TRAINEE TEACHER PRACTICES : A CASE STUDY

Selva Ranee Subramaniam
Department of Science and Mathematics Education
University of Malaya, Malaysia

Questioning skills are significant pedagogical strategies in science teaching and learning. This study explored the questioning skills of a trainee teacher during a 10-week practicum period. The trainee teacher was audio-taped and evaluated in the form of an action research methodology was done in the first two weeks. The quantitative data collected was analysed according to the categories of questions, the frequency of questions in each category, the probing and follow-up questions leading to high-order thinking were noted. The wait time period for each question was recorded with reference to the level of the question. The findings showed that the trainee teacher focused on the yes-no type of questions and the short-answer type of questions with little or no probing or follow-up of the student's answers. The wait-time was on the increase indicating that a longer wait time for higher-order questions was emphasized.

INTRODUCTION

Teaching is a complex activity, and questions of the depth and the width of the components that need to be incorporated in the teaching and learning process besides emphasizing the content can be a dilemma for practitioners. The conception that many teachers still uphold is that their task is to deliver what is explicitly outlined in the curriculum and to prepare the students for examination purposes. With this belief still 'hanging over their heads', then the ultimate goal of producing individuals who are versatile and capable

of applying knowledge contextually in the workforce seems to be an end difficult to achieve. Our schooling system has been influenced by the onslaught of technology. Malaysia, like many other developing countries, has given a high priority to educational development and has emphasised the use of technology in education over two decades. This appears obvious in the recent policy of language change in the teaching of Science and Mathematics, which is fully supported by technology.

The emphasis on science and technology has been reiterated in the challenges of the Vision 2020 policy document which outlines "the challenge of establishing a scientific and progressive society that is innovative and forward looking; one that is not only a consumer of technology but also a contributor to the scientific and technological civilization of the future." Now Malaysians are faced with a situation to turn out students who are not only academically knowledgeable, but also those who can apply this knowledge contextually. This is only possible when students are trained to think "out of the box" to cope and face with the challenges of this rapid technological age. As we are moving towards an era which emphasizes on "thinking out of the box" it is essential that this practice be seriously infused into the teaching and learning process. At the end of the day, we do not want to churn out students who apparently can only memorise but are unable to transfer knowledge and skills to other situations. The client charter of the Malaysian National Examination Board which has set targets in developing 60% high-order questions is a policy to fulfill this vision of a "thinking society".

BACKGROUND

Classroom questioning, which is significant for developing a "thinking society" has a long history dating back to the time of Socrates. The Socratic method of using questions and answers to challenge assumptions, and to evaluate contradictions, can lead to

the construction of new knowledge. This certainly leads to a powerful pedagogical strategy. Research indicates that questioning is second to lecturing in popularity as a teaching method and that classroom teachers spend about thirty-five to fifty percent of their instructional time conducting questioning sessions.

Questions take a form of interrogation. Analysis of literature shows that questioning for a variety of purposes includes among other things the prime purpose for evaluation to gauge student understanding of content knowledge, ascertain the extent the students have achieved the learning outcomes, review and summarise the lessons of the day or of earlier lessons. The other paradigm looks at questioning as a platform for stimulating critical thinking skills and to nurture insights into new knowledge thereby stimulating interest and instilling intrinsic motivation to the students to pursue knowledge independently (Cotton 1988).

Investigations of the role of classroom questioning have drawn several conclusions which are as follows. Redfeild and Rousseau (1981) review twenty research articles on the achievement differences produced by higher and lower cognitive questions and conclude that asking higher-order questions has a significant and positive effect on student peformance. A meta-analysis of fourteen studies of the relative achievement effects of asking higher and lower cognitive questions in classroom discussions found that students exposed to higher cognitive questions outperformed other students, but that the effect size is small (Samson, Strykowski, Weinstein, Wallberg, 1980). Sitko and Slemon (1982) described a study in which twenty teachers were trained in questioning technique to enable them to ask more higher cognitive questions and to vary the level of questions posed during discussions. Results showed that the training enables them to ask more higher level questions, that there was a close correlation between the level of questions and student responses, and the incidence of higher level student responses increased.

