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Analyzing the Effects of Computer-Supported Collaborative Learning on Agricultural Students Knowledge regarding Sustainable Water Resources Management: Case Study of Iran

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ABSTRACT

Computer-Supported Collaborative Learning (CSCL) is a new trend in educational sciences. This study investigates how knowledge sharing and transferring can be facilitated by using CSCL in a problem-solving setting. Intervention of research is education regarding Sustainable Water Resources Management (SWRM) by Computer-Supported Collaborative Learning (CSCL). The purpose of this research was to determine whether change of knowledge was accomplished after utilization of CSCL in agricultural MSc. and PhD. students of Science and Research Branch University, Ahwaz, Iran. Education by CSCL was accomplished in a two-week period. As a part of the experimental design, 173 university students were randomly assigned and divided to four groups. The first group with 43 students was labeled pretest-posttest treatment group (E). The second group, with 44 students, labeled pretest-posttest control group (C_1), only received face to face education, which was known as the control group. Thus, we compared the effect of the treatment between the first and second group. The third group as the posttest-only treatment group (C_2) received the CSCL, with 44 students, and the fourth group as posttest-only control group (C_3) with 42 students did not receive the treatment. The results showed that there was significant difference between posttests knowledge score of C_2 and C_3, and E and C_1. Also, there was a significant difference between pretest and posttest in the experimental group. This result indicated the impact of treatment (CSCL) on the knowledge level of students. In addition, F-test analysis showed there were significant differences among posttests in all groups.

Keywords: Collaborative learning, Computer-supported collaborative learning, Solomon four group designs.

INTRODUCTION

The structure of the learning environment, based on constructivism, is to promote opportunities that encourage the building of understanding (Kala *et al.,* 2010). Groves (2008) pointed out, using a constructivist approach in the education where the educator encourages the learner to discover knowledge through group work, inquiry, and experimentation. Splitter (2009) describes that the constructivism is a psychological theory about how we learn actively and consciously by bringing our past experiences and understandings into a collaborative exercise with other students and negotiate the meaning of new information. Wilson (1995) describes a model to computer

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supported education in which technology could be an engine to help keep students active, constructive, collaborative, intentional, complex, contextual, conversational, and reflective. A dominant phenomenon of constructivist learning is collaboration among learners. In a constructivist learning environment, the predominant communication configuration is that of learner to learner and refers to a teaching method whereby students are encouraged or required to work together on problem solving tasks (Barajas, 2003). Using technology in constructivist environments enables the learner to be more responsible and active in the learning process, which contributes to an increase in learning outcomes (Al-Bataineh *et al.,* 2008) (Figure1).

Therefore the major element of collaborative learning as the key part of constructive learning is that learners can learn in the best manner when they have opportunities to learn with other people in a collaborative way (Dillenbourg, 1999).

Emerging Trends of CSCL

CSCL is an emerging trend of learning sciences concerned with studying how people can learn together with the help of information technology (Stahl, 2006). Environments for CSCL can be designed to facilitate argumentative knowledge construction (Noroozi *et al.,* 2013a). CSCL

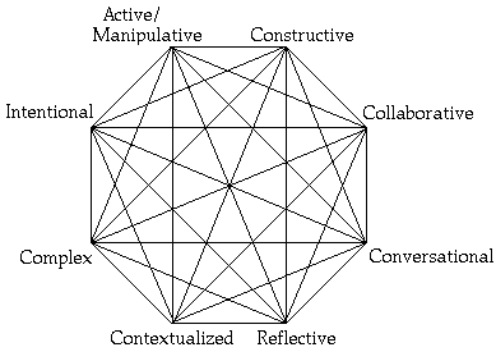

Figure 1. Constructive learning environments (Wilson, 1996).

is one of the more dynamic research directions in educational psychology (Gress *et al.,* 2010). CSCL is about teaching and learning the knowledge and skills required to participate in the knowledge-based environment in society with the basic skills they rely upon (Scardamalia and Bereiter, 2006). It is also a new and emerging trend in the educational sciences (Stahl *et al.,* 2006) and is focused on how collaborative learning supported by information technology can enhance interaction and working in groups, and how collaboration and technology facilitate sharing and distributing of knowledge and expertise among group members (Piki, 2011). Furthermore, based on Figure 2, CSCL helps integrate fields as diverse as educational psychology, situated cognition, small-group research, groupware design, and other research areas from which CSCL borrows (as well as builds on) theoretical models, analytical methods, and contexts of study (Sarmiento-Klapper, 2009).

