Collaborative and Distributed E-Research:

Innovations in Technologies, Strategies and Applications

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Chapter 13

Effects of the Drewlite CSCL Platform on Students' Learning Outcomes

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ABSTRACT

This chapter presents a case study of Computer Supported Collaborative Learning (CSCL) in the field of human nutrition and health at Wageningen University in the Netherlands. More specifically, this study investigates the effect of the type of collaboration (personal discussion in front of a shared computer vs. online discussion) in CSCL on students' learning outcomes. A pre-test, post-test design was used. Eighty-two students were asked (as an individual pre-test) to design and analyze a study which evaluates a certain dietary assessment method. Subsequently, they were asked to discuss their evaluation studies in randomized pairs. The pairs in one group discussed their task results online and the pairs in the other group discussed their results face-to-face while sharing one computer, in both cases using the CSCL platform Drewlite. As an individual post-test, students had to re-design and re-analyze the same evaluation study. Learning outcomes were measured based on the results of teachers' regular evaluation of students' achievements as well as on the quality of the students' knowledge construction. The results showed that both teachers' marks and the quality of knowledge construction of all students improved significantly from pre-test to post-test. However, the type of collaboration had no significantly different effect. Furthermore, the scores on knowledge construction were consistent with exam results as obtained by teachers' evaluations.

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INTRODUCTION

With the arrival of the knowledge-based era, the swift growth of information and communication technology, and the rapid growth and widespread accessibility of the WorldWideWeb, it is inevitable that professionals in all fields will be confronted with rapidly changing global problems and complex issues. These complexities call for appropriate action. In the field of education, it is believed that proper educational designs have the potential to prepare and train students to become capable and qualified professionals, who can analyze, conceptualize, synthesize, and cope with complex and authentic problems (Jacobson & Wilensky, 2006).

The use of new collaborative technologies as teaching and learning tools is now quickly increasing in education. According to many scholars in the field of learning science, collaborative online learning environments prepare learners to adjust to and cope with today's complex issues. Platforms for online learning environments have evolved to increase deep learning and student knowledge construction. They can also encourage students to discuss their ideas, concepts, and problems from different perspectives and viewpoints in order to re-construct and co-construct knowledge while solving authentic and complex problems (Noroozi, Biemans, Busstra, Mulder, & Chizari, 2011; Veldhuis-Diermanse, Biemans, Mulder, & Mahdizadeh, 2006). In collaborative online learning environments, knowledge can be constructed through structuring, elaborating, and evaluating concepts and ideas, eliciting and summarizing information, as well as connecting concepts, facts, and ideas about the topic (Veldhuis-Diermanse, et al., 2006). That is why some theoretical and empirical evidence favors more online instructional settings than traditional (face to-face) settings with respect to knowledge construction processes and outcomes (Andriessen, Baker, & Suthers, 2003; Joiner & Jones, 2003; Kanselaar, De Jong, Andriessen, & Goodyear, 2000; Kirschner, Buckingham-Shum, & Carr, 2003).

However, simply putting learners in a group to work together on an authentic and complex problem in an online learning environment is not always beneficial for learning, knowledge construction or problem solving (Kirschner, Beers, Boshuizen, & Gijselaers, 2008; Kreijns, Kirschner, & Jochems, 2003; Slof, Erkens, Kirschner, Jaspers, & Janssen, 2010). Empirical findings show that online collaborative learners generally encounter communication and coordination problems (Doerry, 1996; Janssen, Erkens, Kanselaar, & Jaspers, 2007) due to the reduced bandwidth or available modes of interaction associated with online learning, resulting in degradation of problem solving performance and knowledge construction (Baltes, Dickson, Sherman, Bauer, & LaGanke, 2002; Doerry, 1996). In response to this, a variety of instructional approaches (e.g. shared workspaces, game-based learning, awareness features, knowledge representations, scripts) has been developed to promote learning performance in online collaborative learning environments. These types of learning arrangements have collectively been named Computer Supported Collaborative Learning (CSCL), which is seen as a promising context in which to facilitate and foster student knowledge construction (Andriessen, et al., 2003; Stegmann, Weinberger & Fischer, 2007; Veerman, 2000). CSCL has recently been recognized as an important and achievable instructional strategy to support learning and thereby help learners achieve a deeper understanding. In today's information and communication era, CSCL is gradually moving into the mainstream of educational designs, as it is currently receiving enormous attention in universities and schools throughout the world (Noroozi, Mulder, Biemans, & Chizari, 2009; Weinberger, Ertl, Fischer, & Mandl, 2005; Weinberger, Stegmann, Fischer, & Mandl, 2007). When students are expected to solve authentic and complex problems and reach a deeper understanding, CSCL provides a fruitful environment in which to integrate different perspectives, theories and ideas with their own arguments, counter-arguments, clarifications, and discussions (Noroozi & Busstra, et al., in press; Noroozi & Weinberger, et al., in press; Noroozi, Biemans, Weinberger, Mulder, Popov, & Chizari, 2011; Van Bruggen, 2003).

