



VOLUME 10 ISSUE 3-4

Journal of

Technologies in Education

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JOURNAL OF TECHNOLOGIES IN EDUCATION
www.techandsoc.com

First published in 2015 in Champaign, Illinois, USA
by Common Ground Publishing LLC
www.commongroundpublishing.com

ISSN: 2381-9243

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Improving Collaborative Skills by Computer Science Students through Structured Discussion Forums

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Abstract: Asynchronous discussion forums have been examined for their usefulness in promoting online learning among students. Recent research has shown that structured discussion forums are more effective for the improvement of critical thinking skills than are unstructured discussion forums. This study proposed a structure for discussion forums and investigated its impact on the improvement of collaborative skills by computer science students. In this study a survey design in the form of a questionnaire was used for measuring collaboration among students in the discussion forums and the improvement of their collaborative skills. One hundred twenty three students from two academic education colleges participated in seven fully online computer science courses. The main findings of the study showed that the students of the structured discussion forum significantly improved their collaborative skills in comparison to the students of the unstructured discussion forum. The findings of the study can contribute to the field of asynchronous online learning in providing a structure for discussion forums that has the potential to increase the effectiveness of online collaborative discussions and thereby the quality of online learning.

Keywords: CMC, Online Learning, Structured Asynchronous Discussion Forums, Collaborative Learning, Collaborative Skills, Problem Based Learning, Project Based Learning

Introduction

More and more online courses are being offered by universities and colleges in addition to traditional face-to-face teaching methods. Students in online courses are separated from teachers and other students by space, time, or both. It is therefore essential to supply carefully designed and tested ways for interaction and collaboration to take place where knowledge, ideas and perspectives can be freely exchanged between teacher and students and among students themselves in order to promote various levels and kinds of learning. Educators have emphasized the importance of interaction among the participants in online courses, noting that it is the dialog that promotes learning (Muirhead and Juwah 2004, 13; Swan 2002, 2). The most widely used asynchronous tool for the purpose of increasing interaction and collaboration among participants in an online course is the discussion forum. Discussion forums can be unstructured or structured. Recent research has shown that structured discussion forums are more effective for the improvement of critical thinking skills than are unstructured discussion forums (Aviv, Erlich, Ravid, and Geva 2003, 16; Gilbert and Dabbagh 2005, 5; Yang, Newby and Bill 2008, 1584).

The current study addressed the problem of how to organize and manage structured discussion forums for facilitating online collaborative interactions among students in online computer science courses in order to improve the development of collaborative skills that are relevant in computer science education.

Background

Social constructivism claims that knowledge is constructed by social interaction and collaborative learning (McDonald and Gibson 1998, 7). Collaborative learning has become one of the most powerful group-based pedagogical methods in recent years. Johnson and Johnson (2004, 793) specified the following five basic elements that are needed for effective group collaboration:

- 1) Positive interdependence: occurs when each member in a group perceives that she or he cannot succeed unless the group does.
- 2) Individual accountability: refers to each participant's responsibility to accomplish the group's goals.
- 3) Promotive interaction: exists when group members act as trustworthy members by acknowledging and challenging each other's ideas and facilitating each other's efforts to reach the group's goals.
- 4) Social skills: collaborative learning requires group members to have interpersonal and small group skills which are the actions needed to effectively interact with other members.
- 5) Group processing: occurs when group members discuss their progress and decide what behaviors to continue or change.

According to Johnson and Johnson (1989), if the conditions are met, collaboration will increase the learner's effort exerted to achieve, the quality of the relationships between participants, and the participants' psychological health "the ability to develop, maintain, and appropriately modify interdependent relationships with others to succeed in achieving goals" (138). Students working in small, heterogeneous groups learn both the subject matter content, appropriate problem-solving and critical thinking skills, and skills necessary to work together collaboratively (Garrison, Anderson and Archer 2001, 8).

