Designing, Orchestrating and Evaluating Inter-professional Collaboration in a Scripted 3D Learning Space for Vocational Education

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Abstract: Along with the development of new technologies orchestrating CSCL has become a topical issue because new learning spaces challenge the teacher to support collaborative learning in new ways. The aims of the study are twofold. Firstly aim is to design scripted 3D learning space to practice inter-professional knowledge construction in vocational context. Secondly, empirical study aims to refer to the challenge of supporting collaboration in naturalistic, complex 3D learning settings. More specifically, aim is to find out how do groups studying in scripted 3D learning space with (condition 1) and without (condition 2) real-time teacher support differ? The findings of this study indicated that groups studying with real-time teacher orchestration used more effort for providing knowledge (especially explaining one's own situation) and less effort for other inputs (especially off-task talk). This suggests the potential of real-time teacher orchestration for future CSCL.

Introduction

The changing needs of working life create new challenges for both learning and teaching in an educational setting. Work tasks have become increasingly complicated and, typically, work is based on inter-professional expertise and the shared construction of new knowledge (Billett, 2008). In traditional vocational school settings, however, students of different fields do not work together to solve problems. As vocational jobs are likely to call for collaboration in the future, it is necessary to find new ways of supporting collaboration in vocational learning. One way to respond to these needs is to create new technology-enhanced learning (TEL) spaces that offer added incentive to practice inter-professional collaboration. During the last years, TEL environments have rapidly improved through the social media, 3D spaces (e.g. Second Life) and games for learning. Thus, technology can be utilized to enhance collaboration in learning and working practices, for example, by offering more illustrative spaces to practice inter-professional work, thus eliminating the danger in work safety compared to traditional methods (Hämäläinen, Oksanen & Häkkinen, 2008). Despite these optimistic notions of new TEL spaces meeting the needs of inter-professional working life, systematic empirical CSCL research in vocational contexts has so far been dealt with less than, for example, learning in the higher education context.

Many researchers have reported the beneficial effects of computer-supported collaborative learning (CSCL) (e.g. De Wever et al., 2010). The potential of CSCL is widely agreed, because through joint construction of shared understanding, meaning, knowledge and expertise, a group can create something that exceeds what any one individual could achieve (Stahl, 2004). However, in practice, the "ideal" high level and productive collaboration is relatively rare and is challenging to "create" in technology-enhanced school settings (Kollar, 2010; Hämäläinen, 2011), thus the problems with collaborative group work (Järvelä et al., 2010). Thus, in authentic learning contexts, totally free collaboration does not necessarily promote productive collaboration or high-level learning. Previous research has focused on collaboration scripts as a particular kind of instructional approach to support CSCL, typically without real-time support of the teacher (Kobbe, Weinberger, Dillenbourg, Harrer, Hämäläinen, Häkkinen & Fischer, 2007). Recent critical studies have suggested that focusing only on specific scripts reduces—or even negates—the role of teachers in supporting collaboration (Dillenbourg & Jermann, 2010; Hämäläinen & Häkkinen, 2010). Along with the development of scripts, it is necessary to pay attention to the effective and flexible use of the potential offered by future learning spaces with regard to more active role of the teacher.

Recently, flexible orchestration (based on research findings) has widely been suggested as a solution for arranging collaboration in naturalistic learning situations (e.g. Dillenbourg, et al., 2009; Kollar, 2010). As such, the concept of orchestrated learning is not new (Brown, 1992); along with the development of new technologies (e.g. 3D spaces), orchestrating has again become a topical issue because new learning spaces challenge the teacher to support collaborative learning in new ways. Orchestrating CSCL highlights the balance between the instructions and "free collaboration processes" as well as contextual nature of collaboration. However, this does not mean "totally free" intuitive teaching (without educational goals). A common feature of orchestrating CSCL is that it draws systematically on research-based productive collaborative learning situations in the design and real-time implementation of teaching. The main idea is to combine the design and the improvisation. The curriculum sets the starting points for activities, the environment supports collaboration, the teacher designs and orchestrates the structure for learning processes (based on research findings of productive collaboration; e.g. solving cognitive conflicts) and the learners are then given a certain freedom for shared knowledge construction. During the collaborative learning situation, the teacher simultaneously designs, monitors and supports learning processes during group work based on contextual needs. This study supplements research on collaboration scripts by teachers, timely orchestration in future TEL space (e.g. Dillenbourg, Järvelä & Fisher, 2009). The aims of the study are twofold. Firstly aim is to design scripted 3D learning space to practice inter-professional knowledge construction in vocational context. Secondly, aim of empirical study is to refer to the challenge of supporting collaboration in naturalistic, complex 3D learning settings. More specifically, aim is to find out what kind of effects do *real-time teacher orchestrations* have on processes of collaborative knowledge construction? To find out this we seek whether groups studying in scripted 3D learning space with (condition 1) or without (condition 2) real-time teacher support differ in knowledge construction.

Research question: How do groups studying in scripted 3D learning space with (condition 1) and without (condition 2) real-time teacher support differ?