BENEFITS OF ONLINE PLATFORMS FOR COLLABORATIVE LEARNING IN EDUCATIONAL RESEARCH

Researchers have used various forms of online platforms to support collaborative learning in educational research. Collaborative online or e-learning platforms such as CSCL provide various opportunities for researchers, including the following:

Researchers and scholars in the field of educational research can use various sorts of e-learning and online platforms to promote collaborative learning. They created, for example, asynchronous modes of communication (e.g. ALLAIRE FORUM, KNOWLEDGE FORUM, COLLABORATORY NOTEBOOK, DUNES) to engage learners in high-quality argumentative processes (Clark, D'Angelo, & Menekse, 2009; Clark, Sampson, Weinberger, & Erkens, 2007), and to promote individual knowledge construction (Schellens & Valcke, 2006). They created synchronous modes of communication (e.g. TC3, SENSEMAKER, VCRI, DUNES, DIGALO, DREW, BELVEDERE, NETMEETING, DREWLITE) for coordinating and facilitating task-oriented activities (Janssen, et al., 2007), as well as engaging learners in deep and elaborated discussions (Munneke, Andriessen, Kanselaar, & Kirschner 2007).

Using collaborative online and e-learning platforms enables researchers and scholars to include enriched learning materials in the learning environment remotely without physical interaction. For example, technology-enhanced learning environments provide enriched access to information that instructs learners in how to deal properly with the learning task as well as other materials that boost the authenticity of the learning. Researchers have the opportunity to embed various sorts of information and internet-based sources such as structured knowledge bases, unstructured knowledge bases, media-rich representations, and visualizations to provide learners with rich data to support successful interactions.

Using collaborative online and e-learning platforms enables researchers and scholars with similar interests to run simultaneous educational projects in institutional settings. In the scientific literature we can see many international projects that have been conducted in educational settings using collaborative online and e-learning platforms.

Researchers and scholars with similar interests in the field of educational research can collaboratively create various sorts of e-learning and online platforms, implement them simultaneously in their institutional settings, monitor the processes, evaluate, and if necessary modify them for future joint collaboration without a need for physical presence and interaction.

Using collaborative online and e-learning platforms facilitates quantitative and qualitative data analysis for researchers and scholars with similar interests in educational research. All researchers with similar interests can actively participate and contribute in the processes of the data analysis using technology-enhanced environments. Furthermore, the data in an online platform can be analyzed much faster than in traditional platforms using computerized systems.

Despite all the befits of online learning platforms, it is assumed that the lack of physical, mental and psychological signs and the absence of nonverbal communication in these environments may hamper the communication process (Kreijns, et al., 2003; O'Conaill & Whittaker, 1997), which in turn might limit the effectiveness of the learning processes and outcomes (Van Amelsvoort, 2006; Kiesler, 1986; Coffin & O'Halloran, 2009). Furthermore, social interaction could be missing to a large extent in CSCL (Kreijns, et al., 2003), while it is perceived as being important in learning processes and outcomes (Van Amelsvoort, 2006). This study thus investigates the effect of type of collaboration (Personal Discussion "PD" in front of a shared computer vs. Online Discussion "OD") in CSCL on students' learning outcomes. The main research question for this study is: Does type of collaboration (PD vs. OD) in CSCL with Drewlite platform affect students' exam marks as assessed by teachers, regular evaluation and students' quality of knowledge construction in a real educational setting?