In this study, collaboration is defined as a process in which small groups of students with mixed knowledge levels and abilities are working together in order to share information, solve problems, and carry out learning activities and a final project. This interpretation of this type of collaboration is in agreement with the definition given by Johnson and Johnson (2004, 793).

Online Collaborative Learning

With the explosive growth of the Internet and computer-mediated communication (CMC), there have been many attempts to incorporate collaborative learning methods in online environments. Collaborative learning becomes online collaborative learning when it takes place via CMC technologies – usually the Internet (Belanger 2006, 23). Online collaborative learning adopts a constructivist orientation, which stresses the social interaction in knowledge construction (Belanger 2006, 23; Palloff and Pratt 2010, 29; Moore 2013, 24). It also aims to provide an environment that supports and enhances online collaboration between students in order to enhance students' learning processes (Zhu 2012, 128).

Despite the popularity of online collaborative learning, simply putting students together in an online learning group and asking them to work collaboratively does not guarantee that they will engage in meaningful collaborative inquiry (Biesenbach-Lucas 2004, 156; Johnson and Johnson 1989, 140). Fortunately, there is a growing literature describing how online collaborative learning can be implemented successfully (Achteimeir, Morris and Finnegan 2003, 2). The key appears to be preparation by the instructor in scheduling collaborative learning activities throughout the experience (Hiltz and Turoff, 2002, 57) including projects for co-production (Harasim 2002, 182). Hiltz and Turoff (2002, 58) suggested that collaborative learning activities, which are well-suited for online environments, include debates, group projects, case study discussions, simulations, role-playing exercises, the sharing of solutions for homework problems, and the collaborative composition of essays, stories, and research plans. However, in reality, most online collaborative work is usually relegated to discussion forum conversations, in which students merely generate a dialogue with each other about the weekly readings (Anderson 2008, 55). Although this type of activity can clearly be of relevance, the extent of actual collaboration is usually limited, the reason why well-designed collaborative learning activities need to be combined with online collaborative learning.

It has been argued that incorporating well-planned collaborative activities into online learning benefits students, since higher order thinking skills are more likely to be generated. Other benefits of online collaboration that have been cited include enhancement of critical thinking (Gokhale 1995, 23), reflection, peer feedback (Prasad 2009, 20), and the reduction of anxieties in social situations (Gokhale 1995, 23).

Collaborative Skills in Computer Science Education

The development of collaborative skills is critical in computer science education since students often work in groups developing algorithms and software projects. Collaborative skills are important because to work successfully with others, students need to develop collaborative skills, such as asking for help, arguing and giving opinions, and disagreeing politely. The research literature found that learning computer science is an inherently social activity as good solutions are developed not in isolation; instead they involve interaction and collaboration with other students (McDougall and Boyle 2004, 110).

Overall, the research on integrating collaborative programming into computer science courses reported positive outcomes related to student's learning. Students produced better programming projects in a reduced amount of time and in a reduced rate of frustration, and in some cases they received higher grades in the course (Benaya and Zur 2007, 127; McKinney and Denton 2006, 143; Teague and Roe 2008, 151).

Online collaboration is also important for future work since people must often work collaboratively on projects, using CMC-tools in an effort to overcome the constraints of distance, time zones and organizational boundaries. In addition, collaborative work provides benefits in developing skills expected in the future workplace (Benaya and Zur 2007, 127; McKinney and Denton 2006, 143).

Related Research Studies

This study was concerned with the use of a structured discussion forum in computer science online courses and its impact on the improvement of students' collaborative skills. The research studies referred to in this section addressed online interaction, the use of CMC tools in online courses, and the influence of asynchronous discussion forums in general and structured discussion forums in particular on the improvement of different skills by the learners.

Interaction in Online Learning

Constructivism emphasizes social interaction as a basis for knowledge construction. Most educators agree that interaction and discussion between students and their instructor and among the students themselves are critical in promoting and enhancing online learning (Gokhale 1995, 23; Muirhead and Juwah 2004, 17; Palloff and Pratt 2010, 33; Swan 2002, 4).