Cotton (1988) in the School Improvement Research series put forward several general findings on questioning skills. Instruction which includes posing questions during lessons is more effective in producing achievement gains than instruction carried out without questioning students. Students perform better on test items previously asked as recitation questions rather than on items they have not been exposed to before. Oral questioning during classroom recitations are more effective in fostering learning than are written questions. Questions which focus student attention on salient elements in the lesson result in better comprehension than questions which do not.

Questioning techniques and its significance in developing a student-centered pedagogy are reviewed by Hansen (1994), and Dantonio (1990), and the description of the questioning processes in terms of the following four categories which includes gathering information, sorting out information, organizing information and interpreting, inferring or predicting information. Sometimes as educators, we are confused as to whether we should be asking questions which require recall of text content and only basic reasoning or posing questions which call for speculative, inferential and evaluative thinking? Researchers have designed experiments which examine the effects of questions framed at different levels of Bloom's Taxonomy of school learning. These levels in ascending order of sophistication are, knowledge, comprehension, application, analysis, synthesis and evaluation.

An obvious fact that we are aware of is instruction which includes posing questions during lessons is more effective in producing achievement gains than instruction carried out without questioning students. Students perform better on test items previously questioned than on test items they have not been exposed before. Oral questins posed during classroom recitations are more effective in fostering learning than are written questions. Questions which

focus student attention on salient elements in the lesson result in better comprehension than questions which do not.

Some general finding summarized by Cotton (1988) on the placement and timing of questions included the sequencing, timing, type of questions and the appropriateness of questioning which is a important dimension to consider. The questions should not be posed for the sake of questioning and there are instances where educators pose two or three verbal questions, and where there is an interdependence between questions. The students are in a dilemma which questions should be answered first especially if the answers are interrelated. Frequent questioning during class discussion is positively related to learning facts. Increasing the frequency of classroom questions does not enhance the learning of more complex material. Some researchers have found no relationship while others have found a negative relationship.

The use of wait time needs to be learner,context, and content friendly. Rigidly applying the 3- to 5 second rule is for all questioning opportunities is unlikely to improve the quality of classroom interaction (Carlsen 1991). It is critical for higher-order questions to be allocated an extended wait time. Continuous "bombarding" of questions with a minimal wait time creates an environment which is tense for students to think and there is a tendency that negative responses will be elicited or hardly any response. Higher-order question requires students to mentally manipulate bits of information previously learned to create an answer or to support an answer with logically reasoned evidence. Higher cognitive questions are also called open-ended, interpretive, evaluative, inquiry, inferential, and synthesis questions.

Researchers on questioning strategies speak of two kinds of wait time: "wait time 1" refers to the amount of time, the teachers allow to elapse after he/she has posed a question and before a student begins to speak, and "wait time 2" refers to the amount of time a

teacher waits after a student has stopped speaking before saying anything. Research has shown that the degree of improvement resulting from increases in both higher cognitive questions and wait time is greater than an increase in either of these variables by itself. More complex mental operations require higher cognitive questions call for longer wait times. Honea (1982) reports the results of an experiment in which the effects of increasing wait time studied showed that twenty-four high school students participated in their social studies classes. Increasing wait time to three to five seconds significantly improved student engagement and participation. Mahlios, & D'Angelo (1983) investigated the effects of different types of classroom questioning on the nature of student responses, student achievement and student attitudes. Higher order questions led to higher achievement but did not seem to affect attitude measures. Student answers were both longer and at higher levels when they were exposed to higher levels of questioning.

