will redesign the learning environment to capitalise on the merits of social interaction, peer-support and planning of learning processes. By increasing social presence in our virtual learning environment by using Web 2.0 tools like wiki's and web-videoconference, we hope to increase the relatedness among learners, which has shown to increase the internalisation of motivation regulation (Ryan & Deci, 2000). Socio-emotional support is an important factor in relational development of

networks. In particular in CSCL environments, socio-emotional communication is not an automatic artefact.

These findings are relevant for teachers, managers, admission officers and schedulers as the results imply motivational orientation has a moderately strong influence on the type of discourse and position within the social network. Social Network Analysis tools can be used to assess who is contributing actively to discourse and can be used as a tool for teachers to identify learners on the outer ring of the social network. Appropriate strategies to deal with various types of motivation should be designed to assist each type of learner.

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Chapter 6

SUMMARY AND GENERAL CONCLUSIONS & DISCUSSION

1. RESULTS FROM THIS DISSERTATION

In this manuscript, we tried to contribute to the rapidly expanding research in Computer-Supported Collaborative Learning (CSCL). In particular, we focused on understanding of the complex dynamics of social interaction when learners work and learn together in authentic online settings. Increasingly, researchers in CSCL are aware that comparing the effectiveness of face-to-face education with online education or comparing IT tool X with IT tool Y is less relevant than understanding the complex dynamics of learning and teaching in online settings itself (Bernard et al., 2004; Lou, Bernard, & Abrami, 2006; Resta & Laferrière, 2007; Rienties & Tempelaar, 2009). Therefore, our focus in the current research is on understanding the complex dynamics in (online) educational settings that support or prevent learning in teams (Bromme, Hesse, & Spada, 2005; De Laat, Lally, Lipponen, & Simons, 2007; Järvelä, Järvenoja, & Veermans, 2008; Järvelä, Volet, & Järvenoja, 2010).

In this dissertation, our primary focus was on understanding the social interaction of learners in CSCL. In particular, we focussed on understanding social interaction of learners in authentic and relevant settings, who worked and learned together in virtual teams for an extended period of time. Recent research (De Laat et al., 2007; Hurme, Palonen, & Järvelä, 2007; Järvelä et al., 2008; R. Martens, Gulikers, & Bastiaens, 2004; Martinez, Dimitriadis, Rubia, Gomez, & de la Fuente, 2003; Schunk, 2008; Strijbos & Fischer, 2007; Zimmerman, 2008) indicates that several methods of analysis need to be combined and integrated in order to grasp the complex dynamics of learning, in particular in online settings. In Chapter 1 this was referred to as the *first challenge in CSCL*, as limited research in CSCL has integrated social interaction between learners with their contributions to social and cognitive discourse. Therefore, in this dissertation we used an integrated multi-method approach in order to get a comprehensive understanding of the complex learning processes that occur in CSCL and in particular in virtual teams. In fact, we have integrated three methods to analyse the

complex dynamics of learning processes, namely: 1) content analysis of discourse; 2) social interaction patterns using social network analysis; and finally 3) role of intrinsic/extrinsic motivation in explaining differences in discourse and social interaction.

In particular the last method, whereby we combined the type of motivation of individual learners with the discourse and interaction processes in their virtual team is an important innovative step towards understanding the social interaction of learners in CSCL. According to Pintrich (2003), a key question in motivational science is to enhance our insights into how motivation of learners leads to cognition. In an commentary on a meta-review of 30 years of research on metacognition, self-regulation and self-regulated learning, Schunk (2008, p. 466) states that:

When meta-cognition, self-regulation, and self-regulated learning are assessed with self-report measures ... people may be unrealistic in their self-assessment of what they actually do. More reliable and valid data are obtained by observing people to determine how they actually are employing metacognitive and self-regulatory strategies as they work at academic tasks.

In particular in collaborative learning, Martens and colleagues (2004) argue that process of how motivation influences learning behaviour of students is not well understood. In a review of the role of motivation in collaborative learning, Järvelä and colleagues (2010, p. 16) push the argument of Martens and colleagues (2004) to another level and argue that:

Achieving [coordination in groups] is not an easy process, as each group member is a self-regulating agent with unique cognitions and emotions, which can create major challenges to motivation in social interactive contexts. Although the motivational beliefs of learning with others are well documented ... less is known about how motivation emerges and is sustained in collaborative learning activities.

Furthermore, addressing the role of the social when learners work and learn together in motivational theories is essential for Järvelä and colleagues (2010). In this manuscript and in line with recommendations of Järvelä and colleagues (2010) and others, we focussed on the role of motivation of learners on their behaviour in online groups. By linking the type of motivation of individual learners with their social interaction in online settings, we have addressed the *second challenge in CSCL* research (Järvelä et al., 2008; Järvelä et al., 2010; Järvenoja & Järvelä, 2005; R. Martens et al., 2004; Yang, Tsai, Kim, Cho, & Laffey, 2006; Zimmerman, 2008) in order to understand social interaction in groups and why learners differ in their willingness to contribute to cognitive and social discourse.

