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An Approach for Evaluating Question-posing Ability in a Web-based Collaborative Learning

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Abstract: With the rapid development of e-learning environment, question-posing learning activity has become an important instruction mode for both teaching and learning. Although previous research has demonstrated the benefits for both instructors and students in the question-posing learning activity, this learning approach still has some difficulties. One of the major difficulties is the lack of a practical approach to assist teachers in evaluating the question-posing ability of all learners. To cope with this problem, the present study develops an approach to measure the question-posing ability of individual students in a web-based collaborative learning. As a result, the proposed approach could not only improve the learning performance of individual students, but advance students' attitudes towards question-posing learning activity in a web-based collaborative learning environment.

Keywords: Collaborative learning; Teaching/learning strategies, Question-Posing

Introduction

With the rapid development of e-learning, web-based collaborative learning systems is gaining popularity as a promising learning environment [5][7].

1.1 Review of question-posing

Essentially, the use of questions as a learning activity has been recognized as a useful strategy to improve text retention and comprehension [1][6]. Prior studies suggested that engaging in the process of question-posing may be conducive to students' cognitive growth [1][6]. According to [7], question-posing learning activity was the most difficult task for young students, and high achievement students were tended to pose more questions. Although several studies [2][7] have demonstrated the benefit and effectiveness of question-posing in a web-based learning environment. However, very few attempts have been made at evaluating student's question-posing ability in a web-based collaborative learning environment. This point deserves explicit emphasis because it could provide students' learning status for teachers as well as further enhance learning and reflective thinking.

1.2 Research problems

The aim of present study is to develop and implement a web-based collaborative learning system, called Question-Posing Indicators Service (QPIS) System, designed to assist teachers in evaluating the question-posing ability of individual students, and enhance the reflective thinking and quality of learning activity among instructor, student, and peers. In view of the above, this research would try to answer the following research questions:

- Is there significant improvement in learning performance after using the QPIS system?
- How does using the QPIS system affect learner's learning attitudes?

In the following sections, an overview of the proposed system is presented. Second, findings for research questions are presented. Finally, we discuss implications of our findings for future research.

Overview of the proposed system

2.2 System architecture

The proposed system was designed by providing three modules: question-posing module, tool module, and assessment module. With respect to teacher interface, an instructor can use the assessment module (i.e., expert assessment) to evaluate students' question-posing contents. Additionally, about the student interface, students can use the question-posing module to pose a question, use the tool module to search self or peers' question-posing contents, and evaluate their and peers' posed questions contents. Then, each module is specifically described as follows.

2.3 Modules of proposed system

2.2.1 Question-Posing module

The function of the question-posing module is to pose a question according to individual's knowledge. As shown in Figure 1, student was chosen a type of question, and then the construction area will show the related fields. After finishing a question-posing, students have to give an assessment (i.e., self assessment) of the question they have constructed.

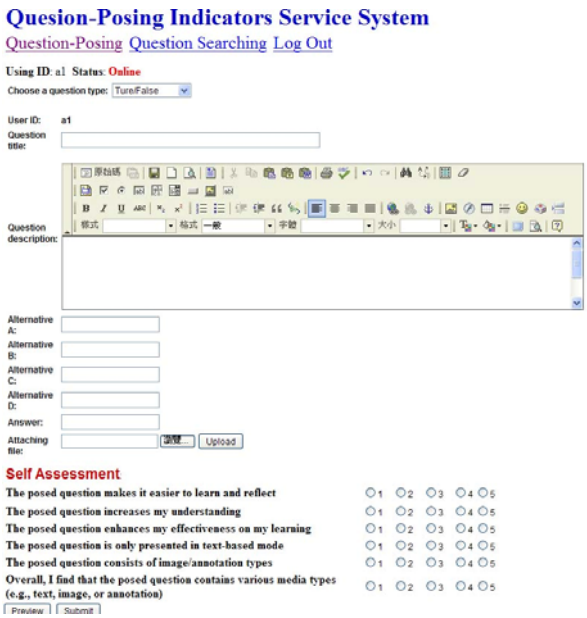

Figure 1. Screenshot of the question-posing function by selected types of multiple-choice question.

2.2.2 Tool module

The proposed system provides a tool module for students to search posed question and give comments of peers. About search function, student could search by keywords from an internal database, or selected a learner's ID to search.

2.2.3 Assessment module

The primary objective of the knowledge assessment function is to assist teacher in evaluating the knowledge contribution of individual students. With respect to how to evaluate a specific question-posing ability value, this study adapts the content usefulness instrument developed and tested by [4] and content richness criteria developed by [3] to measure. Each question created by learners is scored on a 5-point Likert scale, which is represented by explicit descriptions for easy understanding instead of just a number score.