A good question signifies the difference between constraining thinking and encouraging meaning (Kamii & Warrington 1999; Schwartz, 1996: Stone, 1993). Some researchers argue that a teacher's verbal behaviour is a strong indicator of their total teaching behaviour (Adams 1994). Recent focus on the use of questioning in teaching mathematics (Carpenter, Fennema, Franke, Levi & Empson 1999, 2000; Mewborn & Huberty 1999) support the idea that a teacher's questioning strategies are pivotal to the instructional process because questioning is the most frequently used instructional tool (Wassermann 1991). Fewer research studies document the development of questioning skills at the pre-service level (Ralph 1999). Recent research has explored the relationship between teacher questioning and children's thinking (Baroody & Ginsburg 1990; Buschman 2001; Carpenter, Fennema, Petereson, Chiang & Loef (1989), Carpenter, Fennema, Franke & Carey 1993) as more than just an understanding of the child's knowledge which can be gained from using questioning as an assessment.

Research tells us that pre-service teachers are not given adequate training in developing questioning strategies and some receive no training at all. When teachers participate in training designed to help them improve their questioning skills, research indicates that training teachers in asking higher cognitive questions is positively related to the achievement of students above the primary grades. Training teachers in increased wait time is positively related to student achievement. Training teachers to vary their questioning behaviour and to use approaches other than questioning during classroom discussions are positively related to student achievement. Brophy and Good (1985) research on classroom questioning strategies indicates that most questions should elicit correct responses, higher cognitive questions are not categorically better than lower cognitive questions and teaching complex content calls for asking questions that few students can answer correctly (or which have no one correct answer).

Thus, based on the above supporting evidence, it can be concluded that questioning skill is an asset in effective classroom teaching and learning processes. This leads to this research to explore the real practices of trainee teachers who will be teachers of the future .

PURPOSE

The main objective of this study was to investigate the trainee teachers' practices in promoting higher-order thinking skills in Science. This case study will focus on the trainee teachers' practices in a particular school where they undergo a 10-week "on the ground" training. Trainee teachers have to satisfy this course after fulfilling other course requirements. The areas which will be investigated are the questioning strategies employed by the trainee teacher and the wait time involved between subsequent questions and statements.

The purposes of this study were to: (1) investigate and identify the questioning strategies employed in teaching Science (2) investigate the questioning skills employed in promoting the acquisition of high-order thinking skills (3) investigate the wait time between questions and the answers.

DESIGN AND METHODS

Classroom Context

A holistic inquiry research with a qualitative methodology is used to investigate the reality of the teaching and learning culture implemented during the practical teaching. The findings reported in this study are drawn from a 10-week practicum research into the teaching practices of the trainees in promoting high-order thinking skills. The research was carried out from late April to early July this year. The study focused on the practices of a trainee teacher in teaching Chemistry. This particular trainee teacher was selected as a typical student of this training programme, willing to participate thus being purposive in nature and the area of specialization is Physics and Chemistry. The trainee teacher was exposed to all the relevant courses which includes teaching methods, cognition in science education and technology in teaching and learning prior to the practicum. This research was conducted in the educationally authentic context of a Form Four secondary school chemistry classroom associated with the syllabus-specified chemistry content. Students were studying the topics on matter and the periodic table during this ten-week period.

PROCEDURE

Observations

Observations were made by the researcher during a ten-week period. Non-participant observation by the researcher focused on the questioning skills of the teacher and the wait time involved. This type of observation enabled the researcher to observe the real happenings in an authentic classroom situation. The researcher audio-taped the teaching and learning process in the classroom. Observations made were validated with the student's document and the trainee teacher's lesson plan. Data were analysed quantitatively supported with qualitative data. The types of questions were identified, categorized and recorded. The wait time for each question was timed and the wait time for high-order cognitive question was noted. The average wait time for each subsequent lesson was calculated. For the purpose of triangulation of data, the researcher worked closely with the subject teacher of the class who is experienced (more than ten years of teaching experience)in collecting the data. The peer observer was to ensure the validity of the data. The quantitative data were supported with qualitative data.

