SCIENCE TALK IN THE SECONDARY CLASSROOMS OF BANGLADESH: ANALYSIS OF TEACHERS' QUESTIONS IN VARIOUS LESSON DISCUSSIONS

Muhammad Nur-E-Alam SIDDIQUEE*

Hideo IKEDA**

Abstract

Teachers' questioning is an essential part of good teaching. It can scaffold students' thought process towards meaningful learning. In order to develop the skills of asking different types of effective questions –enabling students to practice a wide range of thought process- teachers need to know what kind of questions they are currently asked (Blosser, 2000). Therefore, the study aims to explore teachers' questions at secondary level (Grade VI-X) in various science lesson discussions in Bangladesh context. Video recorded data of fourteen science lessons were used as data source of this study. Data were analyzed with coded category. The results indicated that the questions teachers asked during science lesson discussion at secondary level were mainly lower order basically for checking students 'content knowledge. Rhetorical question and the question that ask for classroom management were also found predominant. Higher order and conceptual-change questions were rarely asked. Analysis of the results indicated that teaching experiences and in-services trainings were found influential in teachers' questioning while gender and the subjects taught at graduating level, were not found as influential agent. Implications of the study were also discussed.

Keywords: *Secondary Classroom, Teachers' questions, Science lesson, Bangladesh*

* PhD student, graduate school for International Development and Cooperation, Hiroshima University, Japan

** Professor, graduate school for International Development and Cooperation, Hiroshima University, Japan

Introduction

Effective learning is the main concern of science education. Effective learning happens best where social interaction, particularly between learners and more knowledgeable others, is encouraged. Teaching styles, therefore, need to take account of the need for discussion, both between pupils and between pupils and teacher (McCormick & Leask, 2005). Cormack, et al., (1998) stated that teachers can be highly influential in shaping classroom discussion so that it aids students' deep learning. Kawalkar and Vijapurkar (2011a) asserted that teachers can provide this support and guidance through questions. Teachers' questioning is significant aspects of classroom talk and asking question is one of the 10 major dimensions for studying teachers' behavior in the widely used system for Interaction Analysis (Flanders, 1970; Ewing & Whittington, 2007). Using questioning technique, for example, Socratic questioning, the teacher acted as an interlocutor and a coach who provided scaffolding through asking guiding questions to advance students' thinking(Chin, 2007). With a similar vein, Aschner (1961) stated that asking question is one of the basic ways by which the teacher stimulates student thinking and learning.

The kind of questions teachers ask and the way in which they are asked can, to a large extent, influence the nature of students' thinking as they engage in the process of constructing scientific knowledge (Chin, 2007) and can become indices of quality teaching(Carlsen, 1991). In the inquiry and conceptual change classroom teaching, the nature of teachers' question and their purpose differ greatly with the questions those asked in traditional teaching (Kawalkar & Vijapurkar, 2011a; Chin, 2007, Yip, 2004). Purpose of questioning, for example, in traditional teaching is to evaluate what students know and following a particular structure of Initiation-Response-Evaluate (IRE) sequence (Lemke,1990) whereas, eliciting what students think, encourage them to elaborate on their thinking and help them to construct conceptual knowledge, is the purpose of inquiry teaching(Baird & Northfield, 1992).

Engaging students into hands-on and discussion with group or peer in developing higher order thinking skills is the core of teaching in Bangladesh (MoE, 2006). As teachers' question can support students to involve active discussion and stimulate students thinking, the study attempts to explore teachers' questions in various science lesson discussions at secondary level (Grade VI-X) of Bangladesh. The following question was tried to address through this research.

What sort of questions do teachers ask to involve learners into teaching and learning process and what are the factors that influence their questioning?

Literature on Teacher questioning

Classification of Teachers' Questions

Teacher questions are frequent, pervasive, and universal phenomena (Roth, 1996) and prominent features of classroom talk (Wellington & Osborne, 2001; Blosser, 2000). Teachers ask many questions (Gall, 1970), sometimes an over hundred questions in a class session to encourage students thinking.