Interaction can be described in terms of the actors participating in the interaction (Anderson 2008, 43). Moore (1989, 2) first distinguished between the three most common types of interactions that support learning in online courses: learner-content interaction, learner-instructor interaction, and learner-learner interaction (Anderson 2008, 46; Swan 2002, 4). In online courses, none of the three kinds of interactions function independently and, therefore, it is important to plan for all three kinds of interaction and not only for some of them (Moore 1989, 4; Swan 2002, 20).

Garrison et al. (2001) expanded these three kinds of interactions to include teacher-teacher, teacher-content and content-content interactions.

Although each of the mentioned types of interaction serves a significant educational function, learner interaction is considered most important, particularly if a learner-centered approach, within a social constructivist framework, has been adopted.

All three types of interactions specified by Moore (1989, 3) and the teacher-content interaction specified by Anderson and Garrison et al. (2001, 8-10), which are supported by the theory of constructivism, play an important role in structuring the discussions within the online courses delivered in this study.

Asynchronous Discussion Forums

In online courses, different asynchronous CMC tools can be used in order to support learning. The most widely used asynchronous tool for the purpose of increasing interaction and collaboration among participants in an online course is the discussion forum. Discussion forums allow the creation of collaborative knowledge since learners can work together, exchange information, share resources and ideas, and comment on each other's work (Preece 2001, 350). Thus, interaction in a discussion forum can result in collaboration between the participants where knowledge can be acquired and exchanged.

A review of online learning by Tallent-Runnels et al. (2006, 116) concluded that students in well-designed and well-implemented online courses learned significantly more than those in online courses where teaching and learning activities were not carefully planned. Also Spatariu, Quinn and Harley (2007) reviewed research on factors that impact aspects of online discussions quality and gave the following two conclusions: (1) collaborative learning structures, message types, and use of open-ended problems can influence aspects of online discussions quality, and (2) "certain interventions (peer mentoring and scaffolding and group structure) appeared to influence students' critical thinking and interaction patterns" (47).

Practitioners continue to question how best to integrate discussions into online courses to meet learning goals. Anderson (2008, 55) stated that one of the critical roles that an instructor performs in an online learning course is the creation and implementation of strategies that will encourage discourse between and among the participants and between students and content resources. According to Lall and Lumb (2010, 382), an effective online course includes the use of online teaching strategies that incorporate discourse as part of the pedagogical design. It is therefore important to structure the asynchronous discussion forums in order to provide a foundation for critical discussions and critical thinking (Brooks and Jeong 2006, 373; Baldwin 2005, 94) and to enhance learning in online courses.

Unstructured and Structured Discussion Forums

A discussion forum can be unstructured or structured. An unstructured discussion forum does not include planned discussions; neither does it provide rules for interaction and collaboration among the participants. It is primarily used for asking questions and obtaining answers and feedback from the participants rather than for posting discussion topics (Yang et al. 2008, 1584). Sometimes it is used by students for personal communication with their peers. In contrast, a structured discussion forum provides well designed, organized and planned discussions with specific topics and goals (Yang et al. 2008, 1584) and has clear interaction, collaboration and etiquette rules (Biesenbach-Lucas 2004, 168; Brooks and Jeong 2006, 386).

There is a general agreement that using discussion forums in order to ask and answer questions (unstructured mode) will not be effective for the acquisition of knowledge and skills. Ali and Salter (2004, 11) suggested that simply asking students to respond to an instructor's given topic or question is not likely to generate an effective collaborative learning environment. They also mentioned that students may not achieve the expected learning outcomes without proper structure and management in online discussions.

Researchers argued that a major challenge facing the instructor in online learning settings is how to structure discussion forums in order to engage students in meaningful discourse (Al-Shalchi 2009, 106; Black 2005, 5; Gilbert and Dabbagh 2005, 5; Vonderwell, Liang and Alderman 2007, 322).