RESULTS AND DISCUSSION

Quantitative Data on Questioning Skills

The data were based on observations of a particular trainee teacher in a chemistry class. The data were not collected for the first two weeks as the trainee teacher had to get accustomed to the new school environment and it was a first experience in teaching in an authentic situation. However, the trainee teacher was guided through an analysis of the questions she posed and the responses received from the students. The analysis enabled the trainee teacher to identify both the effective an ineffective questioning techniques. This form

of action research is significant to guide the trainee teacher understand student's thinking and to assist in the pedagogy used in the classroom.

Several patterns emerged in the observation of the verbal questioning by the trainee teacher. The questions posed by the teacher were categorized into four groups namely the yes-no type, short answer questions, comparison questions and opinion questions. The yes-no type of questions which required a single correct answer failed to stimulate the thinking of the students as there was no further 'probing' on the students' responses. The trainee teacher proceeded from one question to another without any regard to the students' responses. From the observation data, it was inferred that there was a lack of follow-up questions and a lack of 'probing' of the correct and incorrect answers.

Table 1
Time Series of Questioning Patterns (Early part of the week)

Questioning Skills	Week 3 (Early)		Week 4 (Early)		Week 5 (Early)		Week 6 (Early)	
	No	%	No	%	No	%	No	%
Yes-No	3	13.64	16	45.71	20	45.45	5	13.89
Short answer	11	50.00	12	34.29	12	27.27	10	27.78
Comparison	4	18.19	5	14.29	10	22.73	11	30.56
Opinions	4	18.19	2	5.71	2	4.55	10	27.78
Total	22	100	35	100	44	100	36	100

Table 1, above shows that that the questions of the yes-no type showed a rise and fall of percentages in the early part of each week. The yes-no questions which fall into the category of convergent questions focused on a correct response is basically a recall of simple facts. Short answer questions showed a decreasing trend as the week progressed. However, there was an increasing percentage of

the comparison questions particularly during the fifth and sixth week. High-order questions has an important role in stimulating critical thinking. Questions related to opinions seemed to surge to a higher percentage during the sixth week and this was probably due to the content of the lesson presented. The content related tasks were related to decision making and solving problems.

The total number of questions posed during the 80-minute lesson was on the increase though the predominant percentages of the question categories differed. Short-answer types of questions recorded a majority of 50% during the early part of the first week, whereas the yes-no type of questions recorded a majority of 45.71% during the fourth week and fifth week. A considerable high percentage was indicated during the sixth week for comparison questions. The yes-no type of questions which fall into the category of convergent questions focuses on a correct response is basically a simple recall of facts. The literature review shows that teachers pose high-order questions in the range of 10 % - 20 % of the time.

Trainee teachers interviewed on the questioning skills and their tendency to pose higher-order questions revealed that it is of course easier to ask questions which tests recall of facts which is the foundation for further analysis, synthesis and evaluation. The teachers lacked the skill of posing high-order questions and face the anxiety of managing multiple answers given by the students. The responses from the students are less predictable. In planning the lesson, the trainee teacher should have given more thought to constructing thinking questions.

Table 2
Time Series of Questioning Patterns (Later in the week)

Questioning Skills	Week 3 (Late)		Week 4 (Late)		Week 5 (Late)		Week 6 (Late)	
	No	%	No	%	No	%	No	%
Yes-No	4	18.18	17	38.64	2	6.45	6	20.69
Short answer	12	50.00	15	34.09	12	38.71	11	37.93
Comparison	3	13.64	15	15.91	10	32.26	7	24.14
Opinions	3	13.64	7	11.36	2	22.58	5	17.24
Total	22	100	44	100	31	100	29	100

Table 2, above shows that that the questions of the yes-no type showed a rise and fall of percentages in the later part of each week. However there was a decrease in the short answer questions as the week progressed. There is an increasing percentage of the comparison and opinions questions as the week progresses with relatively high figures in the fifth and sixth week. The total number of questions posed during the 80-minute lesson was of a "rise and fall" pattern..