Moreover, for the purpose of understanding learners' question-posing ability, the present study develops four sub-modules to evaluate the indicators of question-posing ability. They are question type analysis agent as well as self, peer, and expert assessment modules.

2.2.3.1 Indicators of question-posing ability

Question-posing ability was calculated by the scoring mechanism according to the above knowledge assessment modules. Both definitions and formulations of the proposed indicators involve various rules of evaluating in the QPIS system. More details concerning definitions and formulations of the question-posing ability indicators are presented as follow:

- t_j: the j-th question-posing score in the expert assessment set $t=\{t_j \mid j=1...n\}$, where n is the cardinality of the score set.
- s_j: the j-th question-posing score in the self assessment set $s=\{ s_j \mid j=1...n \}$, where n is the cardinality of the score set.
- p_j: the j-th question-posing average score in the peer assessment set $p=\{ p_j \mid j=1...n \}$, where n is the cardinality of the score set.
- t_w: the weight of expert assessment.
- s_w: the weight of self assessment.
- p_w: the weight of peer assessment.
- q_w: the weight of question types, where $w=\{1, 2, 3, 4\}$, q_1: true/false, q_2: multiple-choice, q_3: matching, q_4: short-answer.
- I: indicators of a student's question-posing ability represented as $I = \sum_{j=1}^{n} \frac{(t_j \times t_w + s_j \times s_w + p_j \times p_w)}{(t_w + s_w + p_w)} \times q_w$, where $j=1...n$.

- μ_I: the average of the numerical set of all students' indicator scores I.
- σ_I: the standard deviation of the numerical set of all students' indicator scores I.
- $z(I)$: the standard score function of I, where $z(I) = \frac{I - \mu_I}{\sigma_I}$.
- $T(I)$: To assist teacher in simply understanding the score of question-posing ability, the study attempts to transform the indicators from z score to T score normalized by the standard normal function.

3. Experiment

3.1 Participants

The participants from the same department of two classes were divided into two groups, namely experimental group and control group, respectively. The two groups consisted of a total of 100 freshmen, majoring in the Department of Information and Management, who were taking a Basic Programming Design course. Control group students were conducted the traditional teaching approach (i.e., without the QPIS system), while experimental group

students were provided the QPIS system for teaching and learning. All participants have similar educational backgrounds and intelligences. To increase the reliability of the experiment, all participants learn with the same contents of Basic Programming Design materials (introducing java general techniques, objects and equality, and exception handling), which are given by the instructor.

3.2 Experimental tools and materials

Experimental group students were required to pose questions on reflective thinking according to their learning during and after class. The learning materials were provided by the instructor, and the instruction tools was used J2SE SDK 5.0 and UltraEdit v13.10 for students to learn and create their works. After finishing their works, learners were asked to pose questions based on their reflection in the QPIS system.

3.3 Procedures

The experiment was conducted over eight weeks period. After eight weeks, experimental group students were asked to answer a feedback questionnaire for measuring attitudes towards the use of QPIS system, and a post-test for testing their knowledge of the course for both experimental and control groups. Moreover, the system logs and contents of question-posing were also extracted for analysis. A total of 50 responses (100%) were collected.

4. Results

4.1 The changes in the students' pre- and post-test scores after participating in the Basic Programming Design course

In this research, the pre-test scores represent entry behavior of learning, and the post-test scores represent the learning performance. Before the experiment, to measure if there was difference between groups in terms of learners' prior knowledge of Basic Programming Design concepts, an independent sample t-test was conducted for pre-test scores. The result indicated that no significant difference was found between groups ($t=0.32$, $P=0.75>0.05$). In other words, this implied the participants of both groups did not differ in their initial prior knowledge.

After learning the course, the study administrated a post-test to examine whether there was difference in both groups. As shown in Table 1 and Table 2, both groups were significant differences in paired t-test. These imply that both teaching strategies could assist students in learning.

Moreover, we attempted to further use a t-test to examine whether the use of QPIS system of experimental group could really enhance the students' learning performance more than the control group. The analysis results indicated that there was a significant difference in students' post-test performance between the two groups, as shown in Table 3 ($t=4.169$, $P<0.05$).

