

Development and Application of Concerto II : Question-posing Based Collaborative Learning Support System

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Abstract

Along with the progress of information society, many web-based learning support systems have been developed. Such systems enable learners to use them at any time and from any places. The authors created a Web-based collaborative learning system, which supported question-posing by learners, assessment from peers, and communications with question-posers and peers called Concerto. They applied it to an actual university course. As the results they identified some features to be enhanced, i.e., active communication support, and request of question-posing. The authors created a collaborative learning support system based on question-posing called Concerto II to solve the problems. They applied it to an actual university course. As the result, they found learners can communicate for questions in an asynchronous learning environment, i.e., outside of the classroom. As for the function of request of question-posing, they found it facilitated to pose questions and contributed to select questions learners wanted to tackle. On the other hand, some issues were found that similar questions were likely to be created by responding to the requests.

1. Introduction

Along with the progress of information society, many web-based learning support systems have been developed. Such systems enable learners to use them at any time and from any places (as long as he/she has a computer with an Internet connection).

We focus on a question-posing based learning support system in this study. Some literature pointed out that question-posing was a highly intelligent activity, and it contributes to improve students' problem solving skill [2]. Some literature also suggested that question-posing based learning was beneficial to students' cognitive development in the light of cognitive psychology because such learning activities involved the cognitive processes of rehearsal, organization and elaboration [7].

Recently, a lot of question-posing based learning support systems allowed learners not only to pose questions, but also to assess the questions posed by peers, and communicate with question-posers and

peers. Some researchers described that such activities improved students' comprehension of learning materials [5, 6, 7]. Yu et al. found that peer-assessing learning activity encouraged participants to gauge objectively and critically the adequacy and correctness of the posted questions [7]. Yu et al. also described that learners presumably added details to their existing cognition, explore and correct their misconceptions, and/or re-organize their current knowledge structures by online interaction and open communication with peers pertaining to the question-stem and the correct answer [7].

According to the trend of question-posing based learning support systems, we developed a question-posing based learning support system called Concerto in 2006 and applied it to an actual university course [1]. It provided following major functions: question-posing, answering questions, assessment, and threaded Bulletin Board System (BBS)-based communication support. We expected that learners actively communicated with peers by using such features provided by Concerto, but little communication occurred. As the result, we identified necessity that facilitates active communication among learners. In addition, we met a situation that a learner requested peers in a BBS of a question for posing other questions that were similar to the question he/she answered. We considered adding the feature which allows a learner to request of question-posing because such a message will become a hint for question-posing.

We developed Concerto II (enhancement of Concerto) which added the feature of "request of question-posing" and enhanced active communication support, and we again applied it to an actual university course in order to show effectiveness of them. We describe the development and the results of its application in this paper.

The rest of this paper is organized as follows: we describe related work and position of this study in the next section. Section 3 describes overview of Concerto and discusses some problems that were emerged from the results of Concerto application. We also describe overview of Concerto II and its application in section 4 and 5. Section 6 discusses results of Concerto II application. Finally, we summarize this paper.

Table 1. Comparison of question-posing based learning support systems.

	QSIA	Takagi et. al.	QPPA	SHoes	Concerto
main question-poser	instructors	learners	learners	learners	learners
learning form	(simply) organizational learning	collaborative organizational learning	(simply) organizational learning	collaborative organizational learning	(simply) organizational learning
posing mode	multiple-choice question	multiple-choice question (text base)	multiple-choice question (allow to use a figure)	story question (allow to pose by handwriting)	multiple-choice and story question (allow to use a figure and a table)
assessment	*	-	*	*	*
communication support	-	group review (a face-to-face environment)	-	BBS set each question (a face-to-face environment)	BBS set each question (a face-to-face environment) (a distributed asynchronous environment)
request of question-posing	-	-	-	-	-
others	recommendation	online test (instructors' review)	drill-and-practice exercise	-	request comments for the instructor community consist of whole class

2. Related work

This section describes state-of-the-art of question-posing based learning support systems. Some research projects have been conducted with respect to a question-posing based learning support system.

QSIA is a Web-based learning environment, which provides question-posing, knowledge sharing (recommendation of questions to learners), and assessment as major facilities. It mainly focuses on knowledge sharing and assessment. Questions are created by instructors in most cases. When they are created by students, the instructor reviews them and then they are opened [3].