Scripted 3D Learning Space

In this study 3D online learning space (see Figures 1 & 2) for groups of five participants at the time with scripted tasks (see Kobbe et al., 2007) was developed. The aim is to enhance the inter-professional knowledge construction in the area of human sustainability. The learning space is based on RealXtend Technology (Open Source Platform for interconnected virtual worlds http://www.realxtend.org/). In a 3D space participants work as volunteer staff at a charity concert and are supposed to make sure that customers are satisfied and that everything is ready for the gig. To achieve this, participants solve inter-professional puzzles. The environment provides each participant a first-person-view into the 3D space. Participants are connected to each other via a server, which runs the virtual world in which all the action occurs. The space can be used with PC which has a network connection and human-to-human communication is supported by a chat and VoIP speech system. 3D space includes three scripted collaborative tasks (with supplementing inter-professional roles) that require effort and commitment from several students for successful completion. Next in Table 1 the main ideas of scripted tasks with theoretical groundings of collaboration are described.

Figures 1 & 2. 3D Learning Space.

Table 1: Brief description of scripted tasks.

	Description	Key points (Pedagogical idea)
Gate	Groups need to open a gate to the festival area by entering a password to the electronic lock in the correct order. Every student has gotten their own part.	**Coordination**: dependency between group members and control of an aggregate of individuals (Barron 2000).
Restau rant	Groups are supposed to keep customers satisfied by serving them in the restaurant area. Students have supplementing inter-professional roles. The roles are: cook, waitress, receptionist and serviceman. Every role has his/her own responsibility area and students are supposed to integrate and synchronize those tasks together. At the end of the task band members comes to the restaurant to have lunch. One band member has a nut allergy, but he still wants to have a portion which usually includes nuts. Group need to find out the allergy and serve the right portion without.	**Distributed expertise, mutual de-pendency and integration of solo – group activities**: dependency between participants is created by the different knowledge and resources distributed to each of the learners (Price et al. 2003) leading to personal responsibility, shared knowledge construction and need to combine different professions.
Stage	The groups' task is to identify each band member by combining received tips. Each student receives own tips, and players need to recognize who is who of the band members. In this way, players are able to organize the band's stuff in the right place on the stage.	**Cognitive conflict:** A situation is created by having different learners receive different information at the same time, but without proper co-ordination, causing an unsolvable problem (Moscovici and Doise, 1994).

Method

The main interest of this study is in the effect on the processes of designing (with and without real-time teacher orchestration) collaboration in vocational learning settings. The empirical study was conducted in an authentic classroom setting (cameras and recording systems were used). In spring 2010, 18 vocational students and two teachers (four groups of five persons) participated in the study. The experiment included a two-to-three hour working period in a scripted 3D learning space at the College of Jyväskylä, Finland. Data were gathered by using observational notes on the sessions as well as by videotaping and recording the groups' discussions (6016 transcribed utterances). The aim of the study is to deepen the understanding of the relationship between scripting with (condition 1) or without (condition 2) real-time teacher orchestration and productive knowledge-construction. More specifically, the study compared shared knowledge construction within different scripted 3D-learning conditions (with and without real-time teacher orchestration).

This approach is derived from the methodological development of our earlier studies (e.g. Hämäläinen, 2010; Hämäläinen et al., 2008). After the experiment, all video data were transcribed (four groups with a total of 6016 utterances), and discussion entries were read through several times. Then, all the data were verified: videos were watched, observations were rechecked and transcribed utterances were re-examined (at this stage, 5386 of 6016 utterances were categorised to include activities of shared knowledge-construction). As our earlier studies (Hämäläinen et al., 2008) have indicated that faster groups do better in their final test results than the slower playing ones, we compared the time used in the game with and without teacher orchestrating collaboration activities. To evaluate whether groups engaged in high-level knowledge construction and how different collaboration settings differed, two types of content analysis were conducted (unit of analysis=utterance). The analysis used quantitative and qualitative content analyses to focus on the group knowledge-construction processes (Berelson, 1952). Five thousand three hundred and eighty-six utterances were categorized into six main categories ("providing knowledge", "contextual questions", "shared problem solving", "management of interaction", "summing up/discovering solution" and "other inputs"). Then, to find qualitative differences within the knowledge-construction processes, the utterances were sorted further into 25 different data-driven subcategories (see table 2 in the result section for more details). Regarding the quantitative content analysis, the aim was to describe whether shared knowledge construction in two different research settings would be dissimilar, while the aim of the qualitative content analysis was to develop understanding how real-time teachers' activities enhance high-level knowledge construction.

Results

In orchestrated learning setting the learning session lasted an average of approximately 1 hour 58 minutes, while with the groups without orchestration the session lasted an average of 2 hours 31 minutes. Between the groups studying with (2405 utterances) and those studying without (2981 utterances) a real-time teacher's orchestration, the findings indicated two main differences in knowledge-construction activities in the categories "providing knowledge" and "other inputs" (see Table 2). More specifically, in providing knowledge, both groups brought in new information, gave technical and contextual advices to group members and stated their (non-justified) opinions. Thus, neither of groups did not use justified opinions. However, groups with teacher orchestration used 18 percent of their utterances for explaining their own situation, while groups without teacher orchestration only used 5.9 percent of their utterances for this (see, Table 2). The other main difference concerned the amount of other inputs; especially off-task talks. Groups without teacher orchestration used 36.1 percent (1077 utterances, of which 452 off task) of their utterances for other inputs, while groups with teacher orchestration used 13 percent (315 utterances, of which 35 off task) of their utterances for this (see Table 2).