However, the types of questions teachers ask are more important that the number of the questions asked by the teachers. Several categories of teachers' questions have been proposed by many researches. Well known among these are lower and higher order questions (Bloom et, al., 1956), and open and close-ended questions (Graesser & Person, 1994). Lower cognitive, corresponding to close-ended question, are those that invite brief answers and place few cognitive demands on the student while open-ended or higher-cognitive questions invite extended answers, may have several acceptable answers and place more demands on the learner (Kawalkar & Vijapurkar, 2011a). Wilen (1991) concluded that teachers use questions to deal with both instructional and managerial tasks. Blosser (2000) identified questions as falling into one of four categories: Managerial-type, rhetorical-type, open-type and closed-type. *Managerial* questions are those used by the teacher to keep the classroom operating and *Rhetorical* question are used by teachers to reinforce a point or for emphasis(2000, p.4).

Kawalkar and Vijapurkar (2011a) found five broad categories of teachers question in inquiry classroom: *exploring pre-requisites or setting the stage*; *generating ideas and explanations*; *proving further*; *refining conceptions and explanations and guiding the enter class towards the scientific concept*. They reported that traditional teachers ask few open-ended questions. Yip (2004) identified 10 types of questions under four broad categories namely: lower order, higher order, motivational and conceptual change. He asserted that the "conceptual-change" questions, unlike most traditional questions, play a distinctive role in science instruction in that they aim at facilitating students to undergo conceptual change and construction (2004, p78) through eliciting preconception or alternative conceptions, challenging students to review and resolve inconsistent ideas, extending students idea from existing knowledge and applying the knowledge in novel situation. He reported that lower order questions were frequently asked by the teachers (35.1%), the proportion of higher order question (25.4%) and conceptual-change question is also constitute a significantly high percentage (27.4%).

Chin (2007) analyzed teacher's questions in science classroom. She described four approaches namely *Socratic questioning*, *Verbal jigsaw*, *Semantic tapestry* and *Framing* and several strategies within these approaches that encourage student responses and thinking.

Previous studies on teacher questioning focused on the recitation or the IRE(Initiation, response, evaluation) pattern of discourse (Mehan, 1979) and the importance of wait time in increasing students' thoughtfulness(Tobin, 1987). Dillon (1985, 1988b) discussed the lack of student active engagement when teachers asked too many question based on IRE format. He asserted that prevalence of evaluative questions of the IRE format in classroom talk would be counterproductive to students articulating their thought.

Use of Teachers' question in inquiry

The purpose of teacher questioning in traditional lesson is to evaluate what students know (Lemke, 1990) in which, teacher asks a closed question that is basically information-seeking, that requires a predetermined short answer and that is usually pitched at the recall(Goodrum, 2004) or lower-order cognitive level. However, in inquiry oriented science classrooms the role of teachers' questions is to encourage true dialogue (Lemke, 1990) aiming at conceptual understanding. Such questions are more open requiring one- or two-sentences answers, and the teacher engages students in higher-order thinking (Baird & Northfield, 1992). Goodrum (2004) stated that in inquiry teaching the main engine for facilitating learning is the use of questions and discussion while in traditional lesson the driving force of teaching is teacher explanation.

Roth (1996) described a case study where the teacher's questioning was designed to 'draw out' students' knowledge and scaffold students' discursive activity to lead to independent accounts and student –centered discussion. Erdogan and Campbell (2008) found that teachers facilitating classrooms with high levels of constructivist teaching practices not only asked a significantly greater of number of questions but also more open-ended questions.

Beccles (2012) studied teacher intensions by using the teacher questions and the purposes of the questions during science lessons in Ghana. He found that the intention of the teachers questions were mainly to check students focus in lesson (38%) and students' prior science content knowledge (42%). Less emphasis was given on checking students' procedural knowledge (2%), checking students' understanding (5%), and eliciting student thinking (8%). To promote meaningful learning that can solve real life problems, students need to be asked a variety of question (Blosser, 2000). To develop variety in questioning teacher need to know

what kind of questions they currently ask. This study, therefore, tried to explore teachers' questions in various science lesson discussions in secondary level of Bangladesh. As far as the researcher concern, this study will be the basic one of its kind in the case of Bangladesh. I believe, it would be helpful for science teachers at secondary level to check their current questioning practices. Additionally, the results of the study would be exemplary evidence to the science teachers, teacher educators and future science teachers regarding tactical questions in classroom discussion, and provide guidelines for teachers to increase their repertoire of questioning skills.