Therefore, in this manuscript we comprehensively analysed the learning processes in an online setting that allowed us to assess the role of personal

traits like motivation on the contributions to discourse and social interaction. More importantly and in line with the *third challenge in CSCL*, we looked for a setting where learners learn and work together in an authentic and relevant (i.e. for their future studies) learning environment (Norman & Schmidt, 2000; Pintrich, 2003; Van den Bossche, Gijsselaers, Segers, & Kirschner, 2006). Therefore, this manuscript was built upon the idea of offering online preparatory courses to prospective students. Since 2005, the Maastricht University School of Business and Economics has offered a range of preparatory courses for 1200+ prospective bachelor and master students in the field of economics (Giesbers, Rienties, Gijsselaers, Segers, & Tempelaar, 2009; Rienties, Tempelaar, Waterval, Rehm, & Gijsselaers, 2006), statistics (Tempelaar, Rienties, & Giesbers, 2009), mathematics (Tempelaar et al., 2006), finance, marketing and accounting. The primary aim of these courses was and is to help prospective students with deficiencies to increase their prior knowledge before entering their next step in higher education.

Given that these preparatory course students were aware of the fact that they had deficiencies before entering their first-year economics program, these students had a real incentive to participate. Furthermore, the duration and intensity of the course was sufficient in order to establish a group- or team identity (Van den Bossche et al., 2006; Wheelan & Lisk, 2000). These online courses were given over a period of six weeks in which participants were assumed to work for 10-15 hours per week. Finally, the participants never met face-to-face before or during the course and had to learn using the virtual learning environment “on-the-fly” (Rienties et al., 2006). In other words, the social interaction patterns that occurred resulted from the learning processes in the team rather than from previous established relations between learners. Hence, this setting provided a unique opportunity to assess how social interaction patterns develop in virtual teams and what the role of motivation in social interaction is as the learners had never met each other before and collaborated exclusively in the virtual learning environment. The overview of our approach to analyse the complex dynamics of social interaction in this manuscript is illustrated in Figure 6.1.

Figure 6.1 Overview of manuscript

1.1 Ecological validity of our setting

Before we could address the role of motivation on contributions to discourse and social interaction among learners in online settings, we first had to verify the ecological validity of the course design and the relevance of the economics online preparatory course in our research setting. Therefore, in Chapter 2 we explored the essential ingredients of effective preparatory course design by assessing the perceived learning satisfaction of two course designs, namely the self-directed learning design of the mathematics online preparatory course (Doignon & Falmagne, 1999; Tempelaar, Rienties, & Giesbers, 2009) and Problem-Based Learning (PBL) design of the economics online preparatory course (Barrows & Tamblyn, 1980; Hmelo-Silver, 2004). We defined four success factors for online preparatory course designs, namely: access and availability 24/7 online; adaptiveness; interaction; and rapid feedback (Rienties et al., 2006). These four success factors were confirmed by a recent literature review of European preparatory courses by Brants and Struyven (2009) and by a multiple correspondence analysis and two-step clustering analysis of 118 preparatory courses (Kaper, Rienties, Struyven, Tempelaar, & Van Gastel, 2009; Rienties, Kaper et al., Submitted). The results in Chapter 2 indicated that both preparatory course designs appeared to be successful in terms of better preparing students with deficient prior knowledge for their regular study. A similar remark refers to students' satisfaction based on the evaluation questionnaire: both courses and both pedagogical scenarios achieved positive evaluations on all criteria in the publication in *Industry and Higher Education*. A limitation of the results reported in Chapter 2 was that only the results of the first year of implementation were considered. However, consistently over the last five years, the 1200+ students who participated in the online preparatory courses were very positive about the course design, interaction, feedback, flexibility and support by the

instructors (Giesbers, Rienties, Gijssels et al., 2009). Since 2005, in almost all groups, courses and cohorts the average grades of the courses and instructors were above 8.0 on a scale from 1-10. In other words, the course design that was used for the rest of the manuscript was highly appreciated by the participants.

A second step in our analysis of an authentic and relevant online learning environment was that we needed to assess whether there were structural and longitudinal learning effects of our intervention. It may be that students are satisfied with the course but eventually do not enhance their knowledge and skills and do not perform better on the courses where they had difficulties. Therefore, in Chapter 3 we analysed the long-term learning effects of offering online preparatory courses to prospective students. The success of these courses was measured in a longitudinal study of the 850 participants in a first-year international business bachelor programme. We found empirical support that both courses improved study performance as well as study success. Not only did preparatory course participants perform better on the course where they previously had deficiencies, preparatory course participants also performed better than their peers after one year of study. Preparatory course participants passed one exam more compared to students who did not join any preparatory course and had 11% higher GPA than their peers. As a result, not only did learners appreciate the course design of these preparatory courses as described in Chapter 2 but these learners also performed better in their regular 1st year programme afterwards. Similar positive longitudinal learning results were found for the next cohorts of students who participated in the preparatory courses in the following years (Tempelaar et al., Submitted-a, Submitted-b). A propensity score matching of five cohorts of 552 mathematics preparatory course students were compared with 3851 other students on a range of learning attitudes, self-regulation, motivation and background characteristics. 50% of the learning effects of remedial education indeed were explained by more favourable learning attitudes of preparatory course participants, but the other 50% were actual learning effects of the preparatory course (Tempelaar et al., Submitted-a, Submitted-b). In the near future, we intend to conduct a similar analysis for the long-term learning effects of the economics preparatory course.

