THE TYPES, FREQUENCY AND QUALITY OF ELEMENTARY PUPILS' QUESTIONS IN AN ONLINE ENVIRONMENT

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ABSTRACT
This study explored the types, frequencies and quality of student questioning based on three kinds of question-stems (detailed-stem, simple-stem, and no-stem). A questioning-supported thinking and learning system (QSTLS) was developed to scaffold stem-based student questioning. One hundred fifth-grade students participated in this study. Students were assigned to three groups: a detailed-stem group, simple-stem group, and no-stem group. Results show that the detailed-stem groups used more types (11) of questions, asked a greater number of questions (472) and asked questions of higher quality than both the simple-stem group and the no-stem group. The conclusion of the study is that online questioning is a useful learning strategy, and more specifically that detailed question-stems in particular help students to develop their questioning skills. This study also shows that with the assistance of question-stems, the QSTLS system can provide a student-centered and active learning environment for elementary pupils.
Keyword: online questioning, question type, question frequency, question quality, question stem

1. INTRODUCTION

Student questioning, which plays an important role in student's active learning, has several advantages. Firstly, student's attention can be focused (Chin & Osborne, 2008; Rosenshine, Meister, & Chapman, 1996), and cognitive comprehension can be enhanced (Koch & Eckstein, 1991; Pedrosa de Jesus, Almeida, & Watts, 2004). Secondly, students' knowledge can be elaborated (Black, Harrison, Lee, Marshall & Wiliam, 2004; Chin & Osborne, 2008; King, 1992; Rosenshine et al., 1996; Schmidt, 1993)**.** And thirdly, productivity, creativity and high-order thinking can be promoted (Gallas, 1995; Shodell, 1995).

The frequency of student questioning in classroom is relatively low (Dillon, 1988; Graesser & Person, 1994; Van der Meij, 1988). Graesser and Person (1994) pointed out that only 1.3 to 4 questions were asked each hour in classroom (the median is 3). Dillon (1988) indicated that there were approximately 26.7 students in a class the average of question number a student asking was just 0.11 questions. Scholars have indicated that students' questions are mostly factual questions (Chin & Osborne, 2008). The phenomena of low questioning frequencies and of mostly factual questions might be caused by the insufficient ability of students, limited time of classroom instruction, and unfriendly atmosphere in the classroom (Chu, Li, & Hsia, 2007; Pedrosa de Jesus, Teixeira-Dias, & Watts, 2003). To avoid the disadvantages of classroom questioning and to improve the quality of student questioning, network-supported online questioning is a possible alternative.

A specific online environment may have advantages for promoting student questioning. In such an environment, students will have more opportunities to think, ask, and answer questions. Students also can avoid the sometimes uncomfortable classroom atmosphere (Chu et al., 2007). Some online questioning systems have been developed for student questioning, such as P&Q (Point and Query) (Graesser & McNamara, 2005; Langston & Graesser, 1993), NATA (Not afraid to ask) (Chu et al., 2007), QSIA (Question Sharing and Interactive Assignments) (Barak & Rafaeli, 2004), DFAQ (Dynamic Frequently Asked Questions environment) (Ng'ambi & Hardman, 2004), and QBISS (Question-Based Instructional Support System) (Chiou, Liao, & Hu, 2007) . Studies based on these systems indicate that students can have a good learning experience, that is, their learning can benefit from various online questioning activities. Although an online questioning system can stimulate students' questioning, unfortunately those systems were developed for high school, undergraduate, or postgraduate students. An online questioning system for elementary pupils is needed if educators want to understand the online questioning of elementary pupils.

Introducing online questioning activities into elementary classrooms can provide pupils with more questioning opportunities and thinking time; however, elementary pupils' prior knowledge and meta-cognitive skills aren't as good as those of high school and college students. If elementary pupils are placed in an online environment without guidance, they may not get any substantial learning benefit. Scholars have proposed some strategies to assist students in their questioning. For example, researchers used the strategies of "peer-questioning" and "questioning tips" to guide students' questioning (Choi, Land, & Turgeon, 2005). King (1989, 1993) used the strategy of "question-stems" to scaffold students' elaborative questioning. King found that question stems have clearly positive effects on student questioning, that is, they have a positive learning effect. In this study, we want to know whether these supportive strategies are also effective for elementary pupils in an online environment.