Although there is little research about the impact of discussion forums on learning, the opinions expressed by many educators suggest that structured discussion forums are more effective for the improvement of critical thinking skills than are unstructured forums (Aviv et al. 2003, 16; Gilbert and Dabbagh 2005, 5). Also Yang et al. (2008, 1584) investigated the impact of structured online discussions on the improvement of learner's critical thinking skills. The results showed that learners who participated in the structured discussion forums significantly improved their critical thinking skills than the learners who participated in the unstructured discussion forum.

The studies mentioned above provide sufficient evidence that asynchronous structured discussion forums are more effective for the improvement of critical thinking skills by the students than are unstructured discussion forums. However, it is not clear how to structure and manage discussion forums in computer science online courses in order to make their use among the students more effective for the improvement of their collaborative skills.

Methodology

Design of the Structured Discussion Forum: Summary

The first step in this study was to develop a plan for the structure of the discussion forum based on the theory of constructivism, on pedagogical principles and on principles of group interaction and collaboration. The plan of the structured discussion forum contains the following three elements: (1) preparatory instructions about individual participation, (2) instructions about group collaboration, and (3) instructors' role in organizing the discussion (Figure 1).

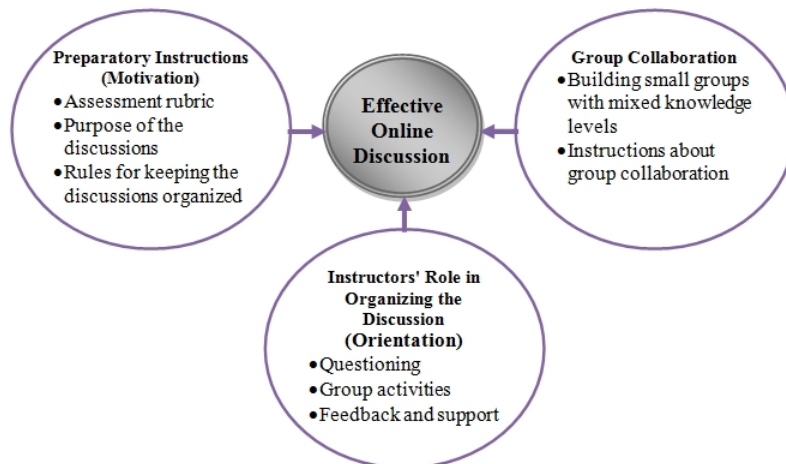


Figure 1: Main components of the structured discussion forum

Following is a summary of steps that have been taken regarding the design of the structured discussion forum.

- In the first step, the instructor explained (through an assessment rubric) how students will be evaluated in the course, the purpose and the nature of the discussions in the discussion forums and requested the students to fulfill the rules set for the participation in the discussion forums in order to keep the discussions organized.
- The instructor then constructed heterogeneous small groups of three or four students with mixed knowledge levels according to the results of the pre-test. This way of forming the small group assures at least that the best students in the class do not cluster

together, leaving the weaker ones to fend for themselves. Each group received a group name.