1.2 Role of motivation on social interaction in CSCL

After having established the ecological validity of our setting, we moved to the core part of this manuscript, namely understanding social interaction in CSCL by assessing the role of motivation on contributions to discourse and social interaction among learners in virtual teams. In Chapter 4 we looked into the effects of motivation of learners on their contribution to discourse using the Deci and Ryan (1985) framework of (intrinsic/extrinsic)

motivation. This study of 100 participants who were randomly distributed in six groups of 14 members collaborated in a virtual setting to remediate deficiencies in economics indicated that individuals differed with respect to the amount of discourse activity. An integrated multi-method model of Content Analysis (Veerman & Veldhuis-Diermanse, 2001), Social Network Analysis (Hurme et al., 2007; Wassermann & Faust, 1994) and Academic Motivation Scale (Vallerand et al., 1992) was used in order to examine the impact of academic motivation on the type of discourse activity contributed and on the position of the learner in the social network. We found that highly intrinsically motivated learners became central and prominent contributors to cognitive discourse. In contrast, extrinsically motivated learners contributed on average and were positioned throughout the social network. In other words, differences in academic motivation influences the type of contributions to discourse as well as the position a learner takes within the social network in our setting.

In Chapter 5, we continued the research of the role of academic motivation on the social interaction by distinguishing types of learners based upon their motivational profile. Three (self-directed) sub-groups were formed within virtual teams by a K-means cluster analysis of academic motivation measured by the AMS-instrument. Afterwards, the different motivational profiles were added to the social network of each virtual team. The research results revealed that the motivational profile influenced with whom a learner was interacting. Extrinsically motivated learners had a preference to connect to highly intrinsically motivated learners. However, intrinsically motivated learners preferred to discuss mainly among themselves, implying that extrinsically motivated learners received less feedback and discourse possibilities from other members within the virtual team (Rienties, Tempelaar, Giesbers, Segers, & Gijselaers, Submitted). Our findings might explain why in distance learning large differences in participation are found and why certain learners are more inclined to drop-out in class.

2. WHAT ARE THE IMPLICATIONS FOR EDUCATIONAL PRACTICE?

In a number of studies on online learning and CSCL, substantial differences in participation among learners are found (Caspi, Gorsky, & Chajut, 2003; De Laat et al., 2007; Schellens & Valcke, 2005). In our research, we have found that one important mechanism that may explain why learners differ in their willingness to contribute to discourse is their type (intrinsic/extrinsic) of motivation. Furthermore, the social interaction patterns between learners in virtual teams are (in part) influenced by the

type of motivation of learners. These findings are relevant for teachers, managers, admission officers and schedulers as the results imply the type of motivation has a moderately strong influence on the type of discourse and position within the social network when learners learn and work together in online settings. In our context of the economics online preparatory course, we found that intrinsically motivated learners are well-suited to be(come) active contributors to discourse. In addition, low-intrinsically motivated learners have considerable difficulties to actively participate to discourse. Furthermore, low-intrinsically motivated learners are more likely to position themselves on the outer fringe of the social network. Finally, in due time intrinsically motivated learners are becoming central contributors to discourse, while low-intrinsically motivated learners are more likely to stop participating or even drop-out of the online course. Given that most learners who enter university have a combination of metacognition, self-regulated learning and motivational strategies and attitudes (Järvelä et al., 2008; Järvenoja & Järvelä, 2005; T. Martens & Martens, 2009; Schunk, 2008; Tempelaar et al., Submitted-b; Tempelaar, Rienties, & Schim van der Loeff, 2009; Vallerand et al., 1992; Zimmerman, 2008), it is important for teachers to be aware of the influence of the learning environment on the motivation and behaviour of learners.

2.1 Using motivational science to understand and facilitate interaction

A first helpful tool for teachers to understand the complex dynamics of social interaction is to use the insights from motivational science to enhance learning (Boekaerts & Minnaert, 2003, 2006; Järvelä et al., 2010; Pintrich, 2003; Ryan & Deci, 2000). We suggest that teachers ask their students to fill in a motivation questionnaire before the beginning of the course. This can for example be the Academic Motivation Scale developed by Vallerand and colleagues (1992) or the Motivation and Self-regulated Learning Questionnaire developed by Pintrich and de Groot (1990). These two questionnaires focus on the motivational constructs of the self-directed learner. In contrast, recently two questionnaires have become available that also allow teacher to assess the role of motivation of individuals in groups. The Quality of Working in Groups Instruments developed by Boekaerts and Minnaert (2003, 2006) measures the situational interests of students who work and learn together in teams. The Adaptive Instrument of Regulation of Emotions (AIRE) developed by Järvenoja and Järvelä (2009) focuses on the students' personal goals for the collaborative task at hand and their socio-emotional perceptions. The above questionnaires can be used to assess what type of motivated learners teachers have in their course. In addition, it may be helpful to measure motivation several times during a course in order to follow the learning process of students. For example,

research by Martens and Martens (2009) indicates that using the QWIKI motivation questionnaires at several moments during a course can enhance intrinsic motivation of students.