This study uses three question-stem conditions (detailed-stem, simple-stem, and no-stem) to understand the types, frequencies and quality of pupils' online questioning. Pupils use a questioning-supported thinking and online learning system (QSTLS) to read a teacher-selected science text, to post/ask questions, and to answer posted questions. The purpose of this study is to explore pupils' questioning under different question-stem conditions. The research questions are: What types of questions do pupils tend to ask? Does the detailed-stem group manifest more questioning frequencies and types than both the simple-stem and the no-stem groups? And does the detailed-stem group demonstrate a better (higher) quality of questioning than both the simple-stem and the no-stem groups? In this study, "question" and "questioning" are alternately used. "Question" refers to the actual question that is asked, either mentally or as a spoken (interrogative) sentence. And questioning refers to the process or act of asking.

2. RELATED STUDIES

2.1. Advantages and difficulties of the student questioning

Student questioning has the advantages of guiding self-learning, monitoring self-understanding, driving knowledge construction, triggering deep-thinking, improving learning comprehension, helping self-evaluation, enhancing discussion, and strengthening the quality of dialogue (Chin & Osborne, 2008). These advantages are important for science learning and have been emphasized by some scholars (Black et al., 2002; Chin & Osborne, 2008; Graesser, 1993; Pedrosa de Jesus et al., 2003; Rosenshine et al., 1996).

The difficulties associated with student questioning are primarily the tendency toward lower questioning frequencies and more factual questions being asked in the classroom (Chin & Osborne, 2008; Dillon, 1988; Graesser & Person, 1994; Van der Meij, 1988). The causes of these difficulties include students' lack of ability to detect contradictory information (Grasser & Person, 1994), to identify their own knowledge deficits (Glenberg, Wilkinson, & Epstein, 1982; Markman, 1979; Pressley, Ghatala, Woloshyn, & Pirie, 1990), and to acquire questioning skills. Students also fear that their questions might induce negative reactions from classmates or teachers (Dillon,1988).

2.2. Strategies for student questioning

To promote students' questioning skills, some studies have proposed strategies that may help students ask questions. King (1989, 1991, 1992, 1993) uses question-stems to help students ask effective questions. In her 1989 study, King used question-stems to guide the questioning of college students in an education course. The question-stems provide some words to help students form complete questions. Examples of question-stems are "How is … related to …?", "What is example of …?" and "What do I (you) still not understand about …?" King's study's results show that the stem-guided questioning group has a significantly improved lecture comprehension ability and more explanatory ability than the unguided group. However, the frequency of questioning wasn't significantly different. In her 1993 study, 34 fifth-grade pupils were randomly assigned to three conditions (highly-elaborated, less-elaborated, and unguided) under which to learn science material presented in classroom lessons. The highly-elaborated group used highly-elaborated question stems such as "Why is…important?" The less-elaborated group used signal words such as "How". Study results showed that the highly-elaborated group had better material comprehension than the other two groups, and also a higher retention score than that of the unguided group.

Choi et al., (2005) designed "questioning tips" to assist the questioning of thirty-nine college students. When students clicked a specific situation on the screen, they could see "Tips" (specific explanations of what to do), "Generic examples" (such as "Would you clearly differentiate between…?"), and "Specific examples" (such as "Does the atmospheric temperature slow down or speed up transpiration rates?"). Study findings revealed that this questioning–tip strategy was useful in increasing the frequency of students' questions. However, this guidance in the form of tips didn't appear to significantly improve students' questioning quality and learning outcomes.

2.3. Online questioning

To alleviate the students' pressure in the classroom, some online questioning systems were developed to facilitate the asking of questions. Forty-eight undergraduate students used the P&Q (Point and Query) system (Graesser &

McNamara, 2005; Langston & Graesser, 1993) to ask questions in a psychology course, and this study pointed out that the frequency of asking questions was 127.2 questions per student per hour in the P&Q system. The NATA system (Not afraid to ask) (Chu et al., 2007) was also developed to overcome the pressure of questioning. 123 college students used this system to ask questions in an introductory computer science course. The results of a questionnaire survey showed that more students preferred to ask questions in this system than in the classroom. And the in-system questioning frequency was far greater than the in-classroom questioning frequency.