Effects of CSCL on Social and Cognitive Behavior

The rapid development of new communication tools has led us to computer applications that have proven useful to supporting learning (Phielix *et al.,* 2010). Collaborative learning by CSCL is the mutual engagement of participants in a coordinated effort by using multiple CSCL tools to solve the problem together (Kirschner *et al.,* 2004). Phielix *et al.* (2010) demonstrated that awareness stimulated by peer feedback and reflection tools enhances group-process satisfaction and social performance of CSCL-groups. Noroozi *et al.* (2013b) investigated how various aspects of a Transactive Memory System (i.e., specialization, coordination, and trust) can be facilitated using a transactive memory script that spans three interdependent processes (i.e., encoding, storage, and retrieval) in multidisciplinary CSCL. Drie *et al.* (2004) indicated that CSCL aims at

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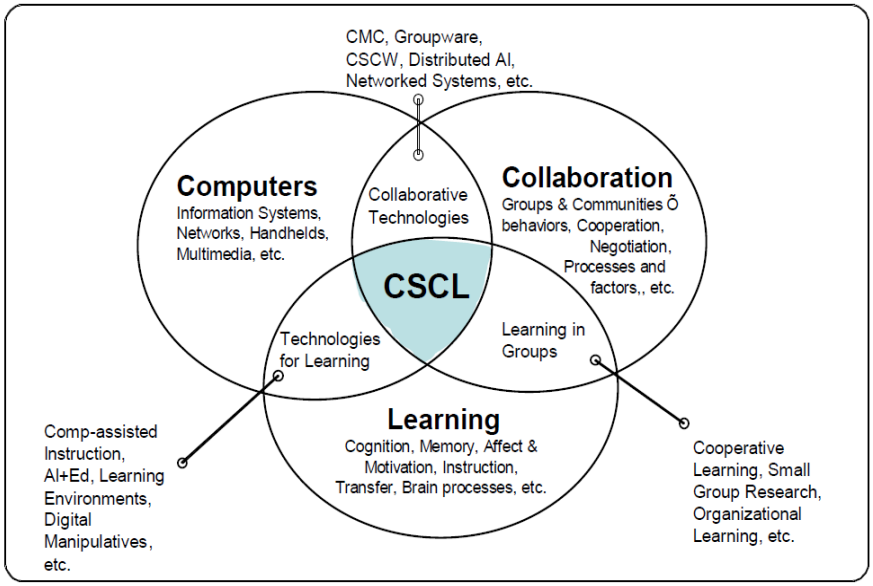

Figure 2. The Multidisciplinary Field of Computer-supported Collaborative Learning. (Sarmiento-Klapper, 2009; P. 21).

enhancing and supporting peer interaction and the joint construction of products through technology. Therefore CSCL provides an educational environment and also facilitates and supports students' learning processes (Hung *et al.,* 2005). Noroozi *et al.* (2013b) showed interaction effects for the transactive memory and discussion scripts on transactive knowledge sharing and transfer. Noroozi *et al*. (2012) showed that online discussion in CSCL appeared to compensate for suboptimal timing of presentation of supportive information before the learning task clusters in interactive digital learning materials. Also several researchers indicated that CSCL has a significant role in terms of learning outcomes (Noroozi *et al.,* 2011). Noohi, Abbaszadeh and Sayad Bagher (2013) concluded that collaborative learning approach with online programs is useful in response to rising demand for university educational system in Iran. Masoumi and Lindstrom (2012) and Zhang *et al.* (2010) concluded that with rapid growth of ICT-based technologies, e-learning is becoming an important part of higher education across the globe in order to meet rising demands for higher education particularly in developing countries. Ahmadi *at al.* (2014) showed that deployment of cooperative learning had a positive effect on the Iranian intermediate students' writing achievement. Shakibaei *et al*. (2011) in meta-analysis of studies on educational technology in Iran, showed information technology has a significant effect on educational improvement in higher education.

According to the theoretical review about CSCL role in learning outcomes and facilitating teaching new content in different areas of expertise in various studies; this study therefore, focuses on exploring and understanding effects of CSCL on the transfer of concepts and learning the basics of SWRM as one of the most specialized subjects in different trends of agriculture between MSc. and PhD. students.