Research Method

An interpretative research framework of Strauss and Corbin (1990) was adapted to conduct this study. It focuses on the in-depth meanings of verbatim lesson transcripts generated from various science lessons. Data were collected from February and March 2012 and February and April 2013.

Participants

Thirteen teachers teaching Grade VI to X science from three schools participated in the study. They were selected purposively. Among the participants four were females. The teaching experiences of the participants ranging between two to seventeen years, held Bachelor in

Table 1 School wise demography of the teachers

School code	Teacher	Sex (M/F)	Years of Teaching experience	Subject taught	In-service training				
					B.ED	SBC	TQI	CPD	OT
A	T1	F	15	P	√	√	√		
	T2	M	About 2	B	√				
	T3	M	17	C	√	√	√	√	√
	T4	F	5	C	√				
	T5	M	9	P	√	√			
	T6	F	14	B	√	√	√	√	√
B	T7	M	6	B	√	√			
	T8	M	12	P	√	√	√		
	T9	M	10	B	√	√	√		
	T10	M	11	C	√	√	√		
C	T11	M	7	B	√	√			
	T12	F	6	C	√				
	T13	M	8	C	√	√			

Education(B.Ed.), have studied separate subjects of Physics (P) and Chemistry (C) along with either Mathematics (M) or Biology (B) at graduating level, received Teaching Quality

Improvement training(TQI), Subject Based Cluster training(SBC), Continuing Professional Development (CPD) training, and short term Overseas Training (OT). Table 1 shows the summary of participants.

Data Source and Procedure

Data of this study was gathered through lesson observation via video taping. Fourteen science lessons of thirteen teachers from three different schools were observed by the researcher. The observed lessons covered a range of topics (Table 2) included in the science syllabus in secondary levels (Grade VI to X). These include motion; living organism and their environment; gas law; state of matter; symbol, formula and valences; work, power and energy; virus; human body; periodic table; plant classification; solution; animal kingdom; chemical reaction and equation; and structure of matter. The average class size was 42 students and average duration of the class was 30-35 minutes. Due to manpower constraints and the availability of limited video camera for use in class, only classroom discussion in whole-class setting was recorded. The video camera was set up at the middle of the classroom and was directed toward teacher and students. For the video documentation, a high definition (HD) video camera was used, which is sensitive to capture subtle knock of tone, therefore, no extra audio recorder was used. The video files of the recorded classroom talk were transcribed verbatim and ready for analysis.

Table 2. School wise lesson topic and grade

School code	Observed lesson topic	Grade level
A	Motion	Nine
	Living organisms and their environment	Eight
	Gas law	Nine
	State of Matter	
	Symbol, Formula & Valences	Nine
	Work, Power & Energy	Nine
	Virus	Nine
B	Human body	Nine
	Periodic Table	Nine
	Plant classification	Nine
	Solution	Seven
C	Animal kingdom	Seven
	Chemical reaction & equation	Eight
	Structure of Matter	Nine