- In the next step, the instructor established a discussion forum for each constructed small group. The participation in a small group discussion forum was allowed only for the members of that small group and not for other students. The instructor's role in the small group discussion forums was to facilitate students' interaction with the materials and with each other in their knowledge constructing endeavor.
- Students were then informed about the objective of establishing small group discussion forums, encouraging them to use these forums for the purpose of enhancing their interaction and collaboration around the learning materials and the group learning activities.
- Students were requested to participate actively in two levels of discussion groups. The first level was the central discussion forum where students from all small groups were participants; the second level was the small group discussion forum. Students were also told about the role of the instructor in each one of these two levels of the discussions.
- The instructor was actively involved in the central discussion forum in order to create a learning environment that motivates the students to construct knowledge through meaningful interaction with each other as well as with their instructor. The instructor regularly posted questions on different levels of knowledge to the forum and gave feedback to students' posts. The increased number of postings to the central discussion forum all over the course can make it difficult for the students to find specific information. Therefore, for each central topic in the course a new central discussion forum was established in order to contribute to a clear and a better organization to the whole process.
- The instructor posted lists of questions and problems to be solved and related each question to a different student. Students then answered the questions directed to them and were requested to give comments on other students' answers within a given period of time. Other types of clarification and support, such as offering explanations, clarification of students' understanding and offering suggestions that guide and improve deeper and further discussions, were also made. This part of the discussion was continuous over the entire course and aimed to encourage more interaction among the participants in order to enhance knowledge acquisition on different levels.
- In the middle of the semester, the instructor organized a group activity that asks each group of students to study a different limited subject and to prepare a short learning unit (composed of four pages) about this subject including three questions, each one related to a different kind of knowledge (know-what question, know-how question, and know-why question).
- In the next step, each group was required to study and discuss a learning unit of a different group, specified by the instructor, and to post the answers to the questions as well as comments on the learning unit within the specified deadline. Then, each group was requested to check the answers and feedback they received and to comment on them.
- Besides the continuous feedback and support throughout the whole course, the instructor also sent a monthly personal positive feedback to the students about their level of participation, motivating students with low participation to be more active in the discussion forums.
- At the end of the semester, each small group of students was requested to complete a final project, which was clearly described by the instructor.

Research Question

The following research question was examined in this study:

To what extent does a structured discussion forum impact the improvement of collaborative skills by computer science students?

Participants

In this study seven different online courses were conducted fully online. The participants in this study were 123 Arab students in computer science education from two different Israeli Academic Colleges of Education. They were divided into two groups: 60 (48.8%) students participated in structured discussion forums (experimental group) and 63 (51.2%) students participated in unstructured discussion forums (control group). In both groups most of the participants (95%) were female with an age ranging from 20 to 24 years. 43.3% of the students in the experimental group were second year students, 46.7% of them were third year students and 10% of them were fourth year students. Likewise, 41.3% of the students in the control group were second year students, 42.9% of them were third year students and 15.9% of them were fourth year students. Student's Prior experience in online learning was measured according the number of fully online courses previously completed by the student. The largest percent of students in both groups (55% in the experimental group and 63.5% in the control group) didn't participate in any fully online course before. 30% of the experimental group and 15.9% of the control group reported taken one fully online course. Since the number of students who completed two or more fully online courses in both groups was relatively small, they were grouped together and displayed as one group. 15% of the students in the experimental group and 20.7% of the students in the control group reported completion of two to four fully online courses before starting this research. The mean of this variable is 0.72 with standard deviation of 1.096. This description of the distributions shows that both groups (experimental and control) have similar background in online learning experience ($\chi^2(2, N=123)=3.613, p<0.164$).

Design of the Study

A survey design in a form of a questionnaire was used to determine the differences in the improvement of collaborative skills by the students of the control and the experimental group. The questions in the questionnaire came from the literature (Brewer and Klein 2006, 341-344; Johnson and Johnson 1989, 141; Lin and Laffey 2006, 387-389) and are based on the definition of effective group collaboration specified by Johnson and Johnson (2004, 793). According to this definition the construct *collaborative skills* consist of the following five components: (1) positive interdependence, (2) individual accountability, (3) promotive interaction, (4) social skills, (5) group processing. The questionnaire consisted of 37 five-point Lickert-style statements, which were ranked from 1-5 with 1 indicating "strong disagreement" and 5 indicating "strong agreement". The statements included in the questionnaire covered all the five components of the construct *collaborative skills*. Scales and the statements in each component are presented in Appendix A. Because this measure instrument was based on the definition of effective group collaboration given by Johnson and Johnson (2004, 793), which assumes the presence of all five components for small group learning to be truly collaborative, the construct *collaborative skills* was measured here as one score.