MATERIALS AND METHODS

The study took place at Islamic Azad University Science and Research Branch, Ahwaz, Iran, which focuses on agricultural and human sciences. As a part of the experimental design, 173 university students from agricultural sciences were randomly

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assigned and divided to four groups. The first group with 43 students was labeled pretest-posttest treatment group (E). The effect of the CSCL as treatment was measured from the pre-test to the post-test. The second group, with 44 students, labeled pretest-posttest control group (C_1), only received face to face education, known as the control group. Thus, we compared the effect of the treatment between the first and second group. The third group as posttest-only treatment group (C_2) received the CSCL and the fourth group as posttest-only control group (C_3) did not receive the treatment.

Procedure

At this research experiment Solomon Four Group Designs (SFGD) was the main experimental design. This design contains two extra control groups, which serve to reduce the influence of confounding variables and allow the researcher to test whether the pre-test itself has an effect on the subjects (Shuttleworth, 2009). An experimental design in which subjects are randomly assigned to two study groups and two control groups. Pre-test measures are used for one of the study groups, and one of the control groups. Following the exposure of the study groups to the intervention or experiment, posttest measures are collected on all four groups.

1. As a pre-test, two groups were selected (E and C_1). To assess the quality of their prior knowledge regarding Sustainable Water Resources Management (SWRM), students were given 30 minutes to individually design and analyze the essential aspects of an evaluation study. After this pre-test, two groups of students (E and C_2) were given two weeks education in the CSCL environment and the essential aspects of the evaluation studies was developed by both groups of students. We gave 180 minutes of different instruction to students prior to CSCL. Next, four groups of students had to do an individual post-test to assess the quality of knowledge construction after collaborative learning for E and C_2 groups, and face to face learning for C_1 and C_3 groups. They had to redesign the same evaluation study individually within 30 minutes based on what they had learned during collaborative and face to face phase. For comparisons between post-tests in some groups independent T-test was used. Also were compared the students knowledge about SWRM in post-test groups by F-test.

Post hoc analysis was used to determine a group which was affected by CSCL environment more than others.

Participation in the course was two weeks on a daily basis and between 8 am to 12 pm. At this time, students were required to participate in discussions in groups and between groups. We had online for at least 5 minutes a day.

The evaluation studies were analysed in the pre-test and post-test by using two types of questionnaires on the principles of SWRM for measuring technical knowledge of students in pre-test and post-test. Its validity was confirmed by a panel of experts and its reliability was determined by Cronbach's Coefficient Alpha of 0.8.

After two weeks, 568 text messages were exchanged between learners to learners and educator to learners. During this time the task of the educator was facilitating and encouraging students to achieve the correct answers.

RESULTS AND DISCUSSION

Characteristics of the Participants

Based on the results 63.58 percent of the respondents were women. The average age of participants was about 28 years. Most respondents (86.13%) had experiences with the online environments and 67.05% of respondents had collaboration experiences. Also, 95.38% and 97.69% of the respondents had high level computer literacy and social

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media affinity, respectively. These are all important factors that could influence learning in the CSCL environments.

Personal characteristics such as age, gender, education, collaboration experience and computer literacy may be important factors that could influence learning in the CSCL environments (Ahmadpour *et al.,* 2016). Bhuasiri *et al.* (2012) concluded characteristics such as age, education, motivation and so on are effective on using computer in education and e-learning success.

Satisfaction with Collaborative Learning

Table 1 contains the group means and standard deviations of the satisfaction variables. The means range was from 3.28 to 4.12. These results indicate that the average scores for all satisfaction variables are above the midpoint. Some authors have stated that collaborative learning can stimulate students to teamwork skills and more positive attitudes towards group members (Johnson *et al.,* 2007). Many researchers have reported that students working in groups tend to learn more of what is being taught, develop higher level thinking skills, promote interaction and familiarity, build self-esteem, enhance satisfaction with the learning experience, promote a positive attitude toward the subject matter, develop oral communication skills and increase diversity understanding (Roberts, 2005).