In a review of a range of motivational theories, Pintrich (2003) has found 14 design principles to enhance motivation. One of the most important design principles of a course according to Pintrich (2003) is to provide clear and accurate feedback. By providing clear support and feedback to learners, teachers can actively stimulate competence and self-efficacy of students (Pintrich, 2003; Roth, Assor, Kanat-Maymon, & Kaplan, 2007; Ryan & Deci, 2000). In addition, by providing feedback on the process rather than on the content a teacher might actively encourage participation and deep-learning (Anderson, Rourke, Garrison, & Archer, 2001; Koehler & Mishra, 2005; Mazzolini & Maddison, 2003; Mishra & Koehler, 2006; Pintrich, 2003). Furthermore, by building a supportive and caring personal relationship with students will enhance self-efficacy of students (Anderson et al., 2001; Mishra & Koehler, 2006; Pintrich, 2003). In order to enhance motivation of students, providing clear tasks, materials and activities that are relevant and useful for students is an appropriate strategy (Arts, Gijssels, & Segers, 2002; Garrison, Anderson, & Archer, 2001; Pintrich, 2003). If a large number of extrinsically motivated learners are in a course, it might be helpful to extend the structure and regulation of the course (Legault, Green-Demers, & Pelletier, 2006; Roth et al., 2007). In contrast, when a large number of intrinsically motivated learners are in a course, providing too much regulation might be detrimental for the drive of learners (Ryan & Deci, 2000). Finally, when a mix of motivated students is present in an online course, a teacher can use AMS, MSLQ, QWIKI or AIRE to identify potential active contributors and low contributors. In this way, when for example extrinsically motivated learners are less active, the teacher can contact these students and use external stimulation in order to encourage extrinsically motivated learners to become more active. At the same time, using motivation questionnaires that measure perceptions of learners about the social group interaction processes may be another helpful mechanism for teachers to enhance and enrich the social interaction in their group.

2.2 Using SNA to understand and facilitate interaction

A second helpful tool for teachers to get a grip on the complex dynamics of social interaction in groups is to use Social Network Analysis (SNA) tools. That is, SNA can be used to assess who is contributing actively to discourse and can be used as a tool for teachers to identify learners on the outer ring of the social network (De Laat et al., 2007; Hurme et al., 2007; Martinez et al., 2003). In particular the number of links to other learners (i.e. ego-density) seems to be a good predictor of contributions to cognitive

discourse (Rienties, Tempelaar, Van den Bossche, Gijssels, & Segers, 2009). When learners are actively contributing to the comments of a learner, this is an indication that this learner is perceived by others as a “good” student (Rienties, Tempelaar et al., Submitted). Furthermore, learners who are central in the network perform better on cognitive discourse (Rienties et al., 2009) and learning outcomes like exams (Russo & Koesten, 2005) than students on the outer ring of the network. When a learner receives limited replies from others, a teacher might need to step in and help/encourage/stimulate this learner (De Laat et al., 2007; Mazzolini & Maddison, 2003; Mishra & Koehler, 2006). For example, if the way in which the message is structured or written is unclear, then the teacher might provide assistance to this learner so that the learner is more likely to receive response from others afterwards (Anderson et al., 2001; Mishra & Koehler, 2006). Alternatively to the SNA method, simple log-file tools of activity of students may provide a helpful tool for teachers to identify potential drop-outs.

3. WHAT IS NEXT?

3.1 Redesigning the pedagogical scenario to enhance discourse for all learners

Appropriate strategies to deal with the complex dynamics of social interaction in online settings should be developed. First and foremost, future research should investigate the impact of metacognition, self-regulated learning and motivation of learners on the behaviours of learners in CSCL. This can for example be analysed by distinguishing various types of learners using cluster analytic methods (Tempelaar, Rienties, & Schim van der Loeff, 2009; Veermans & Lallimo, 2007) or by integrating a range of personal traits measures of learners with their behaviour in online settings (Tempelaar, Rienties, & Giesbers, 2009, Work in progress). In addition, by analysing how learners mutually influence each other in collaborative learning (Järvelä et al., 2010; Järvenoja & Järvelä, 2005; Järvenoja & Järvelä, 2009), future research should assess how motivation and self-regulation of one learner influence the behaviour of others in groups.

Second, design experiments should be conducted in order to assess how social and cognitive processes and teacher regulation are intertwined. Therefore, in line with recommendations of Mishra and Koehler (2006) and Garrison and colleagues (2001) we have redesigned the learning environments described in this manuscript in two phases in 2007-2009 in order to try to facilitate intrinsic as well as extrinsic learners to effectively learn in online settings. In the summer of 2007, in line with common practice in CSCL (Beers, Boshuizen, Kirschner, & Gijssels, 2005;

Garrison et al., 2001; Weinberger & Fischer, 2006) we scaffolded the cognitive learning processes in order to increase the amount of higher-cognitive discourse contributed by each learners. By further clarifying the various (cognitive) steps that learners have to take in solving a task in a Problem-Based Learning setting using the Optima model (Giesbers, Rienties, Bedlovic, & Gijsselaers, Submitted; Segers, Van den Bossche, & Teunissen, 2003) and by increasing teacher presence (Garrison, Anderson, & Archer, 2000), we expected that more learners would contribute to discourse. In addition, we expected that extrinsically motivated learners would be more inclined to contribute in the Optima model than in the design described in this manuscript.