Since the researcher is associated with the study, another computer science teacher was asked to distribute and collect the questionnaires to the students at the end of the online course in a face-to-face meeting.

Pilot Test

A pilot test on twenty students was conducted. The pilot test served the following purposes: (1) to explore problems of lack of clarity on some questions in the questionnaire for examining collaborative skills by the students, and (2) to help testing the validity and reliability of this questionnaire. The participants of the pilot test were third year computer science students enrolled in the fully online course "website building". Sixteen of the students were female and four of them were male. Based on the data of the pilot test 4 statements were excluded from the questionnaire as it is described in the following section.

Validity and Reliability

To deal with the validity of the questionnaire for measuring the dependent variable *collaborative skills*, four education instructors examined the questionnaire for face validity. After incorporating the comments of the reviewers, the questionnaire was distributed to the students of the pilot study.

To determine the reliability of the questionnaire a test-retest method was used. The students of the pilot test were given the questionnaire again two weeks later to check if the results were consistence. The collected data was analyzed for reliability and other validity aspects using SPSS. The results were that some statements from the questionnaire were not clear to the students and the elimination of the statements did not affect or weaken the variable.

Since the number of participants in the pilot test was small relative to the number of statements in the questionnaire it was important to calculate the Alpha Cronbach test of reliability for each component of the construct *collaborative skills* separately. Table 1 shows the results of the Alpha Cronbach test of reliability before and after excluding the items from the questionnaire.

Table 1: Scale Reliabilities in the Pilot Test

	<i>Component</i>	<i>Items (No. in items list-Appendix A)</i>	<i>Cronbach's alpha</i>	
			<i>Before excluding items</i>	<i>After excluding items</i>
<i>A</i>	<i>Positive interdependence</i>	1,2✕,3✕,4,5R,6,7,8,9R,10	.765	.811
<i>B</i>	<i>Individual accountability</i>	11,12R,13R,14,15,16	.824	.824
<i>C</i>	<i>Promotive interaction</i>	17,18,19,20,21R,22,23,24	.918	.918
<i>D</i>	<i>Social skills</i>	25,26R,27R✕,28,29,30,31,32,33,34	.862	.907
<i>E</i>	<i>Group processing</i>	35,36,37,38,39,40✕,41R	.821	.873
<i>All components as one variable (number of items 37)</i>				.970

R-reverse scale, ✕ - item excluded after the pilot test

Final Reliabilities

Before analyzing the data, reliabilities were tested again using the data from all 123 questionnaires of the experiment. Final reliabilities are presented in Table 2. Each one of the five components, separately as well as all components together, exhibited final alpha reliabilities above .70, which are considered good.

Table 2: Scale Reliabilities of the Questionnaire Calculated Using the Experiment's Data (N=123)

	<i>Component</i>	<i>No. of item</i>	<i>Cronbach's alpha</i>
<i>A</i>	<i>Positive interdependence</i>	8	.818
<i>B</i>	<i>Individual accountability</i>	6	.792
<i>C</i>	<i>Promotive interaction</i>	8	.806
<i>D</i>	<i>Social skills</i>	9	.845
<i>E</i>	<i>Group processing</i>	6	.857
	<i>All components as one variable</i>	37	.951

Result

To test the impact of the independent variable *discussion forum type* on the improvement of *collaborative skills* by the students of both groups, a t-test for two independent samples was conducted. Results are shown in Table 3.

Table 3: Effect of Discussion Forum Types on the Improvement of Collaborative Skills

<i>Variable</i>	<i>Experimental (N=60)</i>		<i>Control (N=63)</i>		$T_{(121)}$
	Mean	S.D	Mean	S.D	
<i>Collaborative skills</i>	4.01	0.36	3.1	0.55	10.87**

** p<0.001

The results described in Table 3.3 show that students who participated in the structured discussion forum have a mean of the variable collaborative skills equal to 4.01 (S.D. 0.36) which is higher than 3.1 (S.D. 0.55), the mean revealed for the same variable by the students of the unstructured discussion forum. The obtained difference between both groups was statistically significant ($t_{(121)}=10.87$, $p<.001$) at a high level of significance.