Satisfaction with Network-based Tools for Collaborative Learning

The rapid development and expansion of computer network technology has had a strong influence on the tools and methods of CSCL. Networks facilitate students' collaboration even in situations where there are no opportunities for face-to-face communication. Based on table 2, the means range was from 3.09 to 4.67. These results indicate that the average scores for all satisfaction variables are above the

Table 1. Means and standard deviations of variables in satisfaction with collaborative learning.

Satisfaction with:	N	M [a]	SD
Learning in group	173	3.45	0.59
Other group members	173	3.87	0.78
Working in group	172	3.28	0.66
Communicate by network	172	4.12	0.73
Active engagement in learning	173	4.09	1.08
Lower cost of learning	172	3.89	0.89

[a] 1= strongly disagree, 5 = strongly agree

Table 2. Means and standard deviations of variables in satisfaction with network-based tools for collaborative learning

Tools	N	M [a]	*SD*
Internal sharing system in university	171	3.43	0.79
Intranet system	173	3.87	0.89
Electronic mail	170	3.12	1.04
World wide web	173	3.09	0.93
Administrative network (Local network)	173	4.12	1.07
Virtual education by personal website	173	4.09	0.88
Interaction communication tool	173	4.12	0.78
A multi-media tool	173	4.67	0.93
Computer conferencing	170	4.66	0.79
Computer phone services	173	4.06	0.98

[a] 1= Strongly disagree, 5= Strongly agree.

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midpoint. This means that students in general were quite satisfied with network-based tools for learning collaboratively. Different researchers modified that educational practices have been affected by developments in technology-enhanced environments focusing on the role of new teaching-learning tools and strategies (Schoor and Bannert, 2011; Coffin and O'Halloran, 2008). Network-based tools for learning collaboratively have been designed to facilitate representing, constructing, and sharing knowledge (Kollar *et al.,* 2007). Many researchers have reported that network-based collaborative learning may provide opportunities for more equality in group work than actual face-to-face group work (Crook, 2000).

Students' perception regarding importance of collaborative learning

For analyzing students' perception regarding the importance of collaborative learning, 17 items were used (Table 3). Prioritization was based on the Coefficient of Variation (CV). The top three ranked items in favorable conditions were: (1) Developing Teamwork Practices, (2) Ability to communicate ideas, and (3) Using Problem Solving Methods.

Effects of Computer-supported Collaborative Learning on Knowledge of SWRM Approach: Using Solomon Four Group Design

The research examines issues involved in comparing groups and measure changes by using pre-test and post-test data. Different pre-test post-test designs are presented in a manner which can help rehabilitation professionals better understand and determine effects resulting from selected interventions. In this research intervention is education regarding Sustainable Water Resources Management (SWRM) by Computer-Supported Collaborative Learning (CSCL) based on network-based tools. CSCL by network-based tools was accomplished in a two-week period by 173 students. The results of inferential statistics

Table 3. Students' perception regarding importance of collaborative learning items.

Priority	*CV*	*Sd*	Mean	Items
1	0.213	0.88	4.12	Developing teamwork practices
2	0.214	0.88	4.09	Ability to communicate ideas
3	0.216	0.89	4.11	Using problem solving methods
4	0.217	0.86	3.98	Developing self thought and reliance
5	0.221	0.86	3.87	Information seeking by farmers
6	0.229	0.90	3.91	Discover knowledge through group work
7	0.256	1.00	3.92	Learner is of utmost importance
8	0.275	1.04	3.77	Using visual techniques for education
9	0.312	1.15	3.69	Goal of education is HRD
10	0.321	1.11	3.45	Promote learner-centered instruction
11	0.332	1.14	3.44	Emphasizes discourse and collaboration
12	0.354	1.25	3.52	Programs place a high value on field work
13	0.365	1.18	3.23	Using action research in technology education
14	0.375	1.22	3.24	Learners can learn how to understand other's opinions
15	0.389	1.21	3.12	Role of teacher is a guide, facilitator, and co-explorer
16	0.412	1.27	3.09	Self-direction, self-monitoring, self-assessment to engage Learners on a Personal Level
17	0.416	1.30	3.13	Programs include opportunities for reflection about the various discussions, and experiences.

5= Very high important, 1= Very low important.