This research of redesigning the learning environment using the Optima model addresses the third emergent question in the review of self-regulation and motivation of Zimmerman (2008), namely how can teachers adjust the learning environment to enhance self-regulated learning and motivation of students. That is, by providing more structure and regulation on the co-construction of knowledge (Boekaerts & Minnaert, 2006; Ryan & Deci, 2000), we hoped to stimulate all types of learners to actively contribute to (cognitive) discourse. However, our preliminary findings indicate that students using the Optima model were less satisfied with the course design, contributed three times less to discourse than in the previous years and were less likely to complete the course (Giesbers, Rienties, Bedlovic et al., Submitted). In addition, learners in the Optima design contributed less social and (higher) cognitive discourse than in the design described in this manuscript. In other words, contrary to our expectations in our setting the Optima redesign led to inferior learning processes and learning outcomes.

Finally, given the availability of new and promising Web 2.0 tools that allow for a rich learning experience in an online class setting, we need to assess the affordances and limitations of these tools for collaborative learning. In the summer of 2008 and 2009, we have used the successful pedagogical scenario of the old summer courses (see Chapter 2 & 3) but added a weekly web-videoconference in order to increase social presence, that is the ability to express emotion using CSCL, and teacher presence (Dennis, 2008; Garrison et al., 2000; Giesbers, Rienties, Gijsselaers et al., 2009; Giesbers, Rienties, & Tempelaar, 2009; Gillies, 2008). With the rapid development of user-friendly software and the increasing availability of bandwidth, an increasing number of companies are developing rich online classrooms that allow students and teachers to learn in a synchronous manner. An example of such a rich learning environment is illustrated in Figure 6.2.

Figure 6.2 Rich online classroom using web-videoconference

In Figure 6.2, six students and two tutors worked together in a rich online classroom (Giesbers, Rienties, Gijsselaers et al., 2009). Most participants present used a webcam, while one student participates without webcam but without visual information (highlighted by number 1). Several students used a webcam and audio and at the same time use chat (the chatbox is indicated by number 2). Using audio with a web-camera offers more personal and affective information about a person (moods, tone of feedback, intonation, visual expression, etc.) than non-visual communication such as chat (Dennis, 2008; Häkkinen & Järvelä, 2006). Finally, the whiteboard (highlighted by number 3) allowed participants to draw, to make graphs or mind maps (Giesbers, Rienties, Gijsselaers et al., 2009).

In this way, we expected that low-intrinsically and high extrinsically motivated students would be more inclined to contribute than in the pedagogical scenario of the courses analysed in this manuscript. First of all, the teacher has more control over the learning process and has more opportunities to monitor and support the learners (Bromme, Jucks, & Runde, 2005; De Laat et al., 2007). Secondly, extrinsically motivated learners will be able to get more support, feedback and regulation from teachers in this setting (Pintrich, 2003; Ryan & Deci, 2000). Thirdly, by providing more social presence we expected in line with social presence

theory that students would be more inclined to participate than when learners only use discussion forums. Although the technology and infrastructure are in place for rich online learning, research by Giesbers and colleagues (2009) indicates that students who used the web-videoconference in combination with discussion forums were less satisfied about their own learning and the learning in their group in comparison to students who only used discussion forums as described in this manuscript. In other words, although the possibilities of IT to allow learners to work and learn together and establish social presence in online settings are increasing, considerable research and practical experience is still needed in order to determine the success factors for effective online teaching and learning. Currently, we are analysing whether the use of videoconferences leads to more cognitive discourse by all learners than in the old summer courses (Giesbers, Rienties, Gijssels et al., 2009; Giesbers, Rienties, & Tempelaar, Submitted). Based on our findings, we will continue to redesign the learning environment to capitalise on the merits of social interaction, peer-support and planning of learning processes. In addition, our recent research (Carbonell, Rienties, & Van de Bossche, Submitted; Giesbers, Rienties, Gijssels et al., 2009; Hernández Nanclores, Rienties, & Giesbers, 2009) focuses more on the complex dynamics of social interactions in blended and virtual teams and under which conditions interactions lead to effective co-construction of knowledge.

3.2 Replicating our findings in other contexts

For the validity and reliability of our findings, it is important to conduct similar analyses in different contexts and institutions. The positive results in this manuscript with respect to learning satisfaction and learning outcomes and at the same time our finding that the dynamics of social interaction are related to motivational profiles might be limited to our context and thus the generalisation of our findings might be limited. We hope that other researchers will use our insights and validate them in their settings and contexts. Furthermore, we will continue to test, validate and re-validate our findings in our own research. For example, in the EU-project Studies on Transitional Electronic Programmes (S.T.E.P.)¹ we have analysed on a European level the success ingredients of online and blended preparatory courses. Our findings indicate that the role of the pedagogical scenario used is at least as important as the choice of IT tools (Brants & Struyven, 2009; Kaper et al., 2009; Rienties, Kaper et al., Submitted). In the Dutch SURF NAP Acculturation-project we are currently conducting research on the appropriateness of online preparatory courses developed by nine Dutch higher educational institutes. All nine institutes developed a range of

preparatory courses to facilitate international students to remediate deficiencies and at the same time become aware of cultural differences between international and local students (Rienties, Grohnert, Niemantsverdriet, Kommers, & Nijhuis, 2010). The learning processes and learning outcomes were assessed with the same measurements across all institutes. This will allow us to assess what type of pedagogical scenario in combination with which IT tools in which context (De Laat et al., 2007; Garrison et al., 2001; Mishra & Koehler, 2006; Rienties, Kaper et al., Submitted) is effective for preparatory teaching.