Takagi et al. developed a learning support system that supported the following learning process [5, 6]: (1) a learner poses questions based on the course contents, and review them by groups which are composed of several students, (2) the question-poser registers the question that has finished review into the database, then the instructor reviews the registered question, (3) the instructor prepares the online tests by extracting questions from the database and opens them, and (4) students answer the opened questions and pose questions that are similar to the opened ones. Takagi et al. obtained results on learning effectiveness through group review and posing similar questions.

QPPA is a Web-based learning support system which provides four major functions [7]: (1) question-posing, (2) assessment, (3) browsing of question, and (4) drill-and-practice exercise. In question-posing, only the mode of multiple choices is supported. In order to validate the environment, it was applied to students of the upper grades in an elementary school. The evaluation was carried out from the viewpoint of usability of major functions and difficulty (easiness) of question-posing among

subjects (the system was applied to mathematics, natural science, and social science) by questionnaire. The authors did not evaluate QPPA from an aspect of learning effectiveness.

Sugawara et al. developed a learning support system called SHoes that supported the following learning process [4]: (1) learners pose questions and their correct answer and register them into the system, (2) learners (except for the question-posers) answer the question selected by the instructor and submit the answer to the instructor, (3) learners (except for question-posers and answerers) mark the submitted answers and submit the results. SHoes allows learners to pose questions by handwriting using pen-tablet. SHoes is available on a face-to-face environment in the classroom.

Table 1 shows a summary of state-of-the-art of question-posing based learning support systems. We aim at constructing a Web-based learning support environment whose goal is to improve understanding of what students learned by learner-centered learning with not only question-posing and assessment of questions posed among peers but also communications with respect to questions. Our approach is same as that by Takagi et al., SHoes and QPPA in that it focuses on question-posing by students. Takagi et al. and SHoes aim at "collaborative organization learning [4]" which learning activities are carried out by group, while Concerto and QPPA aim at "(simply) organization learning [4]" which learning activities are carried out by individual. ("organization learning" means that the whole member belonging to the organization learned by learning him/herself or collaborating with others for each member.) As we think assessment for questions from a lot of learners and communications with a lot of learners contribute to enhance effectiveness of learning, we suppose that the above-

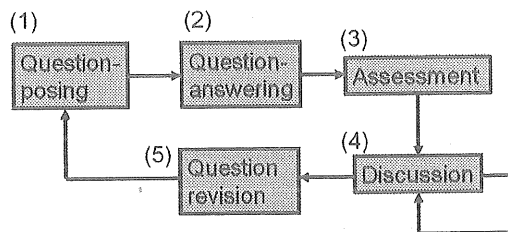


Figure 1. Usage process of Concerto.

mentioned activities are carried out not by groups but by whole class. As for communication support, Takagi et al. and SHOes described group review for questions students posed. QPPA and QSIA do not support communications. Concerto is available on not only a face-to-face environment, but also a distributed asynchronous environment.

3. Experiment Results of Concerto Application

3.1. Overview of Concerto

Figure 1 shows the usage process of Concerto. Concerto supported the following learning process: (1) learners pose questions and the correct answers about learning materials, (2) learners (except for the question-poser) answer the posed questions, (3) the learners who answered questions assess them, (4) communications with question-posers and peers about the questions are exchanged, and (5) the question-posers revise the questions based on the assessment comments and communications.

3.2. Concerto Application

We applied Concerto to a course called "Introduction to computer systems." The objective of the course is to give lectures on principles of digital computers. The course is offered for the first year undergraduate students of Department of Information Education at Tokyo Gakugei University.

We analyzed the results of application from both the data that were stored in the system and those from questionnaire. As the result, we obtained insights on communication.

(1) Problem on communication support

Few discussions occurred. Only eleven threads were created as shown in Table 2. We found current communication support was not positioned in the question-answering process but in the list of questions. For example, a learner who answered a question by free descriptions may not understand whether his/her answer is correct or not. In such a case, communication support will help him/her. In addition, few question-posers responded to the inquiries for them in some threads because there may be no features for question-posers to be aware of the thing which a new comment submitted to the BBS.