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are shown in tables 5 to 9. Four groups were considered in this regard. The first group with 43 students was labeled pretest-posttest treatment group (E). The effect of CSCL as the treatment was measured from the pretest to the posttest. The second group, with 44 students, labeled pretest-posttest control group (C_1), received face to face education known as the control group in which there should be little or no change. Thus, we compared the effect of the treatment (CSCL) between groups 1 and 2 by means of results of the posttests. The third group as posttest-only treatment group (C_2) received the CSCL and the fourth group as posttest-only control group (C_3) did not receive the treatment (CSCL).

Figure 3 shows the experimental Solomon Four Group Designs (SFGD) (Noorivandi and Ommani, 2012). The treatment of CSCL by network-based tools was accomplished in a two-week period. The appropriate pretest and posttest of the experimental group and the first control group were completed, treatment was done for the experimental group and the second control group, plus the appropriate posttest was completed for all groups.

Table 5 indicates pretest and posttest knowledge scores of each group which was achieved from CSCL regarding SWRM. Table 6 indicates comparisons between post-tests in some groups by using independent *T*-test. The results show that there is a significant difference between post-tests knowledge score of C_2 with C_3 (t= 2.89, Sig.= 0.038, Effect Size=1.8 and Percent of nonoverlap= 77.5) and E with C_1 (t= 2.58, Sig. =0.047, Effect Size=1.6 and Percent of nonoverlap= 73.1). The cause of this significant difference was receiving education by CSCL tools (treatment). This result corroborates other research results which showed a positive impact of a CSCL on performance of learning in collaborative settings (Beers *et al.,* 2005). Also, numerous studies reported positive impact of technology on collaborative learning (Magnisalis *et al.,* 2011; Sadeghi and Kardan, 2015). In this regard Davies and Graff (2005) showed that active participation in CSCL environments may be

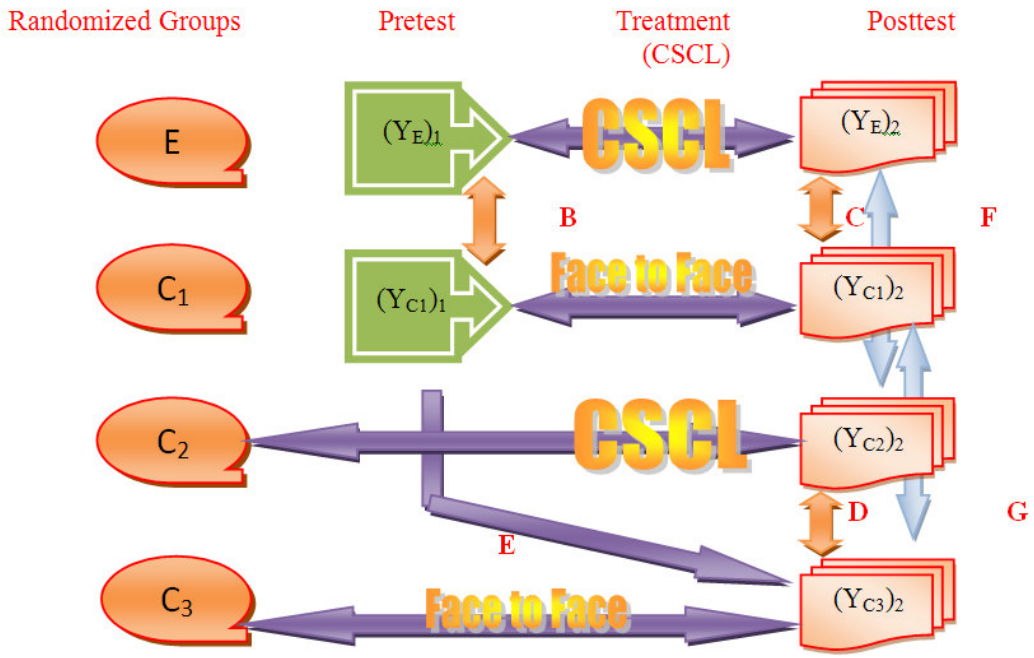

Figure 3. Solomon four group design for analyzing effects of CSCL on knowledge regarding SWRM.

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Table 4. Solomon four group experimental design

Posttest	Treatment	Pretest	Group name
$(Y_E)_2$	CSCL	$(Y_E)_1$	Pretest-posttest treatment group (E)
$(Y_{C1})_2$	-	$(Y_{C1})_1$	Pretest-posttest control group (C1)
$(Y_{C2})_2$	CSCL	-	Posttest-only treatment group (C2)
$(Y_{C3})_2$	-	-	Posttest-only control group (C3)

Table 5. Mean score pre/posttest groups knowledge.