One of the most difficult elements in the equation of online learning is the role of the teacher. In this manuscript, we primarily focused on the social interaction among students. However, the role of the teacher for establishing a safe and constructive environment is crucial. Therefore, in the SURF MARCHet project we will conduct research on how to effectively train teachers in making appropriate choices with IT among six higher educational institutes.

Finally, in a Maastricht University-wide project Learning and Working we will conduct research in a professional context, whereby eight schools and faculties will implement pilots and programs for executive teaching and training in blended and online settings. For all these projects we will continue to conduct research on the influence of personal traits on interaction in online learning environments. Thus, the manuscript is just a first stepping stone for more research on understanding social interaction in Computer-Supported Collaborative Learning.

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ⁱ <http://www.unimaas.nl/onlinepreparatorycourse/>. The online preparatory courses are structurally supported by Maastricht University. In addition, the initial courses were developed and implemented as part of the following national and European projects: SURF Web-spijkeren (<http://www.web-spijkeren.nl/>), SURF Web-spijkeren 2 (<http://www.web-spijkeren2.nl/>), SURF NAP Acculturatie (<http://www.acculturation.nl/>), SURF NAP NKBW and NKBW2 (<http://www.nkbw.nl/>), E-Merge Competentie-gericht toetsen (<http://www.e-merge.nl/index.php?id=398>), EU MINERVA M.A.S.T.E.R. (<http://www.masterproject.info/>), EU KA3 ICT S.T.E.P. (<http://www.transitionalstep.eu/>). The new courses are developed in the NAP acculturatie project (<http://www.acculturation.nl/>), Leren en Werken and SURF MARCHet (<http://www.marchet.nl/>)

SAMENVATTING

In dit proefschrift worden een aantal studies beschreven op het gebied van computerondersteund samenwerkend leren, in het Engels beter bekend als Computer-Supported Collaborative Learning (CSCL). In het bijzonder richten we ons in dit proefschrift op het begrijpen van de complexe dynamieken in sociale interactie van studenten die samen leren in een online context. In het verleden lag de nadruk van CSCL onderzoek vaak op het vergelijken van ICT tool X met ICT tool Y, of het vergelijken van een online onderwijscontext ten opzichte van een fysieke context. Hoewel dergelijke vergelijkingsonderzoeken waardevolle informatie opleveren over de meerwaarde van een bepaalde tool of onderwijsmethode blijkt het in de praktijk niet vanzelfsprekend om studenten en lerenden effectief met elkaar te laten samenwerken in een online context. In toenemende mate zijn daarom onderzoekers binnen CSCL bezig met het onderzoeken van de onderliggende complexe dynamieken van leren en onderwijzen in online omgevingen. In dit proefschrift kijken we specifiek naar de onderliggende variabelen die de dynamieken van online teams ondersteunen of juist belemmeren.

Recent onderzoek heeft aangetoond dat verschillende methoden en technieken noodzakelijk zijn om de complexe dynamieken van leren in online omgevingen bloot te leggen, te analyseren en te begrijpen. In hoofdstuk 1 wordt dit aangeduid als de *1ste uitdaging binnen CSCL*. Weinig onderzoek binnen CSCL heeft onderzocht hoe sociale interactie van lerenden gerelateerd is aan sociale en cognitieve bijdragen tot discussie. In dit proefschrift proberen we door het gebruik van een multi-methode benadering juist de complexe dynamieken van online teams in CSCL beter te begrijpen. We hebben drie verschillende methodes geïntegreerd om de complexe dynamieken van leerprocessen in teams bloot te leggen, namelijk: 1) inhoudsanalyse van de bijdragen in discussieforums (wat zeggen studenten tegen elkaar); 2) sociale interactie patronen door middel van Sociale Netwerk Analyse (wie praat er met wie); 3) de rol van intrinsieke en extrinsieke motivatie in het verklaren van verschillen in bijdragen tot discussie en sociale interactie. Met name de derde stap in de multi-methode benadering is een belangrijke innovatieve stap om de sociale interactie van lerenden in CSCL beter te begrijpen.

In veel online cursussen en programma's worden er grote verschillen gevonden in het aantal bijdragen als mede de kwaliteit van de bijdragen door studenten en lerenden, in hoofdstuk 1 aangeduid als de *2^{de} uitdaging binnen CSCL*. Door het linken van het type motivatie van student met de

sociale interactie patronen in CSCL proberen we de 2^{de} uitdaging binnen CSCL te doorgronden. In dertig jaar onderzoek naar de rol van motivatie naar leren komt naar voren dat motivatie van studenten een van de belangrijke factoren zijn voor effectief studeren.

Als 3^{de} uitdaging binnen CSCL hebben we ons onderzoek gepositioneerd in een setting waarbij studenten samen leerden en werkten aan relevante problemen in een authentieke context. Deze lerenden, aankomende buitenlandse economie studenten in onze context, werken en leren samen in online teams voor een periode van vier tot zes weken. Veel onderzoek binnen CSCL vindt plaats in experimentele settings waar studenten voor een korte periode van 15-60 minuten samen online moet werken. Deze experimenten zijn vaak losgekoppeld van het leerprogramma van de studenten. Daarnaast worden deelnemers vaak voor dergelijke experimenten betaald, wat een invloed heeft op hun motivatie. Echter, een belangrijke bevinding in de literatuur van groepsontwikkeling is dat het opbouwen van vertrouwen en rolpatronen binnen groepen of teams (veel) tijd kost, soms wel maanden. Zeker in een online context komt uit de literatuur en onze eigen ervaringen naar voren dat er veel aandacht besteed moet worden aan het opbouwen van vertrouwen in een sociale en veilige leeromgeving.