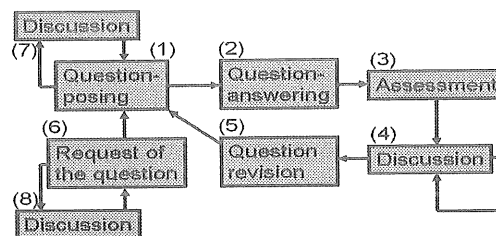


Figure 2. Usage process of Concerto II.

Thus, we found the system should add the feature of awareness support, i.e., messages to inform the learner that comments were submitted to the BBS for questions he/she posed.

(2) Request of question-posing

We met a situation in the experiment that a student requested peers in a BBS of a question for posing other questions that were similar to the question he/she answered. We did not anticipate such a communication pattern in designing the system. If such a message stays in a particular BBS, it may be buried. Such a message will become a hint for question-posing. Therefore we will provide the function, which allows a learner to request of question-posing and follows up the status.

3.3. Improvement of Concerto

We considered the insights mentioned in section 3.2 and improved the usage process as shown in Figure 2.

(1) Addition of feature, "Request of question-posing" We added a feature which learners request other learners to pose questions (Figure 2 (6)). Some learners agree with the request and pose questions that fit to it. The system can associate the request with the posed questions.

(2) Enhancement of the communication support

Figure 1 showed that in Concerto communication was only supported after the assessment process (Figure 2 (4)), but we considered that communication should be done in the question-posing and request of question-posing process. The system enables learners to communicate in such processes (Figure 2 (7), (8)). In addition, the system also enables question-posers to watch a part of current discussion in the BBS and be aware of submitting new messages to the BBS (we call this feature "awareness support").

4. Development of Concerto II

According to the discussions in section 3.3, we developed a learning support system called Concerto II. We describe some main functions of Concerto II.

(1) My page

Each learner has his/her own page. The page presents feedback information (number of questions, assessment comments, level of quality, and so on) for questions he/she posed. We expect such information

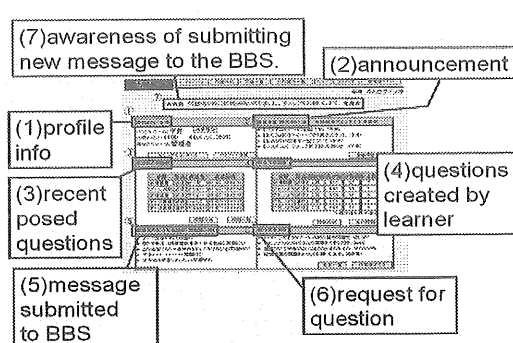


Figure 3. My page in Concerto II.

improve learners' motivation. Figure 3 shows a screen shot of "my page" in Concerto II. The page is consisted of the following seven parts:

- * profile information: shows a learner's profile information, i.e., handle name, ranking of question-posing, and assessment results from other learners (Figure 3 (1))
- * announcements from the instructor: are a list of announcements from the instructor of the corresponding course (Figure 3 (2))
- * list of questions: shows all the questions posed by all learners (Figure 3 (3))
- * questions the user posed (Figure 3 (4))
- * feedback from peers: is a list of comments/inquiries from peers for all the questions (awareness support) (Figure 3 (5))
- * request of question-posing: is a list of requests for questions other learners requested (Figure 3 (6))
- * messages to inform the user that comments were submitted to the BBS for questions he/she posed (awareness support) (Figure 3 (7))

(2) Question-posing

This function enables learners to pose questions in the form of multiple choices or free descriptions. Question-posers are required to fill the following attributes: unit, description of a question, choices for the question (only for questions by multiple choices), the answer, comments for the question, and intent of the question. Concerto II enables learners to pose questions with figures and/or tables and to revise the posed questions.

(3) Question-answering

Learners enable to answer posed questions. They create their answer with texts, figures and/or tables.

(4) Assessment

Learners allow to assess questions they answered. They assess questions from the viewpoint of both quality and degree of difficulty by Lickert Rank Scale and qualitative comments.

(5) BBS

We provided a threaded BBS for each question. We expect that BBS is used for Q&A and/or discussions for the question. Learners can ask the TA (Teaching Assistant) and/or their instructor for help unless the learners themselves can solve problems for the question.

Table 2. Results for Concerto II application in combination with Concerto.