Table 3 below shows the pattern of the wait time between the teacher's question and the student's response. The asterisk indicates the wait time for the high-order questions. The data revealed that there was an increase in average wait time for the subsequent weeks. The average wait time during the third week was 2.23 seconds but eventually reached a maximum value of 1.74 minutes during the sixth week. The average wait time for high-order questions shows an upward trend with the lowest value being 4.50 seconds to a maximum of 3.2 minutes in the sixth week. This findings show that the teacher is less anxious on getting immediate feedback from the students and has pre-planned for an appropriate wait time before getting student's responses.

Table 3
Time Series of Wait Time

Week 3 (Later in the week)								
3	1	2	1	2	3	4*	5*	1
2	3	1	2	3	2	2	1	3
2	2	3	1					

* Higher-level questions (comparison and opinion)
Average wait time = 2.23 seconds
Average wait time for high-order questions = 4.50 seconds

Week 4 (Early in the week)								
3	5	7*	6*	5	4	5	7*	3
4	5	3	5	3	2	2	3	2
5	7*	7*	3	5	6*	3	2	5*

* Higher-level questions (comparison and opinion)
Average wait time = 4.11 seconds
Average wait time for high-order questions = 6.57 seconds

Week 4 (Late in the week)								
3	2	5*	7*	3	5	4	3	2
5	8*	2	3	4	5*	6*	6*	3
4	5*	6*	6*	5	3	4	6*	6*

* Higher-level questions (comparison and opinion)
Average wait time = 5.50 seconds
Average wait time for high-order questions = 6.00 seconds

Week 5 (Early in the week)

2 min*	1 min	0.5 min	2 min*	1 min	3 min	1 min*	1 min	1 min
0.5 min	0.5 min	2 min	1 min	0.5 min*	0.5 min*	1 min	1 min	1 min
2 min*	1 min	0.5 min*	1 min	1 min	1 min	1 min	1 min	0.5 min

* Higher-level questions (comparison and opinion)
Average wait time = 1.09 minutes
Average wait time for high-order questions = 1.33 minutes

Week 5 (Late in the week)

3 min	2 min*	2 min*	3 min*	1 min	1 min	1 min	1 min	1 min
0.5 min	0.5 min	0.5 min	0.5 min	1 min	2 min*	1 min	1 min	0.5 min
0.5 min	0.5 min	1 min	1 min	2 min*	1 min	1 min	1 min	1 min

* Higher-level questions (comparison and opinion)
Average wait time = 1.43 minutes
Average wait time for high-order questions = 2.4 minutes

Week 6 (Early in the week)

3 min*	2 min	0.5 min	1 min	5 min*	1 min	0.5 min	2 min	3 min
2 min	1 min	1 min	0.5 min	2 min*	0.5 min	2 min	1 min	4 min*
2 min*	1 min	1 min	2 min	2 min	1 min	2 min	1 min	3 min

* Higher-level questions (comparison and opinion)
Average wait time = 1.74 minutes
Average wait time for high-order questions = 1.33 minutes

Week 6 (Later in the week)

1 min	2 min*	1 min	0.5 min	3 min*	1 min	2 min*	1 min	3 min
2 min	1 min	1 min	0.5 min	2 min*	0.5 min	2 min	1 min	1 min
3 min*	1 min	1 min	1 min	2 min*	1 min	1 min	0.5 min	0.5 min

* Higher-level questions (comparison and opinion)
Average wait time = 1.5 minutes
Average wait time for high-order questions = 3.2 minutes

QUALITATIVE DATA

The qualitative data presented were excerpts of scenarios to depict the question categories which were most predominant and the limited probing and follow-up questions, based on students' responses.

SCENARIO ONE

The teacher introduced the physical properties of the elements in the Periodic Table. The types of questions posed by the teacher were simple yes-no types of question. Based on the students's answers, the teacher just accepted the answer assuming everyone in the class understood. There was no follow-up questions by the trainee teacher irrespective of whether the answer is correct or incorrect. The following observations depicts the situation:

T: As you move from the left to the right of the Periodic Table _ that is across the Periodic Table, does the size of the atom increase or decrease or is it the same?