Daarnaast wordt er veel CSCL onderzoek gedaan in de context van psychologie of onderwijskunde. Hoewel deze context veel belangrijke bevindingen heeft gegeven over de dynamiek van leren in teams, is het maar de vraag of in andere contexten vergelijkbare bevindingen worden gevonden. In de context van onze online zomercursus werkten aankomende studenten met een kennisachterstand op economie samen aan praktijkgeoriënteerde problemen binnen de economische wetenschap. Sinds 2005 biedt de Universiteit Maastricht een waaier van online voorbereidingscursussen aan voor aankomende bachelor en master studenten. Het belangrijkste doel van deze cursussen is om aankomende studenten met kennisachterstanden bij te spijkeren en daarmee een succesvolle start in het hoger onderwijs aan te bieden.

Gegeven dat de online zomercursus studenten bewust waren van hun kennisachterstanden hadden zij een echte impuls/reden om mee te doen aan de cursus. Daarnaast, de cursusduur van 4-6 week geeft voldoende kans om de dynamieken van teams te laten bloeien. Als laatste is het belangrijk om te vermelden dat de deelnemers elkaar nooit vooraf fysiek waren tegengekomen. Met andere woorden, de sociale interactie patronen die ontstonden in onze setting zijn het gevolg van leerprocessen binnen het team en niet veroorzaakt door eerder ontwikkelde relaties tussen studenten. Op deze manier proberen we in dit proefschrift de drie

uitdagingen aan te gaan en de onderliggende dynamieken van sociale interactie binnen CSCL beter te begrijpen.

In hoofdstuk 2 onderzoeken we de ecologische validiteit van onze onderzoeksomgeving. Gezien het feit dat online bijspijkeronderwijs in Nederland rond 2005 nog nauwelijks vaste bodem had gekregen, is het belangrijk om vast te stellen of het onderwijskundig concept van online bijspijkeronderwijs door studenten als waardevol wordt ervaren. In hoofdstuk twee vergelijken we de toepassing van twee onderwijskundige concepten, namelijk individueel zelfgestuurd leren (in de vorm van wiskunde bijspijkeronderwijs) en probleemgestuurd leren (in de vorm van economie bijspijkeronderwijs) met in groepen. In de wiskunde cursus waren er 55 participanten, terwijl in de economie cursus 50 participanten deelnamen. Op basis van de ervaringen in de twee cursussen en literatuuronderzoek hebben we vier succesfactoren voor effectief online bijspijkeronderwijs gedestilleerd, namelijk: toegang tot leeromgeving 24/7; adaptiviteit; interactie; en snelle feedback. Deze vier succesfactoren zijn recentelijk bevestigd door een literatuur review van bijspijker cursussen in Europa en door een twee-staps cluster analyse van 118 bijspijker cursussen uit 24 landen. De resultaten in hoofdstuk 2 laten zien dat het ontwerp van beide bijspijker cursussen effectief is in het wegwerken van deficiënties bij studenten. Daarnaast zijn studenten zeer positief over de cursussen en hun onderwijskundig ontwerp op basis van een evaluatievragenlijst. Een beperking in hoofdstuk 2 is dat de grootte van de twee cohorten relatief klein zijn in de beschreven publicatie. Inmiddels hebben in de laatste vijf jaar zo'n 1200 studenten deelgenomen aan verschillende bijspijker cursussen en de meeste studenten geven gemiddeld de cursussen, docenten en interactie een cijfer van 8 op 10. Met andere woorden, het ontwerp van de cursussen die gebruikt worden in de rest van dit manuscript zijn door studenten als zeer waardevol gevonden.

In hoofdstuk 3 onderzoeken we de twee stap in onze analyse of onze onderzoeksomgeving een authentieke en relevante leeromgeving is voor studenten. Daarom onderzoeken we de longitudinale leereffecten van de twee bijspijker cursussen. De leerwinst van de 100+ studenten die deelgenomen hadden aan een van de twee bijspijker cursussen is vergeleken met 750 andere eerstejaars studenten internationale bedrijfskunde. De resultaten geven aan dat beide cursussen het studiesucces van de bijgespijkerde studenten heeft verhoogd. Niet alleen presteerden de bijgespijkerde studenten beter op de cursus waar ze oorspronkelijk deficiënties hadden, maar de bijgespijkerde studenten presteren aan het einde van het jaar beter dan hun "peers". Bijspijker studenten halen gemiddeld één examen meer dan hun peers en behalen 11% hogere gemiddelde cijfers. Met andere woorden, niet alleen zijn bijspijker studenten tevreden over de cursus maar presteren ze ook

beter in het reguliere vervolgprogramma. Vergelijkbare resultaten zijn gevonden in de daar opvolgende cohorten van bijspijkerstudenten.