In addition to increasing questioning frequency, the online questioning system also provides other advantageous functions. For example, questions and responses can be easily accessed, updated, maintained, and managed (Yu, Liu, & Chan, 2005), and therefore students have more opportunities to reflect, internalize, and increase practical debating skills (Ng'ambi & Hardman, 2004; Kuminek & Pilkington, 2001). In DFAQ (Dynamic Frequently Asked Questions environment), learners asked questions and responded to posted questions. During a two-hour session, twenty-five learners asked 154 questions. And these stored information (questions and responses) became an important resource for a learner community (Ng'ambi & Hardman, 2004). The QSIA (Question Sharing and Interactive Assignments) system (Barak & Rafaeli, 2004) was used in a postgraduate MBA course. This study examined the learning effects of merging question-posing, peer assessment and the attitude toward QSIA . Results indicated that students were highly engaged in online question-posing and peer-assessment activities, and gained higher scores on final examination. A QSIA study also found that online questioning-supported learning could promote active learning, constructive criticism, and knowledge sharing.

The QBISS (Question-Based Instructional Support System) provided an environment for vocational school students to engage in online questioning activities in class. The system has questioning, answering, and evaluating functions. A QBISS study found that students' questions were mostly factual and there was no significant difference between the learning effects of the QBISS and the classroom groups, although students kept a positive attitude toward QBISS (Liao, 2007). QBISS also was applied to a basic computer concept course for vocational school senior students as an after-school learning aid (Wang, 2008). An experimental group of 50 students used QBISS after school, while a control group of 50 students asked questions in the classroom. The results showed that the experimental group had a better achievement than the control group, in particular a higher frequency of questioning and responding.

2.4. Question types

Question type has been extensively studied in questioning research. Graesser, Person, and Huber (1992) developed a taxonomy of questions according to cognitive science. Their taxonomy includes eighteen types: verification, disjunctive, concept completion, feature, feature specification, quantification, definition, example, comparison, interpretation, causal antecedent, causal consequence, goal orientation, instrumental/procedural enablement, judgmental, expectational, assertion, and request/directive. Costa, Caldeira, Gallastegui, and Otero (2000) used this taxonomy to explore the question types, numbers, and quality of 289 students (grades 8, 10, and 12). Results showed that students could ask many questions and generate a large volume of causal-antecedent questions related to science texts. However, no clear effects were found with regard to achievement and task type.

King (1994) mentioned three question-types: factual questions, comprehensive questions and integrative questions. These three types have the functions of knowledge integration, knowledge assimilation and knowledge representation, respectively. Scardamalia and Bereiter (1992) investigated the ability of elementary school students to ask and recognize educationally productive questions. Their study defined three question-types: basic information questions, uneducated guess questions, and wonderment questions. Basic information questions and uneducated guess questions are basic questions which usually have fixed or simple yes-no answers. wonderment questions reflect students' curiosity, puzzlement, and skepticism. Their findings showed that students will adjust the questioning type according to their own knowledge level. Lacking domain knowledge, pupils will ask basic questions; students possessing more domain knowledge will ask higher-level questions.

2.5. Question Quality

Grasser and Person (1994) indicated that there may be three reasons for the low questioning frequency and lack of consideration of question quality. First, students have difficulty in identifying a knowledge deficit. Second, students have difficulty in detecting contradictory information. And third, students lack good questioning skills. In their study, degree of specification, content, and question-generation were used to analyze the quality of college students' questions. Results showed that students' achievement was positively correlated with the quality of their questions.

Some studies analyzed the levels of questions, and characterized the nature of high-level questions. Grasser and

Person (1994) mentioned that inferring, multi-step reasoning, the applying of an idea to a new domain of knowledge, synthesizing, and evaluating are high-level questions. Elder and Paul (1998) indicated that a good quality of questioning demonstrate clarity, accuracy, precision, relevance, depth, breadth, and logic. King (1989) used the strategies of cooperative and independent questioning to examine college students' comprehension, indicating that applying, interpreting, analyzing, and evaluating were important for questioning quality. Pedrosa de Jesus et al. (2003) explored the understanding of chemistry through the generation of questions. They found that a low-quality questioner asks one type of question only, while a high-quality questioner asks a judiciously mixed type.

Based upon the aforementioned research literature, this study adopts King's question-stem approach in order to assist pupils' questioning. By collecting the data on pupils' questioning activity in an online environment developed specifically for elementary pupils (the QSTLS), the study intends to understand the types, frequencies and quality of elementary pupils' questioning.