Analysis of Data

Data were analyzed through coded category suggested by Glaser and Strauss (1967). In order to get a sense of data corpus, the verbatim lesson transcripts of classroom discussion were read through several times. In deciding which utterances were to be considered as questions, the study focused on those that had the grammatical form questions and intonations of an interrogation were taken to be questions. All questions in the lessons were classified under five major categories: rhetorical, management strategy, lower order, higher order, and conceptual change. The emergent categories were refined by adding to, deleting from, or modifying the existing list. This resulted in a number of sixteen codes which were subsumed under five major categories. The codes depicted specific questions while the major categories characterized more holistic questioning groups. For example, the four codes 'eliciting' (EPA), 'challenging' (RRI), 'extending' (CNK), and 'applying' (UKS) constitute the major category 'conceptual-change' questions. The codes were developed according to each questions cognitive demands and purposes. Beccles (2012) used similar strategy to analyze teachers' intention for posing questions during classroom discussion. In order to determine questions' cognitive demands and purpose, the study taken into consideration the three dimensions of teachers' questioning suggested by Carlsen (1991): the context of questions, the content of questions and the responses and reactions to questions. Therefore, researcher considered aspects of questioning related to the situational contingencies of the conversations, the development of subject matter knowledge, and the management of turn-taking (Chin, 2007). Table 3 shows an illustrative example of these code and categories along with examples taken from various science lessons.

Researcher along with a rater (educational expert graduated from the graduate school for International Development and Cooperation, Hiroshima University, Japan) coded one lesson jointly to establish a common understanding of the coding regarding questions. The two raters proceeded by coding all subsequent transcripts independently. Inter-rater reliability was calculated by percent agreement, which was 82%. Disagreement between the two raters occurred mainly in the classification of 'higher-order' and 'conceptual-change' questions. The discrepancy was settled through discussion and negotiation between the raters. Finally, the frequencies of different questions were computed. The results were explained according to category of the questions.

Table 3. Coding method for teacher' question in lesson discussion

Category		Code	Guide line	Examples
Rhetorical question		QR	Questions that do not seek answer directly from the students. Emphasize point, reinforce a idea, or statement	What should I do now? We discussed the matter yesterday, isn't it?
Management strategy questions		MQ	Classroom control and organizational questions	Can you hear me? Are you OK? Is it clear? Where is the captain? Why are you talking or not listening to me?
Lower order	Checking student daily life experience, knowledge(factual and conceptual), observation , meaning of the term, read and draw	MT	Question that eliciting the meaning of term	What does virus mean?
		RDL	Question that checking students' ability to read and draw or label	Is it same? Cant' you know the answer? Can you give an example? What it will be?
		CK	Questions that checking student prior content knowledge	Can you tell about previous lesson?
		PAQ	Questions that Providing a predictable answer to a question	What will happen if you mix sugar with water?
		DE	Questions that seek for definition, asking for an example	What is the definition of velocity? Can you give an example of animal virus?
		WP	Question that representing something by a word or phrase,	What is inside of the cavity of the virus?
		ULC	Questions that checking student understanding of lesson content	Can you explain further why diffusion is important?
Higher order	Analyzing	AAK	Questions that checking students ability to analyze knowledge	How would compare diffusion and extraction?
	Evaluating	AEK	Questions that checking students ability to evaluate knowledge	Can osmosis and diffusion occur at the same time in a plant?
	Synthesizing	ASK	Questions that checking students ability to synthesis knowledge	What gases are released by a green plant in day time and night?
Conceptual- change	Eliciting	EPA	Questions that eliciting pre-conception or alternative conceptions	How do viruses spread in the environment?
	Challenging	RRI	Questions that challenging students' to review and resolve inconsistent ideas	The virus carries RNA. Why is it still called animal virus?
	Extending	CNK	Questions that extending students to construct new ideas from existing knowledge	What component of the virus is important? Why do you think so?
	Application	UKS	Questions that check students' ability to use knowledge in novel and concrete situation	How do you keep yourself protected from virus infection?

Results

Table 4 summarizes the distributions and frequencies of the various types of teacher's questions. Altogether, 617 teachers' questions in different science lessons were identified in various questioning subcategories.

