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Investigating the Relations between Motivation, Tool Use, Participation, and Performance in

an E-learning Course Using Web-videoconferencing

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Abstract

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

Keywords: e-learning, synchronous communication, web-videoconference, technology acceptance, self-determination theory, academic motivation

1. Introduction

E-learning tools become increasingly rich, and offer more opportunities for synchronous communication resembling face-to-face situations. For instance, web-videoconference tools like Skype or Adobe Connect facilitate real-time communication through audio, video, chat. A particular feature of web-videoconferencing is that users can actively determine and decide whether to use audio, voice, chat, and video tools (Garcia, Uria, Granda & Suarez, 2007), which is substantially different from earlier tools like discussion forums, where users were restricted to a single (text-based) functionality. It has further been proposed that tools that foster more direct social interaction and feedback amongst learners and teachers would foster higher levels of learner engagement (Carr, Cox, Eden, & Hanslo, 2004; Hrastinski, Keller, & Carlsson, 2010; Strømsø, Grøttum, & Lycke, 2007). An elaborate meta-analysis of interaction types in distance education (Bernard, Abrami, Borokhovski, Wade, Tamim, Surkes, & Bethel, 2009) showed that increasing either one of three interaction types (i.e. student-student, student-content, or student-teacher) increases learner engagement (see also Anderson, 2003). So, if tools foster interaction and interaction fosters engagement, one would expect that the richer the available tools are, the higher the levels of learner engagement. However, research has also suggested that it is the *actual* use of tools and the resulting interactions in the learning situation which are related to students' motivation (Roca & Gagné, 2008; Sørebø, Halvari, Gulli, & Kristiansen, 2009). Therefore, we investigated the relationship between available tools used, student motivation, participation, and performance on a final exam, in the context of a distance education program in economics for prospective university students. Because participation was voluntary, this context offers a unique possibility for studying the role of student motivation and student engagement (defined here as the extent of tool use and participation). This may foster our understanding of how

different types of learners engage and interact with available tools, and may ultimately contribute to guidelines for optimizing synchronous e-learning.

1.1 Technology Acceptance and Motivation

One factor that is considered pivotal in the degree to which students will use ICT tools is their acceptance of technology. The Technology Acceptance Model (Davis, 1989) is a commonly used model, and aims to predict the intention to use ICT. TAM is founded on the well-established Theory of Planned Behaviour (Ajzen, 1991), which explains human behaviour by stating that it is directly preceded by the *intention* to perform this behaviour. Intention, in turn, is influenced by three factors: personal beliefs about one's own behaviour, ones norms, and the amount of behavioural control one has. Building on this theory, TAM states that the intention to use ICT is influenced by two main factors: the perceived usefulness (the extent to which a person believes the use of ICT will, for example, enhance his or her performance on a course) and the perceived ease of use (the perceived effort it would take to use a particular communication tool like a webcam). Furthermore, research has shown motivation to be a key mediator for behavioural intention to use ICT (Davis, Bagozzi, & Warshaw, 1992; Venkatesh, Morris, Davis, & Davis, 2003).

Only recently has the link between technology acceptance and motivation been made in the domain of e-learning, more specifically in computer-supported collaborative learning (CSCL; Roca & Gagné, 2008; Sørebø, et al., 2009), by linking TAM with self-determination theory (SDT; Deci & Ryan, 1985, 2002). Self-determination, which is understood as the extent to which learning is perceived to be self-steered and autonomous, has been found to be a dominant factor that influences learning behaviour in various settings, including in e-learning settings (Chen & Jang, 2010; Rienties, Tempelaar, Van den Bossche, Gijselaers, & Segers, 2009). Self-determination is strongly related to motivation (Vallerand, 1997), or in terms of SDT "is specifically framed in terms of social and environmental factors that

facilitate versus undermine intrinsic motivation" (Ryan & Deci, 2000, p. 58). Intrinsically

motivated learners are also referred to as 'autonomous', as they typically engage in learning

because they find it enjoyable or challenging and they have an internally focused locus of

causality (Black & Deci, 2000). Extrinsically motivated learners are referred to as 'control

oriented', as they feel they have limited control over their learning process.

According to SDT, motivation is not a dichotomous construct where students either

have an intrinsically or extrinsically directed drive (Deci & Ryan, 1985). Instead, extrinsic

motivation is perceived as a continuum of types differing in how close they are to intrinsic

motivation and vice versa. Self- determination has been shown to explain differences in

amount and quality of students' e-learning activities (Chen, 2010; Martens, Gulikers, &

Bastiaens, 2004; Rienties, et al., 2009). For example, Martens et al. (2004) showed higher

activity levels in online tasks when students were more intrinsically motivated. In addition,

the quality of contributions to discussion forums in online courses have been found to be

higher for more intrinsically motivated students (e.g. Rienties et al., 2009).

