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USING TEACHER QUESTIONS TO DISTINGUISH PEDAGOGICAL GOALS: A CASE STUDY OF THREE SINGAPORE TEACHERS

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ABSTRACT

As part of the Learner's Perspective Study (LPS), three competent mathematics teachers were studied for periods of ten lessons each. Data were collected using the complimentary accounts methodology. Since teacher questions are viewed as a critical teaching tool by many researchers and educators, the different types of questions posed by the teachers during their lessons were studied. An attempt was made to link the types of questions and the teachers' pedagogical goals. This paper will share with the participants the methodology used and respective findings.

INTRODUCTION TO THE STUDY

This is a case study of three secondary two mathematics classrooms in Singapore. An analysis was conducted into the types of teacher questions posed in the classrooms with the intention of connecting them to the pedagogical goals of the teacher.

A question is an expression of inquiry that invites or calls for a reply. In a classroom,

questions are used by teachers as instructional cues to assess student progress and to motivate student thinking. Since teacher questions are viewed as a critical teaching tool by many researchers and educators, this research project set out to identify and study the different types of teacher questions posed in three classrooms. The study focused on the teacher's verbal questioning within three mathematical classrooms, and attempted to link the types of questions asked to the teachers' pedagogical goals.

REVIEW OF THE LITERATURE

A teacher spends 'thirty-five to fifty percent of their instructional time conducting questioning sessions' (Cotton, 1988, p. 1). Teachers do not just ask questions to evaluate student understanding and knowledge, but also to stimulate recall, to motivate participation, to prompt discussion, to review subject matter, and to develop creative and critical thinking skills.

Questions asked by a teacher are known as passive questions. Each question asked should be based on a particular coherent pedagogy. However, these pedagogies may not have been articulated by the teacher; that is, they may represent a form of tacit knowledge – what Shulman has called the "the Wisdom of Practice" (Shulman, 1987). Before analysing the different kinds of questions that can be asked, it is important to review what is meant by the teacher's pedagogical goals.

Pedagogy is the art of teaching, and the principles and methods of instruction.

During their training, teachers are taught how to use both pedagogical and conceptual tools to organise and orchestrate a lesson (Thompson, 2005).

Goals are objectives directed towards desirable outcomes. According to Borich (2004),

pedagogical goals would identify what a teacher must teach, and energise and motivate the teacher to be actively involved in and committed to meeting the standards. Goals are identified during the planning stage of teaching.

A teacher writes his/her goals for a particular lesson in a lesson plan. This lesson plan should include specific instructional objectives, expressed in terms of learning outcomes (Cole & Chan, 1994). Manouchehri and Lapp (2003) believe that a fundamental aspect of effective instructional planning is to determine the types of questions the teacher should ask in a classroom.

'In order for questions to be effective, they must be directed toward instructional goals' (Dantonio & Beisenherz, 2001, p. 36). Furthermore, questions should be 'reflection on and analysis of the mathematical pedagogical goals of lessons' (Manouchehri & Lapp, 2003, p. 564). Hence for each lesson, teachers require clear instructional objectives. Then, based on these objectives, the teacher can plan appropriate kinds of questions according to the different levels of student ability.

Many types of questions are posed in a classroom. The next part of the literature review outlines the different classifications of questions by the different researchers, and how these questions are linked back to the pedagogical goals.

Question-asking is seen as a highly important instructional procedure. According to Dantonio and Beisenherz (2001), researchers use different taxonomies and classification systems to classify the cognitive level of questions. One such model is highlighted.

It is the six category systems of questions adopted from Cole and Chan (1994). The first two categories are discussed in depth as they initiated the framework of the question types in this case study.

High- and low-order questions: Lower-order questions are fact questions which require knowledge of subject matter or recall material previously taught by the teacher. Lower-order cognitive questions are frequently posed in classrooms. Higher-order questions can be viewed as 'thought questions' which require students to mentally use pieces of information already acquired to form or support an answer with logical evidence (Cotton, 1988). These questions require students to infer, synthesise, evaluate and comprehend, through more complex cognitive operations than those demanded by lower-order questions.