3. METHODS

3.1. Participants

Participants are 100 fifth graders from three classes in a city elementary school in southern Taiwan. Fifty-five pupils were boys. The three classes have 34, 33, and 33 pupils respectively. Classes were assigned to three question-stem groups. The prior knowledge of science among three classes are homogeneous (ANOVA reveals no significant difference: $F_{2, 96}=0.130$, $p=.878$). Pupils participated in the online questioning-supported science activity at a computer lab, and each class had one science period (40 minutes) per week to engage in online questioning activity. Three classes were guided by the same science teacher. The role of that science teacher was to assist and guide pupils while they were engaging in a designated science activity, and the teacher didn't intervene during the activity. Pupils participated in the online questioning activities for twelve weeks.

3.2. System: Questioning-supported thinking and learning system (QSTLS)

QSTLS, an Internet-based questioning and learning support system, was developed for this study. The functions of QSTLS are to assist pupils' questioning and learning in the science course. Figure 1 and Figure 2 shows the user interface.

QSTLS has the following modules:

- Questioning module: This module is for question-posing. Pupils are requested to type the keyword(s) and title, choose a question mode (text-based or audio-based mode), and type the contents of a question.
- Question stem module: This module provides structured stems. It provides detailed-stem, simple-stem and no-stem for the three groups. Students can select an appropriate example of question stem for assisting their questioning.
- Checking module: This module is for checking similar questions. It helps pupils avoid asking repeated questions.
- Searching module: This module is for searching for posted questions. Pupils input a keyword or an author's name to find questions in which they are interested.
- Answering module: This module is for answer-posing. Pupils can type the answer to a question and post it.
- Evaluating module: This module is for evaluating questions and answers. Pupils can mutually assess questions and answers according to the evaluation criteria.
- Motivating module : This module is for maintaining learning motivation. System will automatically give points when students ask questions, answer questions or evaluate questions and answers. An automatically updated list shows the ranking of students' points.

The functions of QSTLS have been tested by one sixth grade class before experiment. Pupils perceived that the interface of system is clear, consistent and easy to use.