S: Decreases

T: Yes, correct

There was a minority of students who did not agree with the answer. The very fact that this question requires more thinking before the answer could be obtained should instill awareness in the teacher to create a doubt in the answer so that everyone has his/her piece to say. It seemed that it was a mere recall of fact without any prior analysis or synthesis of knowledge.

SCENARIO TWO

In another instance, clues were not given to the students to construct the meaning of electronegativity based on the earlier understanding of electropositivity; the teacher disseminated the abstract concepts in the form of long definitions as in the example below:

T: The definition of electronegativity is the affinity of the atom to attract an electron to form a negative ion. Do you understand?…

S:… Yes, a bit…affinity what is it?

T: Affinity means…the attraction of an electron by an atom to from negative ions.

S: So..the atom likes electrons?…is it?

T: Yes, it likes electrons. Why do you think it likes or attracts electrons?

Instead the teacher could have asked the students to recall what they studied in electropositivity and guided them to relate between these two concepts by the coining of the word electron and negative.

The scenarios above show that there was limited follow-up questions or probing of the student's responses. The question categories that predominate are the yes-no type and the short answer questions.

CONCLUSION

Questioning is a skill that can be nurtured over time and is important in science teaching. The inquiry approach adopted in teaching science is heavily dependent on the questioning ability of the teacher to facilitate the understanding of scientific concepts among students. The questioning categories that the trainee teachers use during the teaching and learning interactions in typical classrooms would also contribute to our knowledge based on the types of questions used and their opportunities in different situations. These analyses of the questions posed could lead to a better understanding of the types of questioning skills that could be developed in pre-service teacher training programmes to support questioning skills for trainees.

Action research can be conducted by focusing on the skill of questioning in a one-on-one diagnostic interview. This could be a starting point for developing the scientific questioning skills as this is an asset for future teachers facing the challenges in re-engineering a student-centered classroom.

The questioning skill of the trainee teacher in this study is reflective of the lack of experience of the trainee teachers. Trainee teachers are not expected to be competent in questioning but if continuous reflection is being done, this skill could be developed in time. Different types of questions are used to assess different types of knowledge and scientific process skills and are appropriate to different situations.

The data obtained showed that the trainee teacher who participated in this research did exhibit characteristics of the beginnings of competent questioning, especially in the sequencing and the timing of the questions. There was a diversity of question types depending on the appropriateness of the lesson. Follow-up questions and probing which are investigative in nature is an

important skill to develop for teaching science. The trainee teacher only attempted to use follow-up questions and probing when it involved higher cognitive questions. However, the follow-up and probing were limited its scope as can be inferred from the qualitative data. Sometimes the trainee responded to follow-up questions that were non-specific or questioned only incorrect answers.

Competent questioning by the teacher can provide students with the opportunity to reflect on their cognitive processes within the context of their course in mathematics. Students should reflect on the conceptual nature of the material they were learning in relation to the processes that they were using to acquire knowledge covered by the course. The students metacognitive processes were analysed from their metacognitive log. The metacognitive log gave a clearer and a more detailed account of their learning process and enhanced the understanding and stimulated the thinking process in the scientific activities. The students articulated their understandings with greater clarity.

In summary, questioning is a powerful intervention which can have an impact on multiple dimensions on students' cognitive processes and metacognitive processes. Questioning can stimulate students to think beyond the limited perimeters of content acquisition, utilize more active and transformative cognitive strategies, demonstrate better structuring of knowledge and the development of logical relationships. A proactive action research on questioning skills of trainee teachers can be a significant instructional intervention in enhancing high-order thinking skills in science. Questioning skills should be incorporated as an essential component in future teacher training programmes. Further research could be carried out to investigate the pattern of questioning skills for other teacher trainees.

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