SDT states that motivation and well-being are determined by the extent to which three

basic needs are satisfied: the need for autonomy (i.e., the extent to which a learner feels in

control), the need for relatedness (i.e., the extent to which a learner feels included), and the

need for competency (i.e., the extent to which a learner feels competent with respect to tasks

and learning activities). All three needs are affected by contextual factors, like the interaction

between learners, teachers, and the learning material (Deci & Ryan, 2000). Because of the

nature of e-learning, processes such as monitoring classroom activity, providing timely

feedback, and fostering students' sense of competence, autonomy, and relatedness are

different from face-to-face education (Chen & Jang, 2010). However, research in face-to-face

education showed that offering autonomy support and structure profoundly influence student

engagement (Guay, Ratelle, & Chanal, 2008; Jang & Deci, 2010), and similar results have been found in e-learning (Chen & Jang, 2010; Rienties, et al. 2012).

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

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

participating due to competing activities, such as work, family or leisure (see Bernard et al., 2004; Marks, Sibley & Arbaugh, 2005). So the question is what role motivation plays in actual participation and actual tool use during participation. Therefore, the present study investigated the link between observed student behaviour (i.e. how often students participate and what tools they use), motivation, and performance on a final exam in the context of a facultative course.

1.2 The Present Study

Previous research has already shown that the combination of the theoretical frameworks of SDT and TAM was useful for explaining the relation between motivation and the *intention* to continue e-learning usage, but without specifying if the e-learning context used synchronous or asynchronous communication (e.g., Roca & Gagné, 2008; Sørebø et al., 2009). The present study uses the combination of those theories as a starting point to address the *actual* usage of *synchronous* tools. The model depicted in Figure 1 shows the variables in this study and their assumed relations.

Insert Figure 1 about here

Regarding the relation between the level of motivation and the actual use of web-videoconference, two hypotheses can be stated building on the findings by Davis (1992), and Roca and Gagné (2008) about the relationship between motivation (SDT) and the intention to use ICT (TAM): first, it can be hypothesized that higher levels of autonomous motivation would be associated with higher participation in web-videoconferences (H1), and secondly, that higher levels of autonomous motivation would be associated with the use of richer communication tools when taking part in a web-videoconference (H2).

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

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

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

2. Method

2.1 Participants and Design

Participants were students in a facultative summer course in economics for prospective Bachelor students of an International Business degree programme at a Dutch business school, which was offered entirely online and aimed to bridge potential gaps in prior knowledge of economics. This summer course is part of a wider summer course program that has been offered since 2004 to over a thousand students and has been fully integrated in the admission

and application processes of the respective business school (See Rienties et al., 2009; 2012; Rienties, Tempelaar, Waterval, Rehm, & Gijselaers, 2006). Participants who successfully completed the summer course have been found to be more likely to successfully complete the first year of the Bachelor program (Rienties, Tempelaar, Dijkstra, & Gijselaers, 2008; Tempelaar, Rienties, Kaper, Giesbers, Schim van der Loeff, van Gastel, et al., 2012). All students who subscribed to the Bachelor program were informed of the possibility to participate in this course via a letter with information about the course and a link to a prior knowledge test. Based on their score on the prior knowledge test, students could decide to voluntarily enrol. Students with a low prior knowledge score who did not enrol received a follow-up e-mail recommending enrolment. The prior knowledge test was used for enrolment purposes only, and as the majority of students in the course had a low level of prior knowledge, it was not taken into account in the remainder of this study.

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

2.2 Materials and Procedure

2.2.1 Online preparatory course

The course design was based on principles of Problem-Based Learning (PBL, for a recent review of PBL, see Loyens, Kirschner, & Paas, 2011) by letting groups of students collaboratively solve six authentic problems: two introduction tasks addressing basic economic concepts, two tasks about micro-economics, and two tasks about macro-economics. The web-videoconference process was structured in a manner similar to the face-to-face courses in the Business degree programme, according to the PBL Seven-Jump model (see Schmidt & Moust, 2000; Segers, van den Bossche, & Teunissen, 2003). The original model was adapted slightly to accommodate the online setting (Rienties et al., 2009; 2012) , and required students to: 1) identify difficult terms; 2) identify the main problem(s) and brainstorm to formulate learning goals; 3) start to solve the learning goals by referring to personal experience, course literature and/or additional literature; 4) elaborate on the findings in the previous step; 5) reach agreement on the answers through discussion, 6) check if all learning goals are answered and; 7) summarize the main points of the entire discussion. This process is guided by a tutor.