Table 4. Frequencies of different types of teacher questions asked in various science lessons

Lesson topic	Rhetorical question	Management strategy questions	Meaning	Read, draw, label	Content knowledge	Predictable answer	Definition and example	Word or phrase	Understanding	Analyze	Evaluation	synthesis	Eliciting	Challenging	Extending	Using /application	Total No. (n)
	QR	MQ	MT	RDL	CK	PAQ	DE	WP	ULC	AAK	AEK	ASK	EPA	RRI	CNK	UKS	
Motion	10	13		1	16		2	11	2	1			1		2	1	60
Living organism & their environment	12	13			12		1	9		1							48
Gas law	8	14			11			6			2	2		2	4	1	50
State of matter	2	3			7				1	2	2	2	10	3	12	1	45
Symbol, Formula & Valences	9	16		2	14			12									53
Work, power & energy	6	10			3			7									26
Virus	4	7	1		14		3	5		2			1	1	1	1	40
Human body	9	14			13			12									48
Periodic Table	8	10		1	12			7		2			1				41
Plants classification	4	10			15			5					2				36
Solution	8	10			12	1		11		1			1				44
Animal kingdom	7	6			16			13	2								44
Chemical reaction & equation	11	8			10			7									36
Structure of Matter	7	10			18			11									46
Total	**105** (17.0)	**144** (23.3)	**1**	**4** (0.6)	**173** (28)	**1**	**6**	**116** (19)	**5** **(0.8)**	**9** (1.5)	**4**	**4**	**16** (2.6)	**6** (0.98)	**19** **(3.0)**	**4**	**617**

*Figures in parentheses are in percentages

The most prevalent type of questions asked during class sessions at secondary level science was the question which checks students' *content knowledge* with a frequency of 173(28%). Seconded by the *management strategy* question with a frequency of 144(23.3%) followed by the question that representing something by a *word or phrase* with a frequency of 116(19%) and *rhetorical* question with the frequency of 105 (17%). The questions checking students ability to *analyze*, *evaluate* and *synthesis* of knowledge was with the frequencies of 9(1.5%), 4(0.6%) and 4 (0.6%) respectively. *Eliciting* pre-conceptions, *challenging* students to resolve and reviews inconsistent ideas, *extending* to construct new ideas from existing knowledge and check students' *ability to use* those questions were found with the frequencies of 16(2.6%), 6(0.98%) 19(3.0%) and 4(0.6%) respectively.

Table 5 shows the frequencies and percentages of the questions under major categories along teachers' background factors.

Table 5. Summary of the teachers' questions along with background factors

Teacher	Sex M/F	Years of Teaching experience	Subject taught	In-service training					Major questioning categories					Total (n)
				B.ED	SBC	TQI	CPD	OT	Rhetorical	Management	Lower order	Higher-order	Conceptual change	
T1	F	15	P	√	√	√			10	13	32	1	4	60
T2	M	About 2	B	√					12	13	22	1		48
T3	M	17	C	√	√	√	√	√	8	14	17	4	7	50
									2	3	8	6	26	45
T4	F	5	C	√					9	16	28			53
T5	M	9	P	√	√				6	10	10			26
T6	F	14	B	√	√	√	√	√	4	7	23	2	4	40
T7	M	6	B	√	√				9	14	25			48
T8	M	12	P	√	√	√			8	10	20	2	1	41
T9	M	10	B	√	√	√			4	10	20		2	36
T10	M	11	C	√	√	√			8	10	24	1	1	44
T11	M	7	B	√	√				7	6	31			44
T12	F	6	C	√					11	8	17			36
T13	M	8	C	√	√				7	10	29			46
								Total	105	144	306	17	45	617
								Percentage	17.0%	23.3%	49.6%	2.8%	7.3%	

Rhetorical question (105) and the question that ask for classroom management(144), did not elicit higher cognitive levels of students' thought, jointly accounted for 40.4% of the total questions. Excluding these two group of questions, 368 questions were included in the data

analysis for cognitive levels of teachers' questions. It is indicated that among the cognitive level questions, 306 out of 368 questions were pitched at lower order cognitive level. It was accounted for 83.2% of the total questions asked during class discussion. Conceptual-change question has low frequency of 45(12.2%) while higher order question rated as the lowest with the frequency of 17(4.6%).

Table 5 shows that teachers' questioning differs in terms of teaching experiences and in-service trainings. The teachers whose teaching experience is ranging between ten to seventeen years, asked higher order and conceptual change questions along with other question categories. On the other hand, those teaching experience were in between two to nine years, asked basically lower order questions.