Discussion

The findings showed that students of the experimental group significantly improved their collaborative skills as compared with students of the control group. This finding is inline with previous research which shows that students who participated in collaborative group activities, which are problem-based or project-based, benefited from improved communication, teamwork, and conflict resolution skills (ChanLin 2008, 63-64; Xu and Liu 2010, 366-368).

Unlike the students of the control group, students of the structured discussion forum, in each delivered online course in this study, participated in small group activities and carried out a final group project. They also received clear instructions about group collaboration and were directed and encouraged to work collaboratively. Working collaboratively on a group activity, such as a group project, promoted a situation in which group members realized the importance of each member's contribution for the group success and thus challenged each other's ideas and facilitated each other's efforts in order to reach the group's goals. In such a situation, students within the collaborative small group were linked together, were accountable for the group work, received help and assistance from each other, shared their resources and materials, and provided each other with feedback in order to successfully perform the group activity. This implies that the students of the experimental group, in comparison to the students of the control group, had the

opportunity to practice essential skills of collaboration and this enabled them to improve these skills.

Within the small group discussion forums, members of each small group analyzed and discussed the different points of view and the multiple solutions to a problem and searched for evidence to support their arguments. They also monitored each other's work and discussed their performance progress as a group. Through the exchange of ideas and the process of consensus building, group members shared different ideas and perspectives and developed, among other skills, listening and communication skills. As a result, the students of the experimental group improved their social and small group skills such as decision making, trust building, communication, and conflict management skills. Since the students of the control group were not requested to participate in group learning activities and completed their course project independently, they rated lower in the improvement of their collaborative skills compared to the students of the experimental group. This explanation is also consistent with the results of other studies (Benaya and Zur 2007, 130; McKinney and Denton 2006, 143; Teague and Roe 2008, 151), which showed that the integration of collaborative activities into online computer science courses benefits student's learning as well as the development of their collaborative skills.

Another explanation for this finding could be the instructor's role in helping and promoting effective interaction and collaboration between group members. The instructor incorporated well-planned realistic collaborative activities and motivated as well as directed the students to work collaboratively together. From time to time they had to report on how they were functioning. The instructor also regularly provided feedback to the groups on how well the group members worked together and suggested means of improvement. On top of the ongoing feedback and support, the instructor gave positive feedback for each student once a month. The personal feedback aimed to encourage and facilitate the students with low participation to be more active in the discussion forum. As a result, the social constructivist style of the instructional strategy in this study helped the students to learn in a more collaborative, authentic and responsible way and thus influenced the improvement of collaborative skills by the students of the experimental group. This explanation of the finding can be supported by the results of the research conducted by Gafford (2005, 135), which examined the differences between two groups using collaborative learning activities, where only one group received instructor's help about working in a collaborative learning group. The results indicated that the group who received the instructor's intervention had more positive perceptions towards collaborative learning, advantages for thinking on task, student engagement, perceptions of task importance, and best levels of challenge and skills. It has also been reported that simply putting students together and asking them to work collaboratively does not assure that they will engage in meaningful collaborative learning (Anderson 2008, 55; Biesenbach-Lucas 2004, 168; Johnson and Johnson 1989, 138). This highlights the importance of the instructor's support during the collaborative learning process.

Conclusion

Online discussions are an integral part of online courses. In this study data was found to indicate the significant effect of structured discussion forums on the improvement of collaborative skills by students in online computer science courses.

The main contribution of the current study to the field of asynchronous online learning is in providing a structure for discussion forums that has the potential to improve collaborative skills by the students. As such, the proposed structure and management of the discussion forum can be adopted in online courses for the purpose of increasing the effectiveness of online collaborative discussions and thereby the quality of online learning.