Posttest	Treatment	Pretest	Group name
61.45	CSCL	39.41	Pretest-posttest treatment group (E)
45.69	-	37.87	Pretest-posttest control group (C1)
59.08	CSCL	-	Posttest-only treatment group (C2)
41.43	-	-	Posttest-only control group (C3)

Table 6. Comparisons between posttests in some groups.

Sig	*t*	Mean	Frequency	Posttest	Groups	Comparison groups
0.038	2.89*	59.08	44	$(Y_{C2})_2$	C2	C2 and C3
		41.43	42	$(Y_{C3})_2$	C3	
0.047	2.58*	61.45	43	$(Y_E)_2$	E	E and C1
		45.69	44	$(Y_{C1})_2$	C1	

associated with achievement of learning by the student. CSCL has been considered successful especially in explaining critical thinking (Lee, 2015). Guiller, Durndell, and Ross (2008) reported that students participating in online collaborative learning explained more reasons of critical thinking than students in a face-to-face condition. Nuutinun *et al.* (2010) presented effects of CSCL in the learning process. They suggested that it may engage college students in critical thinking through collaborative work.

According to table 7, there is no significant difference between pre/post-test of some groups. In addition the results show that there was a significant difference between pre-test and post-test in the experimental group, indicating the impact of treatment (CSCL) on the knowledge level of students. But there was no significant difference between pre-test and post-test in the first control group. It seems that there was no significant difference between pre-test and post-test in the first control group due to lack of treatment (CSCL) for this group (Table 8). The differences among knowledge of students about SWRM in all groups' post-test were analyzed by independent F-test. Table 9 shows these comparisons among all groups' post-tests. The results show that there was a significant difference among post-tests in all groups, which indicate the impact of treatment on the knowledge level of students. Post hoc analysis indicates that knowledge mean ranking in C_2 and E groups have significant differences with knowledge mean ranking in C_3 and C_1 groups. This condition was created by treatment (CSCL regarding SWRM). Therefore, education by CSCL can be used to achieve higher levels of knowledge regarding SWRM.

Figure 4 shows the interface of the learning group environment, which allows learners to submit their name to the groups. In addition, a discussion area management function is provided, which enables teachers to browse the contents of the discussion area for learning groups. The system also allowed the students to discuss and upload their group projects, as shown in Figure 5. The tasks of students during CSCL included:

-Participating actively in the discussion within the group and between groups in the environment of CSCL.

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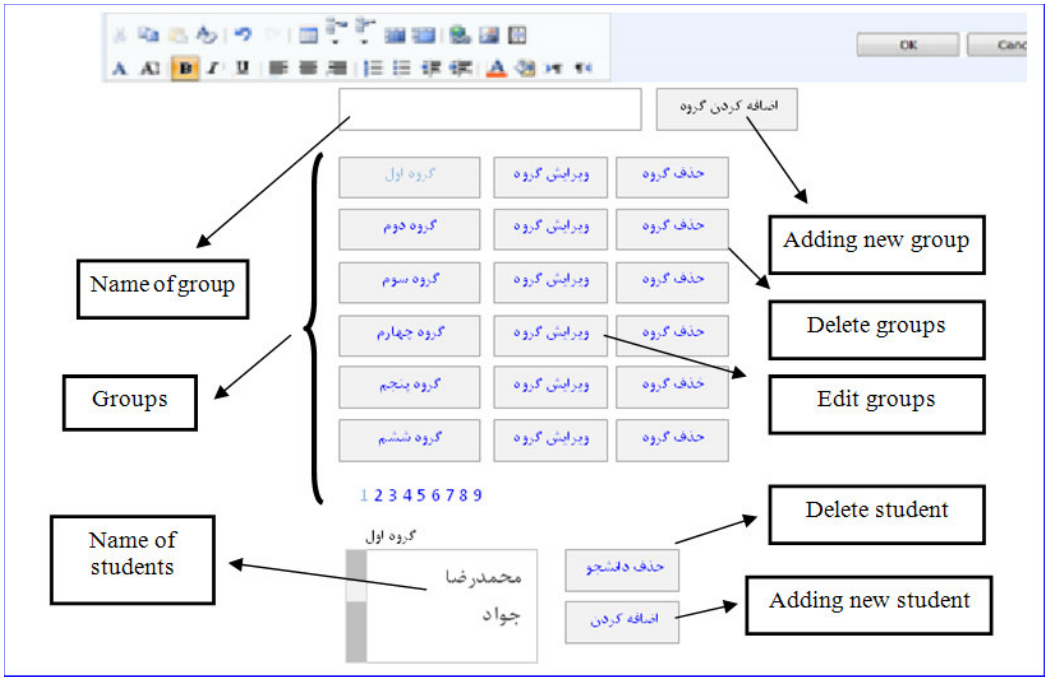