In-service training was found as an influential factor of teachers' questioning. The teacher of the study showed that who received TQI, CPD and short term OT asked higher order and conceptual- change question. Among the in-service trainings, TQI training was found the most influential regarding teachers' questioning. However, teachers who received B.Ed. and SBC asked lower order question along with rhetorical and management strategies questions. Gender and subject taught at graduation level did not found as influential factors regarding teachers questioning in this study.

Discussion and Conclusion

The study revealed that the questions teachers asked during science lesson discussion at secondary level were mainly lower order basically for checking students 'content knowledge. Rhetorical question and the question that ask for classroom management were also found predominant. Higher order and conceptual- change questions were rarely asked. Analysis of the results indicated that teaching experiences and in-services trainings were found influential in teachers' questioning while gender and the subjects (physics, chemistry and biology) did not found as influential agent.

Studies of the classroom discussion show that teachers are generally not good for asking high-quality questions. Most teachers questions are short-answer questions that require the students to recall factual knowledge, while only a small percentage of teacher questions demand higher cognitive skills (Graesser and Natalie, 1994). Swift et al., (1988), for example, reported that 85.9% percent of teachers' questions in middle school science were at recall level. This finding corresponds with presents study results in which 83.2% teachers' question are at lower cognitive

level. Similar results also reported by Yip (2004), and Ewing and Whittington (2007). Yip (2004) reported that teacher asked lower- order questions most frequently which constitute one third of the teachers' question. Correspondingly, Ewing and Whittington (2007) found that professor in their study primarily asked closed-questions during class session and they questioned students at the remembering level of cognition. Professor asked evaluating level questions occasionally. Creating level questions were rarely asked.

Learning begins with questioning and it is the first stage in the learning process (Jarvis, 2006). To create a disjunctural situation - a situation when ones memories of past experiences and ones interpretation of present situation are not in harmony - teachers use questions. It is evident that teachers who are using various questions types during classroom discussions are enabling students to practice a wide range thought processes. On the other hand, if teachers use one particular type of questions frequently, students' thinking may not be challenged at the higher cognitive levels (Blosser, 2004). Thus, the use of multiple types of questions is recommended during class sessions for greater interaction with the courses content.

Blosser (2004) asserted that teachers must be aware of the types of questions they are using during class sessions, the purpose for using the various and the amount of time needed for students to process different types of questions. When teachers ask, for example, open type or higher-order questions that require students to formulate answers on their own the amount of time needed for student to think while simple closed-type or lower order questions require little or no processing time.

Each of the question types has implications in students learning. Students who are exposed with management-type questions may become bored. Students who are not given adequate time to truly process a rhetorical question, soon cognitively disengage from content. Students who are frequently asked closed-type questions learn to value the easy recall of facts (Ewing & Whittington, 2007).

If students are to become better problem solvers and discoverer; comprehend that intuitive; every ways of explaining the world around them need to be adapted in order to better describe, predict, explain; and control natural phenomena – the need to develop higher order thinking skills(Blosser, 2000). By encouraging true dialogue (Lemke, 1990) through quality question can develop higher order thinking skills and conceptual understanding.

Implications of the study

Questioning is an essential part of good teaching and heart of the inquiry approach of teaching and learning. It can scaffold student thought process towards meaningful learning. Since there is no study has been conducted yet regarding questioning at secondary level in Bangladesh, the result of the present study, therefore, would be serve as realization for the science teachers to know what kind of questions they are asking currently in teaching science. They might find the results useful to change their questioning pattern from lower-order to higher- order or conceptual-change types of questions to keep pace with the trend of science education of the county, i.e. the use of inquiry lesson.

The results can also be used as a feedback for modifying teachers' questioning behaviors in the classroom discussion. Future teachers may use the method of the study to reflect on their teaching performance which would help them to improve their teaching skills by employing enhanced questioning skills.

In this study, in-service training was found powerful in shaping teachers' questioning behavior. Therefore, science teacher should be exposed more in-service trainings to enhance their questioning skills that enable them to ask different types of questions that enhance students' involvement in lesson discussion.

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