METHOD

The study took place in an international university in The Netherlands with a student body encompassing over 100 nationalities, namely Wageningen University. About a third of the MSc students and one half of the PhD students come from abroad. This university offers a broad range of research activities and a unique combination of academic and professional education that is embedded in a coherent system of bachelor, master and PhD programs. With its central focus on "healthy food and a healthy living environment," the university stimulates students to combine the natural and social sciences; from plant sciences to economics and from food ingredients technology to sociology. Participants in this study were eighty-two (82) students enrolled in the 168-hour course "Exposure assessment in nutrition and health research" organized by the division of human nutrition. In this 6 ECTS course, students acquire insight into the methodology of assessing food and nutrient intake. The main focus of this course is on knowledge and skills related to the design, analysis and interpretation of validation and reproducibility studies. Of the 82course participants about 50% were third-year bachelor students and the other 50% were first-year master students, both from the Nutrition and Health program. The number of master and bachelor students was about equal in the PD and OD groups, as was the number of Dutch and foreign (i.e. non-Dutch) students.

The Drewlite platform was used as the CSCL platform for this study. The Drewlite platform is a simplified version of Drew, which was developed within the Scale project to support argumentative CSCL (Corbel, Jaillon, Serpaggi, Baker, Quignard, Lund, & Séjourné, 2002). The 'lite' version is less elaborate in managing sessions and traces, which were irrelevant in our study. The platform comprises various tools for communication, collaboration, and argumentation such as chat, graph, text board, view board, and multi modules. The modules can be used both individually and collectively. For the present study both individual and collaborative versions were used. With respect to the individual version, the graph module was used. With the graph module, the student could build boxes and draw arrows between the boxes in a diagram, in this case to construct a representation of key factors for the given assessment. Every box and arrow could be filled with text. The student could also add comments and express his or her opinion in favor of or against given arguments.

In this study, the dependent variable was learning outcomes in terms of teachers' regular evaluation of students' achievements as well as quality of knowledge construction. To investigate the effect of different modes of collaboration on knowledge construction a pre-test, post-test design was used. After receiving guidelines and instructions, students were given a 20-minute introduction on working with the CSCL platform. As a pre-test (45 minutes), students were asked to individually design and analyze the essential aspects of an evaluation study which aimed to evaluate a certain dietary assessment method (a 24-h recall) that was used to assess protein intake in a population of immigrants in the Netherlands. The students were then randomly assigned to pairs to discuss their results under either the Personal Discussion (PD) or Online Discussion (OD) condition using the CSCL platform. The two students in each pair discussed the essential aspects of the evaluation studies they had developed individually during the pre-test. The discussions took 90 minutes, during which the CSCL platform was used. Students within the OD condition used the chat tool in the CSCL platform as the discussion platform. Students within the PD condition viewed the screens of the evaluation studies they designed in the CSCL platform on a desktop computer in front of them. The OD students did not have personal (face-to-face) contact, whereas the PD students were sitting together behind the same computer. The pairs of students in the OD condition were separated in two different laboratory rooms to prevent personal contact.

Finally, a post-test took place in which students were asked to re-design and re-analyze the same evaluation study individually (45 minutes) based on what they had learned during the collaboration. In our study, pairs of students in both OD and PD conditions did not know each other in advance and we did not try to homogenize the pair composition with respect to knowledge awareness. Pairs of students in the OD condition could introduce themselves to one another through online chatting and pairs of students in the PD condition could introduce themselves in person when they were sitting behind the same computer to discuss their own individually made graphs. Furthermore, as the student group was relatively large, and the students were randomly divided over the different conditions, we assumed that possible differences in awareness would be equally distributed.

Learning outcomes were measured based on the results of teachers' regular evaluation of students' achievements as well as their quality of knowledge construction using a developed coding scheme. First, an overall mark was given by teachers to determine which students passed or failed the interim exam in the same way that teachers usually assess their students. Then, using teachers' regular evaluation of students' performances, each student received a score from 1 to 10 both for the pre-test and post-test. Subsequently, the mean quality scores for students' performances were calculated for each individual student by measuring the difference in mean quality score from pre-test to post-test (M = t2-t1). Teachers were not aware of the learning conditions nor of the characteristics of the students during the assessment.