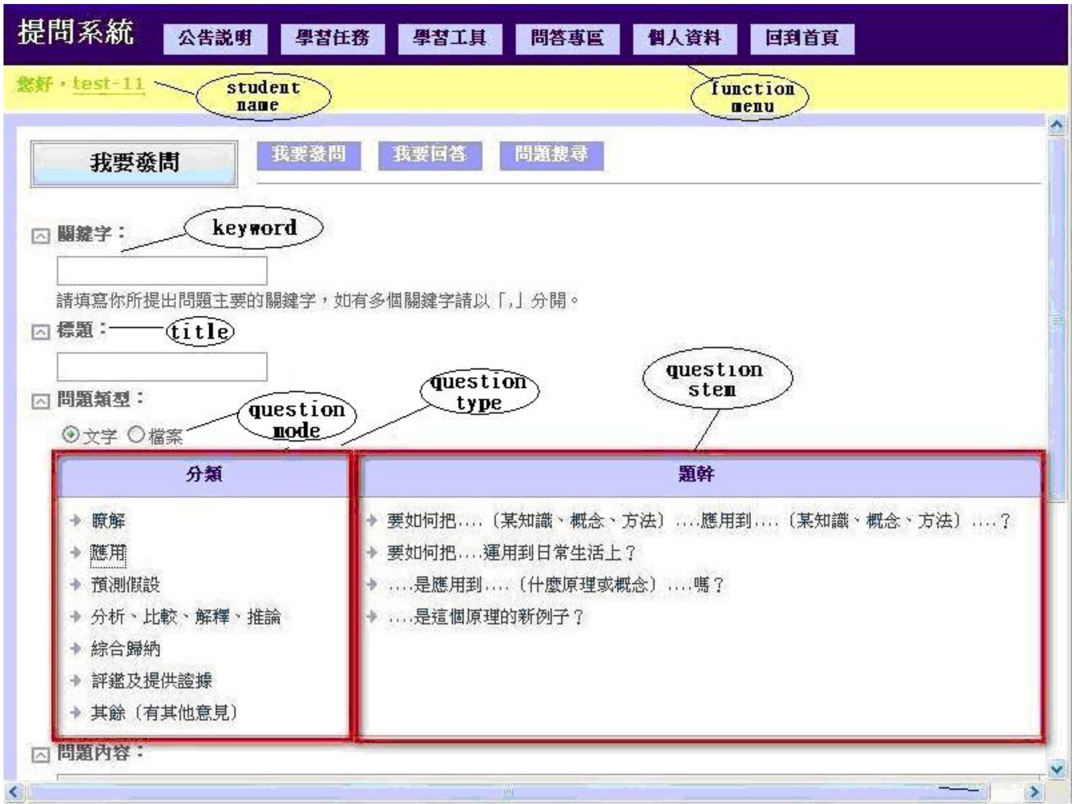

Figure 1 The user interface of QSTLS

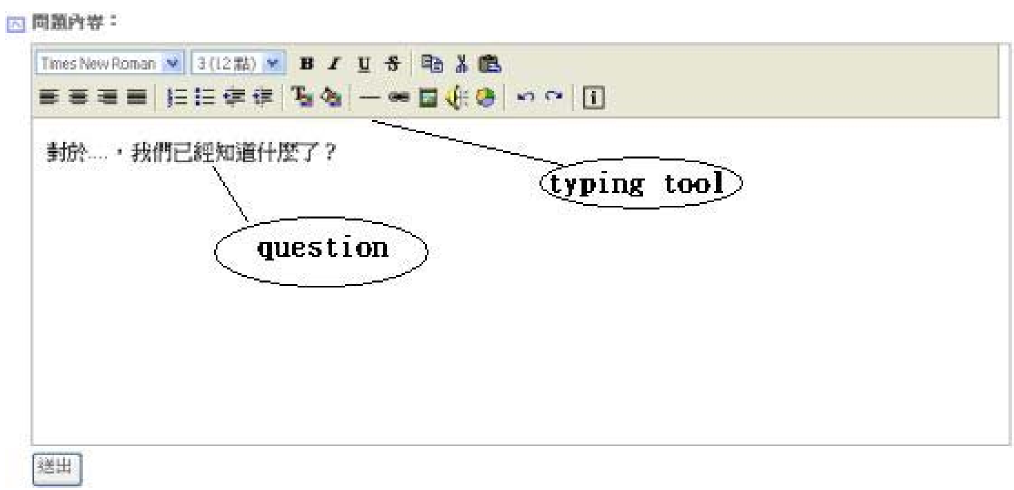

Figure 2 The user interface of typing question

3.3. Procedures, stems and criteria

Three classes were assigned to three question-stem groups. The detailed-stem group was provided with more complete question stems than the other two groups (Table 1). The simple-stem group was only provided with words (Table 1). And the no-stem group didn't have stems.

There are five sessions in the scientific activity and each session is about 2-3 science periods. At the outset, pupils were introduced to the functions of QSTLS, and practiced the operations of the system. There were thirty-four pupils in the detailed-stem group, thirty-three in the simple-stem group, and thirty-three in the no-stem group. During the science learning and questioning activity, each pupil first read an online science text about "weather and rainfall." The science text is an introductory article about the rainfall-factors, including the monsoon, topography, air mass, typhoon, and so on. The pupils read the text and everyone was required to pose at least three questions about the article content. They can carefully think and ask question through the guidance of question stem, and then evaluate posted questions according to five criteria (Table 2). After that, pupils were required to respond to at least three questions and evaluate posted answers according to specified criteria (Table 2).

Table 1 Samples of detailed-stems and simple-stems

Detailed-stems	Simple-stems
What is the example of …? What is the …?	What sample…? What…?
How do you apply … to …? How do you apply…on daily life? What concept (principle) is applied to …	How to apply…?
What would happen if…? How do you solve (handle)…if…? What outcome would happen if…?	If…?
Compare…and …with regard to …How are…and…similar? How are…and…different? Is …(concept) similar to …what we have learned before? What…(concept or principle) is related to what we have learned before?	The relation…? Compare…? …different…? …similar…? …as before…?
Explain why…? Explain how…? Why… is important? Why …is important to…?	Explain…? Why important…?
How does…affect…? What do you think cause …?	How to affect…? What result…?
What are the strengths and weaknesses of…? What are possible solutions for…? Would you draw a conclusion…?	Strengths and weaknesses...? Solution…? Conclusion…?
Which one is the best….and why? Do you agree or disagree with this …and why?	Evaluate...and why…?
For …, what we have known…? What idea do you have…?	What know…? Who know…?

Table 2 Evaluation criteria for questions and answers

Question evaluation criteria	Answer evaluation criteria
● the statement of question is clear. ● the question is important. ● the question is challenging. ● the question is worth answering. ● the question is helpful to my leaning. ● other opinion	● the statement of answer is understandable. ● the answer is correct. ● the answer motivates me to continue the discussion thread . ● the answer is helpful to my learning. ● other opinion.