Recommendations for Future Research

The proposed structure of the discussion forum in this study can improve collaboration among the students in computer science online courses and contribute in the development of their collaborative skills. This suggests that there are areas where further research may build on the findings of the current study that can be summarized as follows:

- In the structured discussion forum, students had mainly worked together in small groups. Each small group delivered a final project separately at the end of the course. It would be of interest to plan for a class collaborative project where each small group would be responsible for completing a part of the project. Then all parts of the project could be set together in order to make the whole project complete. Adding this component to the structured discussion forum might increase inter-group collaboration and contribute more to the improvement of collaborative skills by the student.
- Another possible direction could be to compare the effects of different kinds of structured discussion forums (structured, semi-structured, and unstructured) on the improvement of collaborative skills by the students.

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Appendix A: Questionnaire items of the construct *collaborative skills* and the measurement scale

Component A: Positive interdependence (8 statements)

1. I think that as a group we can learn more than learning as individuals.
2. I think that together we can generate better projects than we could have done as individuals. ✖
3. As an individual I can generate better projects than engaging in a group. ✖
4. I benefited from working with others in this discussion forum.
5. I think that my success in the course project is related only to my own work.(R)
6. I think that the success of the group depends on the contributions of each group member.
7. I made a unique contribution to the joint effort.
8. I felt that we depended on each other while working on the course project.
9. Working with others in this discussion forum was a waste of time. (R)
10. I think that my success in the course project is also related to the contributions of others.

Component B: Individual accountability (6 statements)

11. I felt responsible for the participants in the discussion forum.
12. I didn't feel responsible for the success of each participant in the discussion forum.(R)
13. It wasn't important for me to observe other participants' work. (R)
14. I felt responsible to complete my work on time.
15. I felt responsible to complete my work on the best way possible.
16. I felt responsible to observe other participants' work.

Component C: Promotive interaction (8 statements)

17. I shared necessary materials and information for the project with other participants.
18. We helped each other out whenever necessary while working on the project.
19. I encouraged others for their efforts.
20. I discussed other participants' contributions.
21. I kept necessary materials and information for the project for myself. (R)
22. I tried to discuss concepts being learned with others.
23. I tried to give others helpful feedback.
24. The participants always discussed my contributions.

Component D: Social skills (9 statements)

25. I always tried to find ways to help others.
26. Participants' ideas and opinions regarding the project were not interesting for me.(R)
27. I didn't pay attention to other participants' understanding. (R) ✖
28. From time to time, I checked for other participants' understanding of the learned materials.
29. I helped others to solve group problems.
30. I demanded participants' ideas and opinions regarding the project.
31. Sometimes, I tried to give direction to group's work.
32. I tried to compliment people when I liked something they have done.
33. I apologized to others when I did something wrong.
34. I was initiative in dividing tasks of the project among the participants.

Component E: Group processing (6 statements)

35. We had discussions in order to specify the goals of the project.
36. The participants of the discussion forum tried to find ways in order to solve group problems.
37. We discussed the achievement of the goals of the course project.
38. The participants of the discussion forum provided helpful feedback to each other regarding the course project.

- 39. We monitored each other's work in order to ensure high quality of the course project.
- 40. The participants tried to keep the discussion forum organized. ✖
- 41. The achievement of the goals of the course project was not discussed by the participants. (R)

R-reverse scale, ✖ - item excluded after the pilot test.

Measurement Scale:

1	2	3	4	5
Strongly Disagree	Somewhat Disagree	Neutral	Somewhat Agree	Strongly Agree

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Journal of Technologies in Education is one of the four thematically focused journals that comprise the Technology Collection and support the Technology, Knowledge, and Society knowledge community—its journals, book series, and online community.

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Journal of Technologies in Education is a peer-reviewed scholarly journal.

ISSN 2381-9243