A validated analysis scheme (Veldhuis-Diermanse, 2002) was used to assess the quality of students' knowledge construction which is an elaborated version of the SOLO taxonomy (Biggs & Collis, 1982). SOLO stands for the Structure of the Observed Learning Outcome and is a way of classifying learning outcomes in terms of their complexity. The SOLO taxonomy aims to analyze the quality of students' contributions to reflect their quality of knowledge construction regardless of the content area (Biggs & Collis, 1982). It provides a systematic way of unfolding how a student's quality of knowledge construction develops in complexity when handling complex tasks, particularly the sort of tasks undertaken in school. As students proceed in their learning process, the outcomes of their learning display comparable stages of increasing structural complexity. Since the SOLO levels are not context dependent, the taxonomy can be applied across a range of disciplines. The coding scheme of Veldhuis-Diermanse provided a series of categories for ranking the complexity of students' contributions as a proxy of their level of knowledge construction when performing learning tasks in online environments. This coding scheme categorizes the contributions of students into five hierarchical levels, and within each level into one or more subcategories that characterize the nature of the response:

- Level A: Extended Abstract
  Subcategories: Reflect/conclude/generalize/theorize/hypothesize
- Level B: Relational
  Subcategories: Explain, relate/combine, compare/contrast

- Level C: Multi-Structural
  Subcategories: List/enumerate/number, describe/organize, classify
- Level D: Uni-Structural
  Subcategories: Identify/define
- Level E: Pre-Structural (no subcategories), i.e. irrelevant answers.

To assess the quality of the learning outcomes, the contributions of students (both in pre-test and post-test) were segmented into meaningful units. Each unit was scored according to the coding scheme. Student contributions were given points according to their level in the coding scheme: 1 point for category E contributions, 2 points for D, 3 for C, 4 for B, and 5 for A-level contributions. Subsequently, the points for the contributions of each student were added together and this number was then divided by the number of meaningful units, which resulted in an individual mean score for the quality of knowledge construction in the pre-test and a mean quality score for the post-test (see Busstra, Geelen, Noroozi, Biemans, De Vries, & van 't Veer, 2010; Mahdizadeh, 2007; Noroozi, Biemans, Mulder, & Chizari, 2010a, 2010b; Noroozi, et al., 2011; Veldhuis-Diermanse, et al., 2006 for more information and examples on data analysis). Each student could thus get a score from 1 to 5 both for the pre-test and post-test for the quality of knowledge construction. Finally, a mean quality score for knowledge gain was calculated for each student by measuring the difference in mean quality score from pre-test to post-test (M = t2-t1). Scores of two inactive students were excluded from the analysis due to the limited number of their contributions, which means that for the data analysis 80 students were included in the study.

Two coders analyzed the contributions using the coding scheme described above. They were not aware of the learning conditions or of the characteristics of the students. The teachers of the course helped coders to get in-depth insight into the content-related topics of the learning tasks (on exposure assessment in nutrition and health research). The main teacher of the course and her assistant evaluated students' contributions to give marks to students and determine which students passed or failed the post-test in the same way that teachers usually assess their students. Both intra-analyses and the reliability were calculated for various signifiers and levels of knowledge construction. Cohen's kappa was employed as a reliability index of inter-rater agreement, which was 0.78 for pre-test and 0.81 for post-test. Moreover, intra-coder test-retest reliability was calculated for 20% of the contributions. This resulted in identical scores in 85% of the contributions. For both inter- and intra-analyses, the reliability was deemed sufficient. ANOVA was used to assess the prior knowledge of students in both conditions (OD and PD) in terms of quality of knowledge construction and students' regular marks by teachers as measured by the pre-test. The ANOVA test for repeated measurement was used to assess the effects of the two collaborative learning conditions on the quality improvement of knowledge construction and students' regular marks by teachers as measured by pre-test-post-test.