	Concerto	ConcertoII
Duration of application	Around 7 weeks	Around 7 weeks
No. student who took the course	87	96
No. user registration	51	91
No. login	637	3291
No. posed questions	50	311
No. revisions of questions	16	187
No. answers of questions	1454	7239
No. assessment	926	4196
No. BBS threads	11	110
No. request of question-posing	-	6

Table 3. Discussion theme in Concerto II BBS in combination with Concerto.

	Concerto	Concerto II
Inquiries from learners who tackled a question and the responses to the inquiries	7 threads	39 threads
Appreciation for responding to request of question-posing	0	20
Opinions for questions after learners answering them	0	14
Apology for mistakes of questions by question-poser	1	13
Response from question-posers for assessment comments	2	10
Supplementary explanation for comment on a question by the question-poser	0	8
Comment for enhancement from those who answered a question to it	0	6
Request of question-posing of similar questions	1	0

(6) Request of question-posing

Learners enable to request for question-posing. For each request, the requester and description of the request are shown. Furthermore, questions that were responded to the request are linked with it. BBS is placed so that discussions for the requests are done.

(7) Question-Posing Point and Contribution Point

Concerto II gives points when learners use the features provided the system, i.e., question-posers get points when other learners assess the question which they posed. Learners get points when they assess questions they answered, submit a comment in a BBS, and so on. The reason we introduce these points is to motivate learners to use Concerto II.

5. Experiment of Concerto II

5.1. Overview of the experiment

We applied Concerto II to a university course "Introduction to computer systems" in the 2007 academic year. We provided it during 21 May 2007

Table 4. A use case of Concerto II.

Request of question-posing (requester, date the request was submitted, and the contents)			
Learner A	29, May 13:35	As I can not understand the difference between LD and LAD in CASL II, please pose questions so that we can understand it.	
Posed-question (question-poser, date the question was posed, and the contents)			
Learner B	30, May 22:34	Fill in the blank A and B in order to complete a correct program:	
		MASUO START	LD GR4,2,GR7
		LAD GR7,[A]	LD GR5,3,GR7
		LAD [B],DQN	LD GR6,4,GR7
		LD GR2,0,GR7	ST GR2,0,GR1
		LD GR3,1,GR7	ST GR3,1,GR1
			ST GR4,2,GR1
			ST GR5,3,GR1
			ST GR6,4,GR1
			RET
			ORG DC 'MASUO'
			DQN DS 5
			END
Answer and comment (question-poser, date the answer and comment was submitted, and the answer and contents)			
Learner B	30, May 22:34	Answer: [A]ORG [B]GR1 Comment: "MASUO" is stored in the address from "DQN-0" to "DQN-4". I will briefly explain the point of this program. As for [A], by the instruction "LAD GR1,ORG", not the value that is stored at the address "ORG" but the address "ORG" itself is set. The instruction "LAD" sets the address to an register. On the other hand, the instruction "LD" sets the value of the address the operand designates. As for [B], by the instruction "ST" the general register "GR1" is set.	
Discussions for the question (poster, date, and the message)			
Learner A	11, June 15:10	I'm sorry, but I do not understand difference between the instruction "LD" and "LAD". Could you please explain again? Thanks.	
Learner B	12, June 19:11	OK! I will explain difference between the instruction "LD" and "LAD" according to your request. I cite the following example from anywhere. (1)LD GR1,#0102 (2)LAD GR1,#0102 ("#0102" means (0102)h) (1) means that as the operand "#0102" represents an address, CPU accesses the address "#0102" and then gets the value and sets the value to the general register "GR1". On the other hand, (2) means that the operand "#0102" itself is set to the general register "GR1". Namely, the instruction "LAD" does not access the contents of an address. I am happy if you understand my explanation.	
Learner A	13, June 01:15	Thank you very much!	
Learner C	16, June 23:14	May I explain difference between the instruction "LD" and "LAD"? The instruction "LD" gets the value of a place the address points. The instruction "LAD" gets the address itself. For example, let's assume the address "ORG" (furthermore let's assume the address is physically no. 5) stores a character "a". By executing the instruction "LD GR1,ORG", "a" is set to the general register "GR1" By executing the instruction "LAD GR1,ORG", "5" is set to the general register "GR1" How about you? If you have any comments, please let me know.	
Learner D	17, June 22:43	Learner C, your explanation is very easy to understand. Thanks!	
Learner B	17, June 22:51	Learner C > I agree with you.	
Learner E	18, June 07:17	Thank you for your help!	
Learner F	22, June 16:43	Certainly, this explanation is easy to understand. We have to accustom usage of the LD and LAD instructions.	

through 9 July 2007 and then asked the students in the course for responding to questionnaire. The questionnaire is composed of some items in the form of Lickert Rank Scale (four ranks; 1: disagree, 4: agree) and qualitative comments that corroborate the evaluation of the items by Lickert Rank Scale.