Table 2: Main differences between the groups with and without real-time teacher orchestration.

	Groups with orchestration			Groups without orchestration without		
Providing knowledge	1003	41,7 %		726	24 %	%
Piece of advice – contextual	162		6,7 %	161		5,4 %
Piece of advice – technical	5		0,2 %	11		0,4 %
New information	380		15,8 %	332		11,1 %
Explaining own situation	428		18 %	177		5,9 %
Justified opinion	0		0 %	0		0 %
Non- justified opinion	29		1,2 %	45		1,5 %
Contextual questions	309	12,8 %		349	11,7 %	
New openings	37		1,5 %	31		1,0 %
Technical	13		0,5 %	14		0,5 %
Specifying	158		6,6 %	229		7,7 %
Reasoning	6		0,2 %	8		0,3 %
Opinion	95		4 %	67		2,2 %

Shared problem solving	520	21,6 %		616	20,7 %	
Carry on with one's work	152		6,3 %	240		8,1 %
Answers	286		11,9 %	315		10,6 %
Disagrees / argues	64		2,7 %	47		1,6 %
Reasoning	18		0,7 %	14		0,5 %
Management of Interaction	184	7,7 %		157	5,3 %	
Group organization	54		2,2 %	59		2,0 %
Planning upcoming activity	19		0,8 %	11		0,4 %
Organizational questions	109		4,5 %	81		2,7 %
Support	2			6		
Summing-up / discover solution	71	3,0 %		56	1,9 %	
Based on group activities	59		2,5 %	48		1,6 %
Based on own actions	2		0,1 %	1		0 %
Based on unknown reason	10		0,4 %	7		0,2 %
Other Inputs	315	13,1 %		1077	36,1 %	
Other Inputs – related to game	273		11,4 %	477		16 %
Describing technical problems	7		0,3 %	148		5 %
Off task - Not related to game	35		1,5 %	452		15,2 %
	2405 utterances	100 %	100 %	2981 utterances	100 %	100 %

Discussion

Recent critical studies has indicated several reasons for failure in collaborative learning, such as a lack of teachers to orchestrate learning processes (Arvaja, Hämäläinen & Rasku-Puttonen, 2009), uneven work division (e.g. free riding) (Strijbos & De Laat, 2010), individual working methods of group members (Hämäläinen & Häkkinen, 2010) and inappropriate use of external (e.g. texts, learning tools; Jeong, & Hmelo-Silver, 2010) and internal learning resources (e.g. prior knowledge, Arvaja*,* 2007). Thus, there is an evident need to highlight the role of the teacher in enhancing productive collaboration. At their best, technological environments can offer new learning spaces for knowledge construction and help teacher to orchestrate and to monitor learning activities and to support collaborative knowledge construction within different groups. However, there are many unrealistic expectations connected to role of technology. Firstly, very rarely, the tools or environments that are available to support learning are designed with pedagogical or instructional theories of learning and teaching in mind (Laurillard, 2009) and therefore the technologies itself do not typically guarantee collaboration within groups (Bluemink, Hämäläinen Manninen & Järvelä 2010). Secondly, even the technological environments itself are designed to support collaboration there are several challenges on computer-supported collaborative pedagogies, as no technology alone can replace the teacher in supporting creative collaboration processes (Littleton, 2009). Wegerif (2006) has even argued that some of underlying assumptions behind CSCL pedagogies are mainly based on industrial age and focus too much on individual's knowledge and skills.

To develop pedagogical approaches to really meet the needs of CSCL orchestrating learning must be both pedagogically structured (based on learning theories) and also flexible to reach the learning goals. Thus, the learning goal (and task of which the goal is striven for) itself and contextual needs sets the limits to how much learning should be designed and instructed (Hämäläinen & Häkkinen, 2010). The precondition for orchestrating collaboration is the understanding of collaboration processes and the reasons for the differences in the knowledge-construction processes. This study indicated that groups studying with real-time teacher orchestration used more effort for providing knowledge (especially explaining one's own situation) and less effort for other inputs (especially off-task talk). Thus, scripted 3D space itself gave guidance and help in task solving. However, a teacher's professional competencies were helpful, especially for reducing off task discussions in 3D space and for understanding the inter-professional nature of the task. This suggests the potential of real-time teacher orchestration as explaining one's own situation is highly related to inter-professional work and practicing that is one way to respond to the changing needs of the future of people's work lives. Thus, the findings are in line with the notion that real-time teacher orchestration is suited to collaborative learning (Dillenbourg et al., 2009). To conclude, future research needs to focus further on how to support collaborative learning with both technology and human guidance.

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