The course ran for a maximum of six weeks and had an estimated study load of 10 to 15 hours per week. In the first four weeks, there were weekly web-videoconferences, in which participation was voluntary but encouraged by asking the tutor for a rating of each student's contributions which counted as 10% of that student's final grade for the course (not to be confused with their final test score used in this study).

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

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

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

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

2.2.2 Final exam

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

2.2.3 Academic Motivation Scale

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

2.3 Data Scoring

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

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

3. Results

We will first provide some relevant descriptive data before testing the hypotheses. Figure 2 shows the amount of participation and use of communication tools during the four web-videoconferences.

Insert Figure 2 about here

From the total of 110 participants, 18 never attended a web-videoconference; 27 attended

once; 27 attended twice; 16 attended three times and 22 students attended all four

videoconferences. Because there is a limited amount of groups and because each group was

relatively small, effects nearing significance (i.e. a significance level of $p < .1$) will also be

mentioned.

The first web-videoconference was attended by 70 % ($n = 87$) participants. Most

participants present used all communication tools; a little over 12 % chose not to share visual

information with the rest of the group but did use audio and chat; the same amount of

participants chose to use chat only, and a minority of 5 % combined the use of webcam with

chat but did not participate by using audio. Over time, participation rates decreased, but

interestingly, the percentage of participants using webcam, audio, and chat remained almost

the same. An additional look at the continuity of tool use shows that from the students who

participated all four times, 30% consistently used webcam, audio, and chat and 60% used it

three out of four times. In all web-videoconferences, all participating students communicated;

only one student consistently used chat and one used chat only in three web-videoconferences

plus chat in combination with webcam once.

Table 1 shows the correlations between the variables in our research model (displaying

Spearman correlation coefficients because of the use of both continuous and categorical

variables). Two subscales of the AMS related to intrinsic motivation (IMTK and IMTA) show

significant positive correlations with number of web-videoconferences participated, as well as

with the final test score. This suggests that intrinsic motivation was positively related to the

choice to participate in a web-videoconference. The average tool use, however, did not

correlate significantly with any of the independent motivation subscales. In addition, there

was a high significant correlation between the number of web-videoconferences participated

in and the final exam score. Also, the average tool use correlated significantly with the final

exam score.

Insert Table 1 about here

Finally, 55 % of the participants ($n = 60$) did not take the final exam. This group

contains both students who did not participate in any of the videoconferences and students

who did participate once or more (see Figure 3). An independent samples t-test shows a

significant difference at the .1 level of significance only on the scores of the AMS intrinsic

motivation to accomplish (IMTA) subscale between students who did not take the final exam

($M = 4.77$, $SD = .99$) and students who did ($M = 5.11$, $SD = 1.07$), $t(108) = 1.71$, $p < .1$).

Insert Figure 3 about here

3.1 Motivation, Participation, and Tool Use

Table 2 presents the means and standard deviations of motivation, participation and

tool use. To test our first hypothesis that higher levels of autonomous motivation would be

associated with higher participation in web-videoconferences, an ANOVA on AMS subscales

with number of times participated as the independent variable was conducted. It showed a

significant difference on the IMTA subscale, $F\,(4,105) = 2.55$, $p < .05$. Post-hoc tests showed

that students participating in four web-videoconferences had significantly higher scores on the

IMTA subscale than students who did not participate ($p < .05$), or who participated once ($p <$

.01) or twice ($p < .05$). Differences on all other subscales were non-significant.

Insert Table 2 about here

To test our second hypothesis that higher levels of autonomous motivation would be associated with the use of richer communication tools when taking part in a web-videoconference, multinomial regression analysis was used with average tool use as dependent variable and the AMS scales as covariates (linear regression could not be used because average tool use is a categorical variable for which distances between observations do not have the same meaning). As was to be expected based on the correlation presented in Table 1, results indicate that none of the AMS scales was a significant predictor of the average tool use score.

3.2 Tool Use and Participation

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

3.3 Motivation and Final Exam Performance

The fourth hypothesis stated that higher levels of autonomous motivation would be associated with higher scores on the final exam. A backward multiple regression analysis was performed with the AMS scales as independent variables. Again, IMTA was the only predictor nearing significance in predicting the final exam score, $R^2 = .032$, $B(SE) = .66$ (.35), $\beta = .18$, $F (1,105) = 3.54$, $p < .1$.