RESULTS

Students in the OD and PD conditions did not differ significantly with respect to their pre-test scores ($F = 0.93$; $p = .34$ based on teachers' marks; $F = 0.009$; $p = .92$ based on Veldhuis-Diermanse coding scheme): there thus appeared to be no significant differences with respect to prior knowledge between students in the OD condition ($M = 5.91$; $SD = 1.60$ based on teachers' marks; $M = 3.00$; $SD = 0.48$ based on Veldhuis-Diermanse coding scheme) and students in the PD condition ($M = 5.61$; $SD = 1.21$ based on teachers' marks; $M = 2.99$; $SD = 0.35$ based on Veldhuis-Diermanse coding scheme).

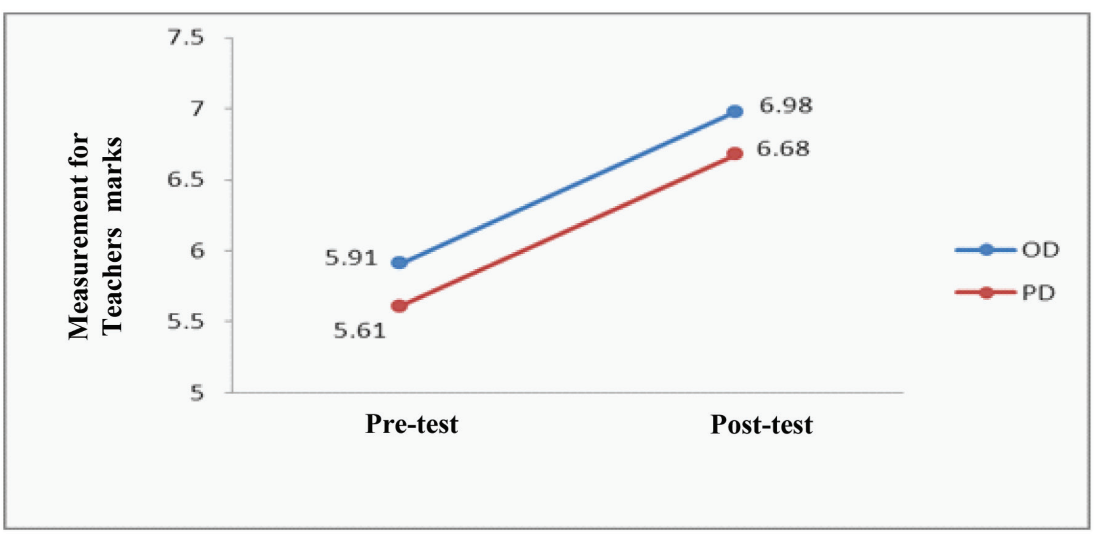
Both the teachers' marks and the quality of knowledge construction of all students improved significantly ($F = 82.19$; $p < .01$; MT1 = 5.76; MT2 = 6.83 based on teachers' marks; $F = 4.40$; $p < .05$; MT1 = 3.00; MT2 = 3.09 based on Veldhuis-Diermanse coding scheme) from pre-test to post-test. The improvement of students' performance based on the teachers' marks was about equal under the OD condition (MT1 = 5.91; MT2 = 6.98) compared to students under the PD condition (MT1 = 5.61; MT2 = 6.68) ($F = 0.004$; $p = .95$) (see Figure 1 for a graphical representation of this result).

The knowledge construction quality improvement of students based on the Veldhuis-Diermanse coding scheme under the OD condition (MT1 = 3.00; MT2 = 3.16) was also about equal to that of students under the PD condition (MT1 = 2.99; MT2 = 3.01) ($F = 2.81$; $p = .10$). (Figure 2 shows a graphical representation of this result). In other words, both types of collaborative learning facilitated improvement in students' scores both in terms of teachers' marks and the Veldhuis-Diermanse coding scheme for knowledge construction. In the latter category, the quality improvement was somewhat larger under the OD condition than under the PD condition, but the difference was not statistically significant.