3.4. Data sources and analysis

All participants were required to ask questions, answer questions, evaluate questions, and evaluate answers. The research data for this study includes pupil-generated questions, pupil-generated answers, and pupils' evaluation of questions and answers. These data were collected in QSTLS. By constantly reviewing and comparing the data, several questioning types emerged. The frequency of each questioning type was calculated and analyzed by Kruskal-Wallis test. The QSTLS was open for pupils during class time and the non-class periods; therefore some of the data collected from the non-class time was also analyzed in order to understand more about pupils' questioning behavior. Besides, when the scientific activity came to the end, the "Critical Thinking Test-Level I "(CTT- I) (Yeh, 2003) was used to measure the critical thinking skill of students. Owing to the data of critical thinking is still under analyzing, therefore, the relation between question-stem and thinking will not be discussed in this paper.

4. FINDINGS

4.1. Types of question

After an analysis of all pupil-generated questions, nine content-focused question-types emerged. Table 3 presents the definitions, examples and "thinking dispositions" of those nine types. Besides, two types of non-content related questioning were also found. They are "Beyond" questions (The content of question exceeds the scope of the designated science text) and "Invalid" questions (title only, question hasn't been completed, question's meaning isn't clear, or it just copies other pupils' question).

Table 3 Definitions, examples and dispositions of content-related question types

Types	Definitions	Examples	Thinking dispositions
What	Asking for the definition or meaning of a science concept or a science term.	What is a wall cloud?	Understanding definition or meaning.
Example	Asking for some instances for some science concepts or phenomena.	Could you give examples of a disaster that will be brought by a stationary front?	Understanding concrete examples.
Why	Seeking a causative reason for a scientific or natural phenomenon.	Why typhoon has the eye?	Exploring cause and reason
How	Seeking a formation process or scientific cause for a natural phenomenon.	How does the typhoon's eye form?	Exploring a formation process
Comparison	Comparing two scientific concepts or scientific phenomena.	Could you tell the difference between a sea breeze and a land breeze?	Analyzing differences
Influence	Affecting what will happen from nature phenomenon	What influence will be brought by an orographic rain?	Understanding effects
Relation	Connecting two scientific concepts	What is the relationship between a fontal surface and a frontal cloud?	Analyzing relatedness
Hypothesis	Mentioning a possible situation that may result in certain events.	If a cold air mass comes to Taiwan, what disasters may be caused?	Assuming and inferring results
Perspective	Asking for an alternative viewpoint on an event, a situation, an idea or a concept.	What are your ideas about a cold air mass?	Evaluating and inducing

4.2. Frequency of question

The total number of questions and the frequency of each type were counted. The results show that the simple-stem group had the largest number of questions (172), and the no-stem group had the smallest number (81). If the number of "Invalid" questions is deducted from the total (172-47=125), the detailed-stem group and the simple-stem group had almost the same number of questions (128 and 125 respectively).

Pupils' questioning can be classified into two categories: content-related and non-content-related. In the content-related category, Table 4 shows that the detailed-stem group has 9 question types during class time, the simple-stem group 7 question types and the no-stem group 5 question types. "Example", "Comparison", "Hypothesis" and "Perspective" types were not found in the no-stem group. The simple-stem group had no "Hypothesis" and "Perspective" types. "What", "Why" and "How" proved to be common questioning types (28.47%, 21.6%, and 8.4% respectively).

Table 4 Numbers and percentages of content-related questioning types in the three groups

	class time / non-class period								
types / group	What	Example	Why	How	comparison	influence	relation	Hypothesis	Perspective
Detailed-stem group	40 (25.6%) 90 (28.5%)	7 (4.5%) 1 (0.3%)	38 (24.4%) 79 (25.0%)	14 (9.0%) 19 (6.0%)	3 (1.9%) 7 (2.2%)	3 (1.9%) 5 (1.6%)	4 (2.6%) 12 (3.8%)	5 (3.2%) 5 (1.6%)	2 (1.3%) 0 (0%)
Simple-stem group	54 (31.4%) 4 (8.3%)	10 (5.8%) 0 (0%)	29 (16.9%) 4 (8.3%)	13 (7.6%) 1 (2.1%)	2 (1.2%) 1 (2.1%)	3 (1.7%) 1 (2.1%)	3 (1.7%) 0 (0%)	0 (0%) 0 (0%)	0 (0%) 0 (0%)
No-stem group	23 (28.4%) 2 (16.7%)	0 (0%) 2 (16.7%)	19 (23.5%) 4 (33.3%)	7 (8.6%) 1 (8.3%)	0 (0%) 0 (0%)	2 (2.5%) 0 (0%)	5 (6.2%) 0 (0%)	0 (0%) 0 (0%)	0 (0%) 0 (0%)

During the non-class time, the total number of questions for the detailed-stem group far exceeded that for the other two groups (316, 48, and 12). The detailed-stem group had 8 types of question and the no-stem group had 4 types. Both "What" and "Why" types had larger percentages in class time than in non-class time, however, these two types reduce substantially in the simple-stem group (31.4% to 8.3% and 16.9% to 8.3%).