3.4 Tool Use, Participation, and Final Exam Performance

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

An ANOVA on final exam score with number of times participated as independent variable (see also Table 2) showed, in line with our expectation and the regression analysis, that students who took part in more web-videoconferences had higher scores on the final exam, $F(4,105) = 25.15$, $p<.001$. Post-hoc tests showed significant differences between all groups except between students who participated once and twice and between students who participated three and four times (all $p < .01$).

4. Discussion

This study explored the relationship between available tools used, student motivation, participation, and performance on a final exam in the context of a facultative summer course in economics. Our first hypotheses concerned the relationship between academic motivation and participation, and stated that higher levels of autonomous motivation are associated with more participation in web-videoconferences (H1) and with the use of richer communication tools when taking part in a web-videoconference (H2).

We found partial support for the first hypothesis: the AMS IMTA subscale was significantly associated with the number of times participated. These results are in line with

previous findings of Roca and Gagné (2008) and Sørebø et al. (2009), but in contrast to those studies, we did not find a significant effect of all three subscales related to autonomous motivation. Potentially, this difference could be related to the facultative nature of the course.

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

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

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

final exam (H5), only the number of times students participated in the web-videoconferences predicted scores on the final exam (H6).

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

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

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

4.1 Practical Implications

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

Second, it is important to try to actively engage students in an early stage. Though we did send regular personalized announcements and updates of occurrences in the course, this was not enough to limit drop-out. However, a solution that can be relatively easily implemented is to assign roles to students (Strijbos & De Laat, 2009). A role is a specific predefined task or set of tasks within the collaboration process like starting a discussion, contributing external sources, wrapping up a discussion, etc.. In a face-to-face PBL setting, there usually are roles assigned like, for instance, discussion leader and scribe (Loyens et al.,

2011). Assigning a role appeals to students' responsibility and can strengthen their sense of

autonomy, competency, and relatedness and thereby may help them to persist in their

engagement.

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Table 1. Spearman intercorrelations between the variables in the research model.

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

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

Table 2. Mean and SD scores for AMS scales and Final exam grade per number of times participated in a web-videoconference.

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

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

SDT   **TAM**   **Performance**
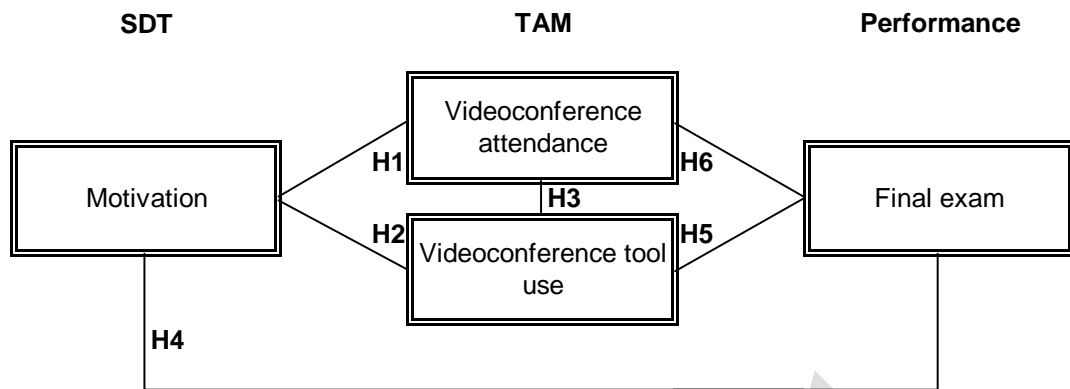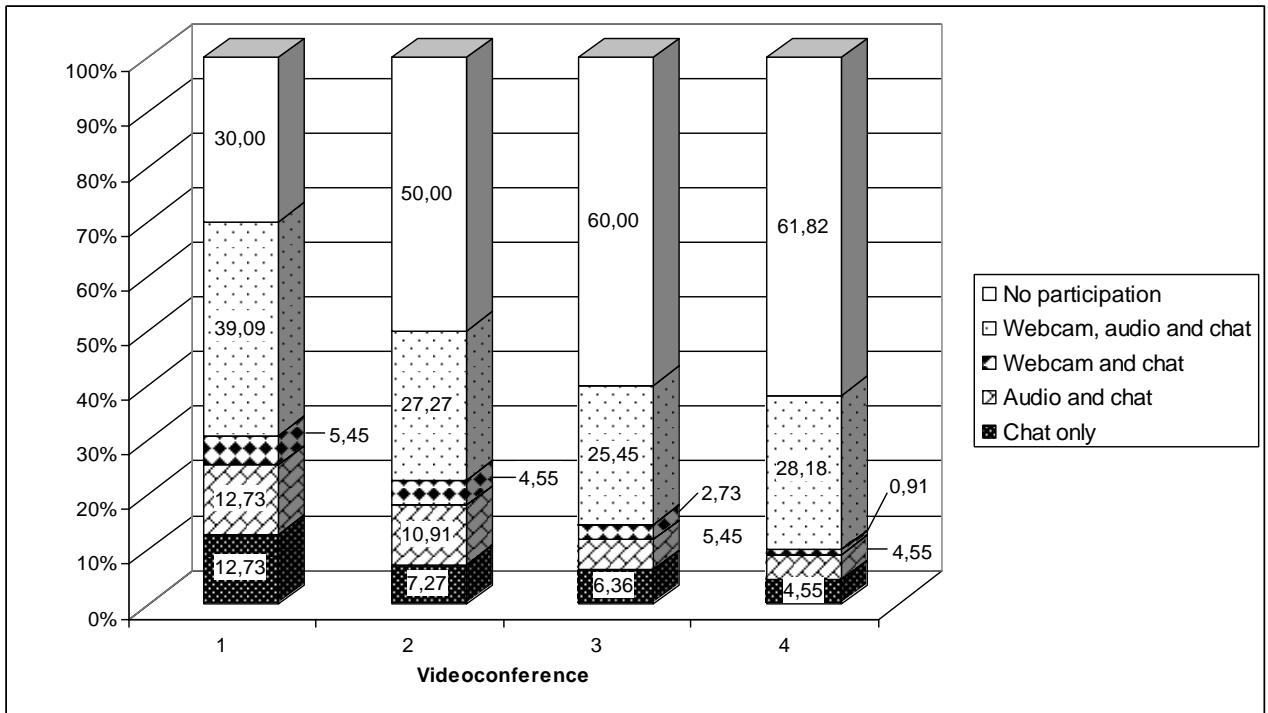