CONCLUSION AND DISCUSSION

This study revealed that a particular synchronous CSCL platform, Drewlite, has the capability to promote learning regardless of type of collaboration. Other researchers, e.g. Clark et al. (2007), have also confirmed that synchronous modes of communication provide learners with an equal opportunity to participate in the learning process with a high degree of integration. Furthermore, other sorts of synchronous platforms (e.g. NetMeeting and Belvédère) have also been found to promote argumentative learning (Veerman, 2000). This is why many researchers now use these platforms in their educational settings. We found that both the students' scores based on teachers' marks and their quality of knowledge construction improved significantly over time under collaborative learning conditions, both through Online Discussions (OD) within the CSCL platform and through per-

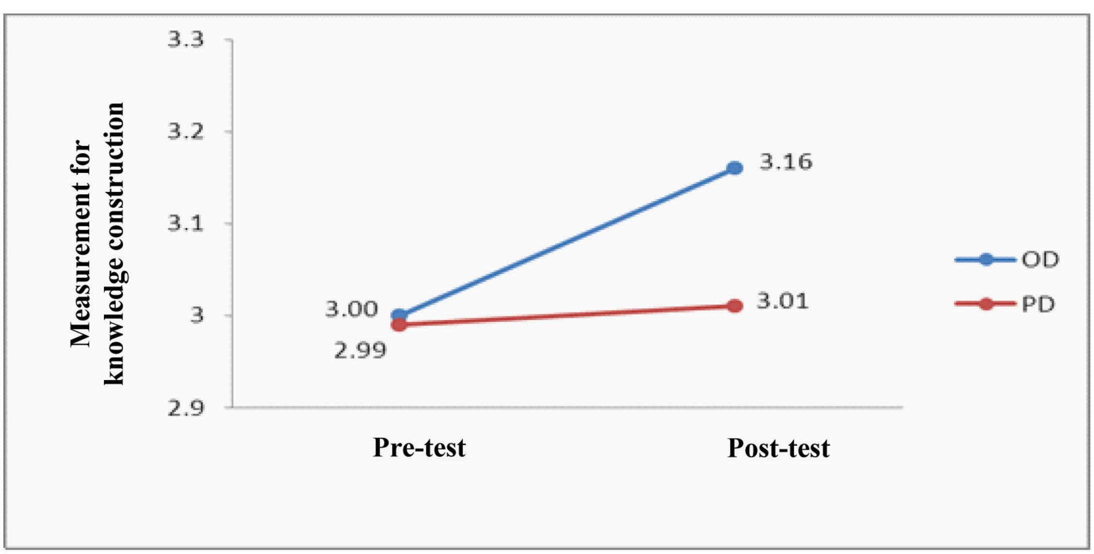
Figure 1. Mean scores of students evaluation based on teachers' marks on pre-test and post-test by collaboration type (OD=online discussion; PD=personal discussion)



sonal face-to-face-discussions (PD) in front of a computer during which they could use the CSCL platform. This result is in line with conclusive findings in research on CSCL showing various added values and benefits of collaboration in CSCL (Ertl, Kopp, & Mandl, 2008; Suthers & Hundhausen, 2003; Weinberger, et al., 2005, 2007). In CSCL with various forms of collaboration, students can discuss their ideas and conceptions from different perspectives in order to re-construct and co-construct (new) knowledge while solving authentic and complex problems (Veldhuis-Diermanse, et al., 2006; Weinberger & Fischer, 2006). Furthermore, in CSCL environments, students can re-construct their thoughts while formulating and organizing ideas and opinions and they can also re-read posted notes by looking at the conversation history. Writing notes and re-reading and re-thinking those notes are regarded as important tools for learning and knowledge construction in CSCL (e.g. De Jong, Veldhuis-Diermanse, & Lutgens, 2002; Veerman, 2000).

There was no significant difference between students under the OD condition compared to students under the PD condition both in terms of teachers' marks and the Veldhuis-Diermanse coding scheme for knowledge construction. This result is in line with inconclusive findings in research on online learning environments. Various studies point to positive effects of online collaboration (e.g. Andriessen, et al., 2003; Kanselaar, et al., 2000; Kirschner, et al., 2003), while some theoretical and empirical evidence also demonstrates various downsides of online collaboration (e.g. Doerry, 1996; Janssen, et al., 2007; Olson & Olson, 1997). Despite the fact that Personal Discussion (PD) in front of a shared computer provides students with various forms of social interaction, nonverbal communication, and physical, mental and psychological signs which can facilitate turn-taking, giving feedback, mutual understanding, etc. (e.g. Kiesler, 1986; Kreijns, et al., 2003; Van Amelsvoort, 2006), learners can compensate for and even benefit from restricted interactive environments (e.g. Fischer & Mandl, 2005) using support techniques (Engelmann, Dehler, Bodemer, & Buder, 2009), and factors that are extrinsic to the technology itself (Walther, 1994).