5.2. Results of the experiment

Table 2 shows the usage result of Concerto and Concerto II. Table 3 shows contents of discussions with Concerto and Concerto II. The number of threads in Table 2 was sum from (4), (7), and (8) in the process of Figure 2. However there are no submissions from (7) and (8).

6. Discussion

We discuss effectiveness of the "request of question-posing" function, that of enhancement of a communication function, and others in this section.

(1) Enhancement of a communication support

Table 2 shows the number of questions increased 6.2 times, the number of threads 10 times from Concerto to Concerto II respectively. In Concerto, learners could use BBS only in a window to select a question. In Concerto II, as "my page" presents various types of awareness information including in which questions messages are exchanged, we think this information contributed to high usage frequency of BBS.

As shown in Table 3, various types of communications were conducted with Concerto II.

Table 4 shows a use case of Concerto II. In this case, learner A requested for question-posing, then learner B responded to the request and posed a question, answer, and comments. After learner A tackled the question learner B posed, learner A asked

the question for learner B. Learner B replied to the inquiry and learner A appreciated. Another learner gave a different explanation from that by learner B. Some learners told this explanation was easy to understand and learner B agreed with it.

We found an aspect of collaborative learning by several learners from this case as follows: a learner asked the question-poser for a question. The question-poser replied to the inquiry. Another learner gave another explanation and several learners gave comments the explanation was easy to understand and the question poser also agreed with the explanation. As QPPA[7] and QSIA[3] do not provide discussions, such kind of learning will not be supported. This question-posing and a series of discussions were done outside of the classroom. That is, learning based on question-posing was accomplished under a distributed and asynchronous environment.

(2) Effectiveness of request of question-posing

Six requests of question-posing were submitted during the experiment as shown in Table 2. Questions were posed for four out of them. From the comments to the questionnaire, we found the function gave a chance to pose questions. This function also enables a learner to answer questions he/she would like to tackle.

On the other hand, some learners pointed out drawbacks for this function as follows: "I think requesters should pose questions by themselves before requesting others". From the data that was stored in the system, the learners who requested for question-posing posed at least four questions. This means they are not free riders, and collaborative learning by posing questions in an inter-dependent manner was observed.

Another learner wrote, "I could not respond a request because it was too ambiguous". For example, the following request was submitted: "please pose questions on storage devices". There are various learning topics on storage devices, for example, terminology, characteristics of devices, performance calculation and so on. He/She could not grasp what the requester wanted. We provided communication space for discussions with respect to request for question-posing, but it was not used.

(3) Others

We asked an item with respect to the Question-Posing Point and Contribution Point in the questionnaire. Some learners responded to it as follows:

* "I frequently used the system to get many points."

* "I was motivated by the point in Concerto II."

* "I was very exciting because I competed with other learners for the Question-Posing Point."

Thus, we found that the Question-Posing Point and Contribution Point introduced into Concerto II motivated the learners to use the system. We think this is one of the reasons, which the number of usage

as shown in Table 2 from Concerto to Concerto II significantly increased.

7. Conclusion

We have proposed a question-posing based collaborative learning support system called Concerto II. Concerto II enhanced Concerto based on the results gained from application of Concerto in a university course, especially provided functions on awareness support and request of question-posing. We also applied Concerto II to a university course. From the results of application, we found awareness support enhanced communication even in an asynchronous (outside of classroom) and distributed environment. We also found positive effects from a feature of "request of question-posing" that gave opportunity to pose questions and to tackle them. We furthermore observed communications based on a question by a trigger of request. On the other hand, some negative aspects (some free riders may appear, i.e., they do not pose a question, but request other learners to pose a question only, and, no learners could respond a request which is too ambiguous.) were pointed out that learners should pose questions for themselves before request and similar questions would increase.

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