Figure 1. Research model

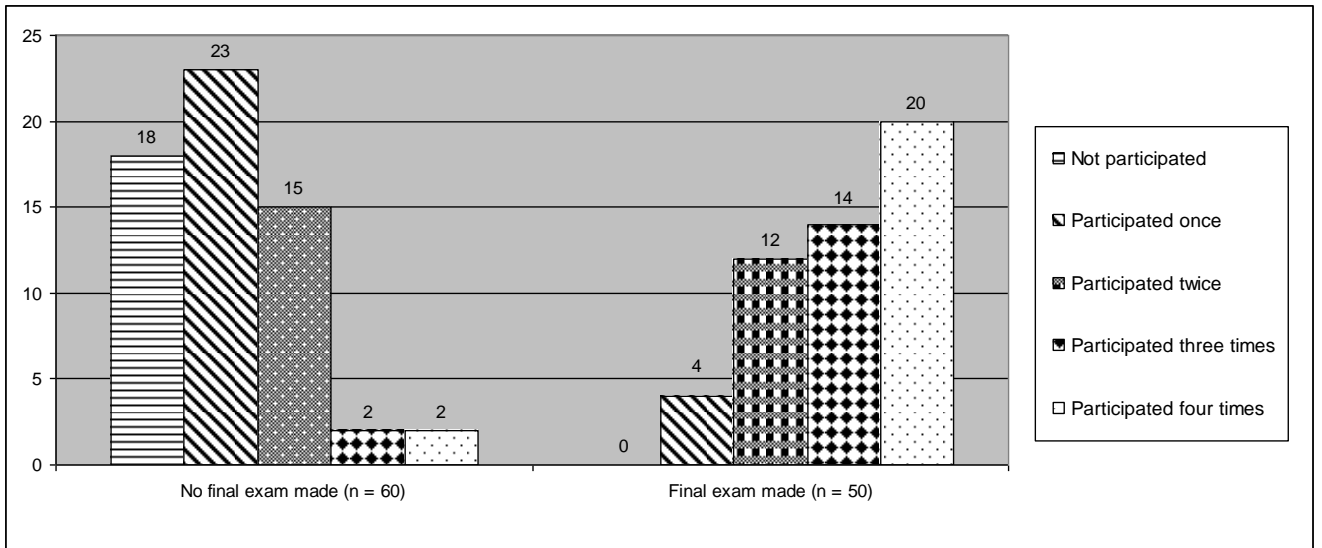Figure 2. Tool use as percentage of total participation per web-videoconference.

Figure 3. Number of participation compared for dropout versus non-dropout.