Figure 2. Mean scores of students' knowledge construction based on Veldhuis-Diermanse coding scheme on pre-test and post-test by collaboration type (OD=online discussion; PD=personal discussion)



Students in the OD condition can also compensate for the restricted interaction by writing notes, and re-reading and re-thinking those notes, which are important tools for learning and knowledge construction in CSCL (Veerman, 2000). Based on our study, we conclude that online discussions within a CSCL platform as well as personal discussions using the CSCL platform can support the process of knowledge construction and this can also be reflected in students' course exam results. The similar performance shown by participants in the two experimental conditions, both in terms of knowledge acquisition and teachers' assessment could indeed be attributed to the fact that in both conditions knowledge was represented in artificial deposits within the same Drewlite CSCL platform.

We found that the scores on knowledge construction as obtained by the Veldhuis-Diermanse coding scheme were consistent with exam results as obtained by teachers' regular evaluations. There was thus a relationship between students' course exam results and knowledge construction. When teachers' marks were used to analyze students' learning outcomes, the scores of all students improved significantly but no significant difference was reported for quality improvement of their scores between students under the OD and PD conditions. Identical results were achieved when students' learning outcomes were measured in terms of Veldhuis-Diermanse coding scheme for knowledge construction. If this had not been the case, and the psychometric properties of the exams passed the minimum quality thresholds, further calibration of the coding scheme for knowledge construction would have been necessary.

Knowledge construction in this study was measured by analyzing student contributions using a slightly revised version of an existing coding scheme developed by Veldhuis-Diermanse (2002), which had already been used in several other empirical studies. Its inter-rater reliability and values had been reported as being satisfactory (Noroozi, et al., 2011; Veldhuis-Diermanse, 2002; Veldhuis-Diermanse, et al., 2006), and these values were even higher in the present study. Furthermore, using existing coding schemes is advocated in the literature (Stacey & Gerbic, 2003). This form of content analysis is very time consuming, but there is hardly any alternative in this research context. It is therefore not surprising that this type of analysis is most frequently used when analyzing written notes and transcripts of discourse corpora in CSCL environments. In our case, meaningful parts within the contributions were coded with a slight variation of an existing five-tier scheme. The codes were seen as proxies for the achievement of learning outcomes. This study was embedded in an existing course with its own dynamics. This means that there is a high level of ecological validity of the study, and therefore we assert that the findings are quite robust. However, this context constrains the possibilities to experiment. Now that we know that using the Drewlite CSCL platform affects learning outcomes in real courses, we suggest proceeding with controlled experiments in which student learning processes are intensively monitored and learning results more elaborately tested. Factors which we suggest should be taken into account are the nature of learning tasks (Veerman, 2000) and student characteristics, including personal character (Rummel & Spada, 2005), communication skills (Weinberger, 2003), and interest in and willingness to work with computers and participate in CSCL (Beers, Kirschner, Boshuizen, & Gijselaers, 2007).

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KEY TERMS AND DEFINITIONS

Asynchronous Platform: A platform that provides learners with the opportunity to participate and communicate at different times.

Computer-Supported Collaborative Learning: A type of learning arrangement that allows researchers, educational designers and planners to scaffold learning in an educational setting using external representations.

Knowledge Construction: Elaborating, evaluating, and linking different facts and ideas that could contribute to the problem solutions.**Online Discussion:** Non-verbal discussion between learners by means of a textual chat.

Personal discussion in Front of Computer: Verbal discussion between learners using spoken language in front of computer.

SOLO: Structure of the Observed Learning Outcome that classifies the complexity of learning outcomes.

Synchronous Platform: A platform that provides learners with the opportunity to participate and communicate at the same time.