Figure 4. Collaborative group learning environment based on virtual space.

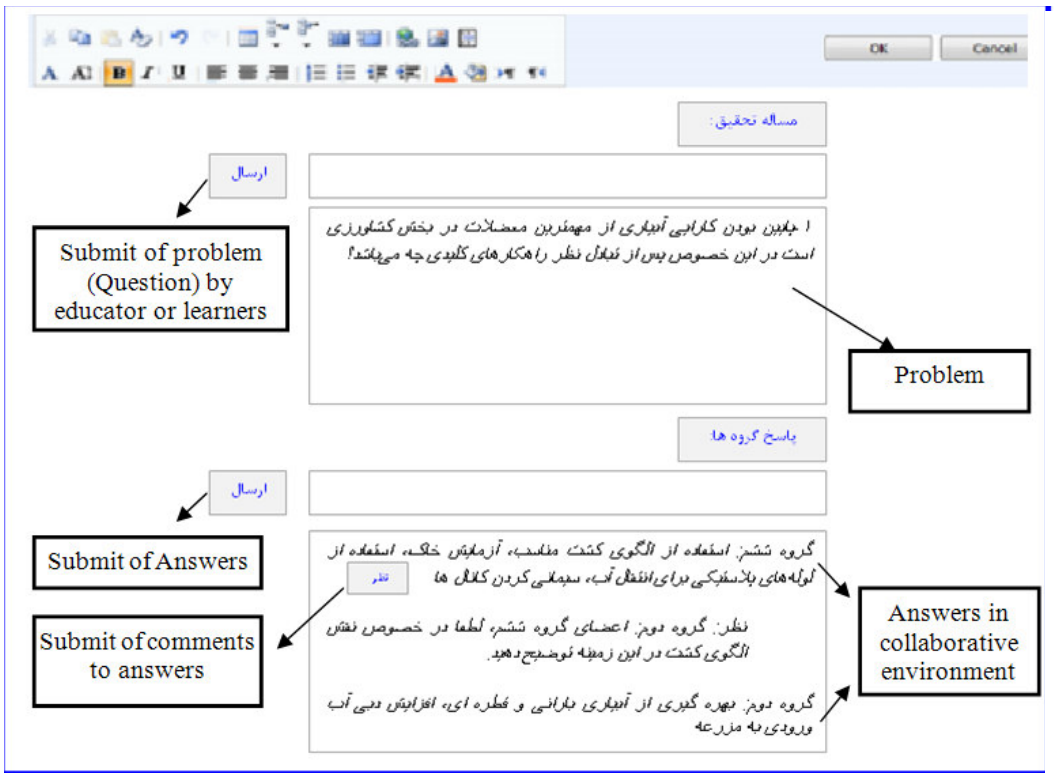

Figure 5. Virtual space for discussion and exchange of information for collaborative learning.

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Table 7. Comparisons pretests and posttest between some groups by independent *T*-test.

Sig	*t*	Mean	Frequency	Pre/Posttest	Groups	Comparison groups
0.189	1.03	37.87	44	$(Y_{C1})_1$	C1	C1 and C3
		41.43	42	$(Y_{C3})_2$	C3	
0.178	1.08	61.45	43	$(Y_E)_2$	E	E and C2
		59.08	44	$(Y_{C2})_2$	C2	
0.051	1.91	45.69	44	$(Y_{C1})_2$	C1	C1 and C3
		41.43	42	$(Y_{C3})_2$	C3	
0.041	2.48*	39.41	43	$(Y_E)_1$	E	E and C2
		59.08	44	$(Y_{C2})_2$	C2	

Table 8. Comparisons between pretest and posttest in E and C1 groups by dependent T-test