In the non-content-related category, Table 5 shows that the no-stem group has the maximum frequency for the "Beyond" type (16.1%) during class time. And the simple-stem group has the maximum frequency for the "Invalid" type (27.3% and 35.4%) during both class and non-class time. The average frequency for the "Beyond" type within the detailed-stem group is lower than that for the simple-stem and no-stem groups (7.05%, 24.05%, and 20.55%).

Table 5 Numbers and percentages of non-content related question types

	class time / non-class period	
types / group	Beyond	Invalid
Detailed-stem group	11 (7.1%) / 22 (7.0%)	29 (18.6%) / 76 (24.1%)
Simple-stem group	11 (6.4%) / 20 (41.7%)	47 (27.3%) / 17 (35.4%)
No-stem group	13 (16.1%) / 3 (25%)	12 (14.8%) / 0 (0%)

As shown in Table 4 and Table 5, the detailed-stem group has the most question types and question frequencies. On the other hand, the no-stem group has the least question types and question frequencies. The ratio of the total numbers of question types and frequencies for the three groups is approximately 4:2:1 (472:220:93). The average question frequency of each pupil is 13.88, 6.67 and 2.82. In the Kruskal-Wallis analysis of question frequency, the result reveals a significant difference: χ^2=14.244, p=.001(Table 6). The post-hoc test indicates that the question frequency for the detailed-stem group and simple-stem are significantly greater than that for the no-stem group (25.86 > 16.97 and 18.17 > 17.10). Moreover, there is no significant difference between the detailed-stem group and the simple-stem group (7.69 < 16.97). "What" and "Why" are the most common question types. Besides, the detailed-stem group has the minimum frequency for the "Beyond" type. Finally, the simple-stem group posted the maximum number of invalid questions.

Table 6 The Kruskal-Wallis test for average question frequency per student

Group	N	Mean Rank	Chi-Square	Post-hoc test
Detailed-stem	34	61.57	14.244**	Detailed-stem > No-stem
Simple-stem	33	53.88		Simple-stem > No-stem
No-stem	33	35.71		
Asymp. Sig=.001 ** P<.01				

4.3. Quality of questioning

In this study, basic-quality questioning is defined as a form of questioning used for recalling factual information or explaining a phenomenon. It includes the types of what, example, why, and how. Advanced-quality questioning is defined as a form of questioning that requires higher-level cognitive skills. It includes the types of comparison, influence, relation, hypothesis, and perspective–taking. Table 7 shows that according to the findings of this study, basic-quality questioning had the highest frequency (89.13%). In comparison, advanced-quality questioning only had a frequency of 10.87%. Although the frequency of basic-quality questioning is almost the same for the three groups (86.2%, 92%, and 89.2% respectively), the detailed-stem group has the lowest frequency (86.2%), and the simple-stem group has the highest frequency (92%). For advanced-quality questioning, the detailed-stem group had the highest frequencies (13.8%) and the simple-stem group the lowest (8%). It therefore seems that the detailed-question stem could help students to develop advanced-quality questioning. If the design of the question-stem involves only one word or a few words (as in simple-stem questions), the questioning quality seems less than for the other question-stems.

Table 7 Frequency of basic and advanced quality in question types

Quality	Basic-quality				Advanced-quality				
group \ type	What	Example	Why	How	comparison	influence	relation	Hypothesis	Perspective
Detailed-stem group	38.9%	2.4%	35.0%	9.9%	3.0%	2.4%	4.8%	3.0%	0.6%
	86.2%				**13.8%**				
Simple-stem group	46.4%	8%	26.4%	11.2%	2.4%	3.2%	2.4%	0%	0%
	92%				**8%**				
No-stem group	38.5%	3.1%	35.4%	12.3%	0%	3.1%	7.7%	0%	0%
	89.2%				**10.8%**				
Total	**89.13%**				**10.87%**				

Pupils evaluated questions posted by peers using five criteria (Table 2). The rates of evaluated questions were calculated. 71.2% of all evaluated questions were rated higher than 3 or equal to 3 on a five-point scale. The detailed-stem group had the highest frequency for level-5, level-4 and level-3 questions, as compared with the simple-stem and no-stem groups; the no-stem group had the lowest frequency for level-5, level-4 and level-3 questions, as compared with detailed-stem and simple-stem groups (Table 8). This seems to show, once again, that the questions of the detailed-stem group were of higher "quality."