Table 1. Results of paired t-test on pre- and post-tests of experimental group

Measure	N	Pre-test		Post-test		t value
		Mean	SD	Mean	SD	
Knowledge of the course	50	34.00	14.14214	65.90	10.62775	-18.119*

* *P<0.05*

Table 2. Results of paired t-test on pre- and post-tests of control group

Measure	N	Pre-test		Post-test		t value
		Mean	SD	Mean	SD	
Knowledge of the course	50	33.10	13.80956	56.80	11.19220	-16.606*

* *P<0.05*

Table 3. Results of t-test on post-test between experimental and control groups

Variable	Post-test		t-test
	Mean	SD	
Experimental group	65.90	10.62775	4.169*
Control group	56.80	11.19220	

4.2 Results of questionnaire analysis

With respect to perceived usefulness listed in Table 4 (Cronbach's alpha=0.890). On average, students reported moderate learning attitudes toward the usefulness of QPIS system. They indicated the use of QPIS system saves their time and accomplishes tasks more quickly. When asked about the learning aspect of QPIS system, students agreed to the statement that using QPIS system enhances their effectiveness on the question-posing; they also agreed that using QPIS system improves the quality of question-posing. Regarding the perception of peer assessments, students strongly agreed that peers fairly evaluate the posed questions contents. On the other hand, regarding the perceived ease of use (see Table 5), students noted when using the QPIS system is not occur in confused and make errors frequently. Overall, they thought using the QPIS system is easy to use.

Table 4. Perceived usefulness of the QPIS system

#	Question	SA	A	U	D	SD	Mean score	Std. dev.
1	Using QPIS system saves me time.	7 (14.00%)	19 (38.00%)	16 (32.00%)	8 (16.00%)	0 (0.00%)	3.50	0.93
2	QPIS system enables me to accomplish tasks more quickly.	7 (14.00%)	17 (34.00%)	17 (34.00%)	8 (16.00%)	1 (2.00%)	3.42	0.99
3	Using QPIS system enhances my effectiveness on the question-posing.	7 (14.00%)	25 (50.00%)	18 (36.00%)	0 (0.00%)	0 (0.00%)	3.78	0.68
4	Using QPIS system improves the quality of question-posing.	8 (16.00%)	24 (48.00%)	18 (36.00%)	0 (0.00%)	0 (0.00%)	3.80	0.70
5	Using QPIS system makes it easier to do my learning.	6 (12.00%)	20 (40.00%)	19 (38.00%)	5 (10.00%)	0 (0.00%)	3.54	0.84
6	I think peer assessment was objective for me.	27 (54.00%)	18 (36.00%)	5 (10.00%)	0 (0.00%)	0 (0.00%)	4.44	0.67
7	Overall, I find the QPIS system useful in my learning.	15 (30.00%)	22 (44.00%)	8 (16.00%)	5 (10.00%)	0 (0.00%)	3.94	0.93

Note: SA: Strongly Agree, A: Agree, U: Undecided, D: Disagree, SD: Strongly Disagree.

Table 5. Perceived ease of use of the QPIS system

#	Question	SA	A	U	D	SD	Mean score	Std. dev.
1	I was not often become confused when I use the QPIS system.	22 (44.00%)	20 (40.00%)	7 (14.00%)	1 (2.00%)	0 (0.00%)	4.26	0.78
2	I was not make errors frequently when using the QPIS system.	23 (46.00%)	20 (40.00%)	5 (10.00%)	2 (4.00%)	0 (0.00%)	4.28	0.81
3	I find it easy to get the QPIS system to do what I want it to do.	20 (40.00%)	21 (42.00%)	8 (16.00%)	1 (2.00%)	0 (0.00%)	4.20	0.78
4	It is easy for me to understand how to perform tasks while using the	10 (20.00%)	22 (44.00%)	18 (36.00%)	0 (0.00%)	0 (0.00%)	3.84	0.74

	QPIS system.							
5	Overall, I find the QPIS system is easy to use.	17 (34.00%)	22 (44.00%)	11 (22.00%)	0 (0.00%)	0 (0.00%)	4.12	0.75

Note: SA: Strongly Agree, A: Agree, U: Undecided, D: Disagree, SD: Strongly Disagree.

5. Discussion and conclusion

The present study developed the QPIS system to be applied in a web-based collaborative learning environment and to assist teacher in evaluating and understanding the individual's question-posing ability. Additionally, this study provides evidence consistent with prior research [2] that question-posing ability can serve as both learning and assessment tools in higher education by encouraging students to carry out active learning, constructive criticism and knowledge sharing. As a result, students could improve their learning outcomes after using the QPIS system.

Moreover, contrary to [7], our study was found different results. They pointed out that younger learners felt difficult in question-posing learning activity. In fact, the good qualities of question-posing need more reflective thinking and mature ideal, but younger learners do not have fully knowledge and ideals. In this study, the experimental evidence supports above view.

Finally, the result of the questionnaire survey showed there are positive attitudes toward using the QPIS system as a question-posing learning environment. Although most students agreed the perceived usefulness and ease of use of the proposed system, it still has few students dissatisfied. Few students noted by using QPIS system with question-posing was spent their time and was not an easy task. The problem might be improved by providing user-friendly interface or more rewards as incentives.

In conclusion, we believe that this research can provide valuable insights to teachers and researchers about the trajectory of question-posing ability in a web-based collaborative learning.

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