Sig	*t*	Mean	Frequency	Pre/Posttest	Comparison groups
0.021*	3.07	39.41	43	$(Y_E)_1$	Experimental group
		61.45	43	$(Y_E)_2$	
0.72	1.23	37.87	44	$(Y_{C1})_1$	First control group
		45.69	44	$(Y_{C1})_2$	

Table 9. Solomon four group experimental design

Sig	Duncan	*Sig*	*F*	*SD*	Mean	Frequency	Comparison groups
0.047	E and C_1			3.45	61.45	43	E
0.038	C_2 and C_3	0.021	4.56	2.98	45.69	44	C_1
				3.62	59.08	44	C_2
				2.87	41.43	42	C_3

-Responding to questions raised by the educator or other learners in an environment of CSCL.
-Raising ambiguity and uncertainty in order to achieve solutions to the problems in the CSCL environment.

CONCLUSION

For analyzing students' perception regarding the importance of collaborative learning, 17 items were used. The top three ranked items in favorable conditions were: developing teamwork practices, ability to communicate ideas and using problem solving methods. We also explained the importance of network-based tools for CSCL settings and pointed out why knowledge awareness, could be helpful for these settings. The research then examines issues involved in comparing groups and measuring change with pre-test and post-test data. The results of inferential statistics showed the critical role of CSCL for increasing knowledge of learner regarding a subject matter (SWRM). The present analysis is based on a relatively small sample of students, but the results provide a direction for developing participation and discussion in the online portions of courses.

The results of the research provide useful insights for educators, university managers and especially for higher education policymakers on planning, policymaking and curriculum development along with methods of teaching students. By locating the important influences affecting online participation in training the students, the present analysis is able to offer a number of suggestions for improving student engagement in a CSCL discussion. Future work should examine these influences on other groups of students in other online classroom discussion contexts. It is concluded that creating a community is not simply a question of implementing a CSCL-environment. The future research on CSCL should focus more systematically on the educational, economical, cultural,

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organizational, and individual constraints of the university context and the teaching-learning situation.

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تحلیل اثرات یادگیری مشارکتی با پشتیبانی رایانه بر دانش مدیریت پایدار منابع آب دانشجویان کشاورزی (مطالعه موردی ایران)

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چکیده

یادگیری مشارکتی با پشتیبانی رایانه (CSCL) یک جهت گیری نوینی در علوم آموزشی است. این تحقیق چگونگی تسهیل تسهیم و انتقال دانش از طریق کاربرد CSCLرا در یک فرآیند حل مسأله مورد ارزیابی قرار می دهد. در این تحقیق متغیر مداخله گر آموزش در زمینه مدیریت پایدار منابع آب از طریق یادگیری مشارکتی با پشتیبانی رایانه بوده است. هدف از اجرای این تحقیق ارزیابی اثر کاربرد CSCL بر دانش دانشجویان مقطع کارشناسی ارشد و دکترای کشاورزی علوم و تحقیقات خوزستان در زمینه مدیریت پایدار منابع آب بوده است. آموزش از طریق CSCLبه مدت دو هفته به اجرا درآمد. به منظور اجرای تحقیق ۱۷۳ نفر از دانشجویان کشاورزی به صورت تصادفی به عنوان نمونه در تحقیق آزمایشی انتخاب شدند. نمونه آماری به چهار گروه تقسیم شد. گروه اول با ۴۳ نفر به عنوان گروه تیمار پیش آزمون پس آزمون(E) ، گروه دوم به تعداد ۴۴ نفر به عنوان گروه کنترل پیش آزمون پس آزمون(C1) ، گروه سوم به تعداد 42نفر به عنوان گروه تیمار فقط پس آزمون (C2) و گروه چهارم به تعداد ۴۴ نفر به عنوان گروه کنترل فقط پس آزمون (C3) در نظر گرفته شدند. نتایج نشان داد. اختلاف معنی داری بین دانش دانشجویان در گروه های Eبا C1 و C2 با C3 وجود دارد. همچنین تفاوت معنی داری بین پیش آزمون و پس آزمون در گروه آزمایشی مشاهده شد. این نتایج نقش مؤثر تیمار بر دانش دانشجویان را نشان می دهد. همچنین نتایج آزمون تحلیل واریانس نشان دهنده اختلاف دانش در تمام گروه های پس آزمون است.

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