Table 8 Frequency of question-rating (on a 5-point scale, from 5 to 1)

	5	4	3	Average
Detailed-stem group	50%	57.98%	61.20%	56.39%
Simple-stem group	45.83%	33.61%	26.76%	35.4%
No-stem group	4.17%	8.40%	12.04%	8.20%

In summary, detailed-stem has the effects on numbers of questions, types of question, and quality of questioning.

5. DISCUSSION AND CONCLUSION

This study set out to explore the use of question-stems to support students' online questioning. The hypothesis was that the question-stem provides a questioning structure to help pupils mentally construct a question, and it was found that indeed question-stems can help pupils to ask questions. Moreover, it was found that detailed-stem questions can increase the frequency, type and quality of pupils' questioning during online learning. The most plausible interpretation of this increase in questioning frequency is that, if we look at question-posing *via* the concept of questioning structure, it is obvious that the detailed-stem has a more detailed questioning structure than the simple-stem. Does questioning structure then affect the frequency of posted questions? Our study's finding is "Yes." The no-stem group had the lowest number of questions posed because, it is also concluded, they had no prompts to assist their question-posing. This finding is similar to that of the study of Choi et al. (2005), which found that the scaffolds were useful in increasing the frequency of college student questioning during online discussion.

Our study thus found that the detailed-stem can help pupils create more question types in the process of online learning. A likely reason for this, it is concluded, is that since the question-stem provides a "thinking point" for pupils, the detailed-stem gives them more thinking points to guide their questioning mindset, and therefore helps them to ask more question types. The no-stem group has no prompt to assist pupils' questioning, and pupils in this group therefore asked the smallest number of question types. Furthermore, some question types at a higher thinking level, such as the hypothesis type, perspective type and comparison type, aren't found in the no-stem and simple-stem groups. These findings support the hypothesis that the level of the question-stem can affect pupils' "thinking disposition" and questioning capacity.

Though this study shows that the majority of posted questions (87.98%) in the online environment are of the basic-quality type, detailed stems can apparently reduce the frequency of basic-quality questioning and increase the frequency of advanced-quality questioning. One unexpected phenomenon found by the study was that the simple-stem group had more basic-quality and fewer advanced-quality questions than the no-stem group, even though the no-stem group had no stems as a prompt or clue to ask questions. A possible explanation is that the simple question-stems are not clear enough or are too simple to stimulate pupils to deeply organize their thinking and construct advanced-quality questions. Another plausible interpretation is that the incomplete stem structures might interfere with pupils' cognitive processes and limit their thinking, whereas the no-stem structures, interestingly enough, had less of a negative effect in this regard. This explanation can be partly verified by the finding that the simple-stem group had more 'Invalid' questions than the other two groups.

This study shows that detailed question-stem can moderately push or pull pupils to think and ask more numbers of questions, more types of questions and better quality of questioning in a specific online questioning environment. With the assistance of question-stems, the QSTLS system can provide a student-centred and active learning environment for elementary pupils. The QSTLS can be a helpful information system and resource for elementary pupils in learning science.

The findings have implications for the use of online questioning activities with elementary pupils. There are three points to be emphasized here. First, elementary pupils lack sufficient domain knowledge and questioning skills compared to graduate student, college student or high school student, and therefore an online questioning environment should provide appropriate scaffolds for assisting pupils in their questioning. Secondly, detailed question-stems can help pupils to formulate quality questions, and thus an online questioning environment for elementary pupils should provide detailed-question stems. Simple-question stems are not recommended. And finally, online questioning is a very useful instructional strategy.

This study showed that a stem-supported online questioning systems helpful to elementary pupils, however, because the participants are just fifth graders, and the subject is only on science, the results of this study may not be generalized too far. Further studies may explore the online questioning behavior in different subject areas, and the relationship between advanced online questioning and thinking skills.

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