Nadat we de ecologische validiteit van onze setting in hoofdstuk 2 en hoofdstuk 3 hebben vastgesteld kunnen we verder met de kern van dit manuscript, namelijk het begrijpen van sociale interactie in CSCL door de rol van motivatie op bijdrages van studenten in online teams. In hoofdstuk 4 hebben we gekeken naar de effecten van motivatie van studenten op hun bijdragen in discussieforums. In deze studie met 100 participanten die willekeurig over zes teams van 14 leden zijn verdeelt voor de economie cursus verschillen significant op bijdrages aan discussie. Een geïntegreerd multi-methode model van een inhoudsanalyse van de bijdragen in discussieforums, Sociale Netwerk Analyse en academische motivatie is gebruikt om de invloed van academische motivatie te onderzoeken op het type bijdrage als mede de positie van de student in het sociale netwerk. De resultaten wijzen uit dat intrinsiek gemotiveerde studenten centraler in het sociale netwerk staan en actiever bijdragen aan (hogere cognitieve) discussies. Extrinsiek gemotiveerde studenten daarentegen zijn verspreid gepositioneerd in het sociale netwerk. Met andere woorden, in hoofdstuk 4 laten we zien dat verschillen in academische motivatie het type bijdragen als mede de positie van studenten in het sociale netwerk beïnvloed.

In hoofdstuk 5 duiken we nog dieper in de rol van academische motivatie en sociale interactie door studenten te splitsen op basis van hun motivatie. De centrale vraag in hoofdstuk 5 is in hoeverre studenten willekeurig met elkaar interacteren, of is er een onzichtbare hand die interactie met sommige studenten aantrekkelijker maakt dan met anderen? Op basis van een K-means cluster analyse van academische motivatie formeren we drie subgroepen die vervolgens toegevoegd zijn aan het sociale netwerk van ieder van de zes virtuele teams. De resultaten geven aan dat extrinsiek gemotiveerde studenten een voorkeur hebben om te discussiëren met intrinsiek gemotiveerde studenten. Echter, intrinsiek gemotiveerde studenten hebben een sterke voorkeur om met andere intrinsiek gemotiveerde studenten te discussiëren in onze context. Met andere woorden, er is een onzichtbare hand die het aantrekkelijk maakt om met sommige studenten wel en met andere studenten niet te discussiëren. Deze onzichtbare hand leidt er toe dat extrinsieke gemotiveerde studenten minder reacties ontvangen en feedback op hun bijdrages. Sociale interactie en “co-constructie” van kennis tussen studenten is een belangrijke voorwaarden voor leren in groepen. Onze bevindingen wijzen uit dat studenten met extrinsieke motivatie minder bijdrages “uitlokken” en daardoor minder feedback krijgen op hun leerproces. Dit kan een mogelijke verklaring zijn waarom in de literatuur van online onderwijs er vaak grote verschillen zijn in interactie in online leeromgevingen als mede vaak lage slagingspercentages.

Wat zijn nu de praktische implicaties van dit proefschrift? Een belangrijke bevinding in dit proefschrift is dat het type motivatie een sterke invloed heeft op bijdrages tot discussie als mede op sociale interactie tussen studenten. Voor docenten, verroosters en managers is het belangrijk te realiseren dat motivatie een invloed heeft op het gedrag van studenten in teams. Met name laag extrinsiek gemotiveerde studenten hebben veel moeite om actief bij te dragen aan discussies in online contexten. Bovendien bevinden (laag) extrinsiek gemotiveerde studenten zich vaker op de rand van het sociale netwerk omdat ze minder reacties uitlokken van medestudenten. Uiteindelijk lopen zij het risico om uit te vallen in de cursus. Docenten kunnen door middel van motivatievragenlijsten actief de motivatie van studenten meten, waardoor op maat gemaakte begeleiding beter tot zijn recht komt. Daarnaast kan het gebruik van log-files als mede sociale netwerk analyse een hulpmiddel zijn voor docenten om gedurende een cursus mogelijke “uitvalkandidaten” te traceren. Door deze studenten actief te benaderen kan de docent proberen om de studenten te stimuleren om meer of andere type bijdrages te geven en te voorkomen dat deze studenten uitvallen. Bijvoorbeeld, een docent kan navragen waarom een student weinig bijdraagt en of alles goed is met de thuissituatie, of het duidelijk is wat van de student verwacht wordt in de cursus, etc. Ook het geven van advies hoe je een bijdrage opstelt die veel reactie van andere studenten uitlokt kan een hulpmiddel zijn om “uitvalkandidaten” in online teams meer bij de sociale interactie te betrekken.

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Bart Rienties was born on 28th of July 1976 in Terneuzen, the Netherlands. He has obtained a Master of Arts degree in International Economics Studies in 2000 at Maastricht University. In 2000, he started his career as junior teacher at the department of Economics at Maastricht University. In 2002, he joined the ELEUM e-learning project innovation team in order to establish an effective e-learning environment for Maastricht University.

From 2006 onwards, he moved to the department of Educational Research and Development at Maastricht University. Bart Rienties is researcher of effective use of E-learning and project manager at Maastricht University of several national and European E-learning innovation projects. He leads a research and development team that has implemented and evaluated new tools that enhance learning in virtual groups. These projects are developing innovative pedagogical approaches to tackle knowledge deficiencies, lack in competencies or problems with self-efficacy of prospective international bachelor and master students as well as professionals. He received several awards for his educational innovation projects and was nominated three times as best teacher. Next to his educational innovation projects and research, he consults higher Education institutes on the implementation of collaborative e-learning environments. Finally, he is chair of the international EDINEB Network.

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