It is important for teachers to identify their specific instructional goals for each lesson according to pedagogy, and plan on the number of lower-order and higher-order questions to ask. In a mathematics lesson, more recall questions are used based on the nature of the subject which requires students to recall concepts. Hence, to help in their planning, teachers can use Bloom's (1956) taxonomy. This method proposed a classification structure of educational objectives in the cognitive domain. This taxonomy, classified questions from the simplest to the most complex operations: knowledge, comprehension, application, analysis, synthesis and evaluation

What, when, how, who and why questions: According to Cole and Chan (1994), this range of question classifications is often used by teachers. They define the different categorise as 1) *What* questions require knowledge and recall of information already received; 2) *When* questions expect students to focus on the temporal sequence of events; 3) *How* questions highlight processes and procedures; 4) *Who* questions require students to distinguish characters in given events; and 5)*Why* questions encourage students to explain reason to a given result.

The other four categories included the **product, process and opinion questions**, the **open and closed questions**, the **memory questions and search questions** and the **contextually explicit, contextually implicit and background questions**.

The classification of question helps teachers to identify the cognitive level of the kinds of questions and helps them to effectively use the different types accordingly while planning their lesson, based on their specific instructional goals.

'The reasons for asking questions are closely related to the types of question asked' (Wragg & Brown, 2001, p. 11). From the categories seen above, there are many types of questions a teacher can chose from to achieve various instructional goals. Hence, what is the connection between a teacher's choice of questions and her pedagogical beliefs?

Teachers have pedagogical beliefs that guide their practice. Often these beliefs have never been explicitly stated as they have arisen from practice. This is what Shulman (1987) meant by the phrase 'the wisdom of practice', which he believes is one of the major sources for the teaching knowledge base. However, we can detect the teacher's pedagogical beliefs by analysing what they do. One of the most visible teacher actions is the way in which the teacher asks questions in a classroom. Through this process, teachers develop a conceptual framework and draw on this framework to guide his/her own sequencing of material and formulating of questions. The aim of this study is to use the analysis of teacher questions to investigate the pedagogical beliefs of three mathematics teachers in Singapore

THE CASE STUDY

A 'case study focus[es] on one particular instance of educational experience and

attempt[s] to gain theoretical and professional insights from a full documentation of that instance' (Freebody, 2003, p. 81). The case study reported in this paper focused on three Singapore mathematics classrooms. The data was gathered and collated by the Centre for Research in Pedagogy and Practice (CRPP), National Institution of Singapore. Before reporting the analysis of the data, the method for data collection is discussed.

Procedure: An initial pilot study was carried out using the Learner's Perspective Study (LPS) data. One school from the Singapore data, coded as SG2 was identified and used for the analysis. During the analysis of teacher questions, a framework was emerged. This framework included the seven types of teacher questions used in an earlier study (Benedict, 2006).

This framework was then put to test and used on the other two schools, namely SG1 and SG3, from the LPS data. The data were collected for sequences of ten consecutive lessons in a "well-taught" eighth grade (Secondary two) mathematics classroom. Lesson one was coded as L01 and the rest of the lessons followed on. So, the lessons were coded from L01 to L10. The lessons were taught by teachers who were identified for their teaching competence.

Method: The study in these classrooms adopted the research design as set out in the LPS(Clarke, 2006).The data consisted of video records of the ten lessons, together with transcripts of classroom dialogue, selected students' video-stimulated post-lesson interviews (audio and visual) and written assignments, teacher interviews, lesson plans and field notes, for each of the two schools.

The data set consisted of ten Secondary two mathematics lessons, each from SG1 and SG3. The first step was to briefly scan through the lessons for basic information. The

main topics covered during the ten lessons in SG1 were Standard Form and Congruence and Similarity and in SG3, was Pythagoras' Theorem There were a total of thirty seven students (15 male and 22 female students) in SG1 and forty students (25 male and 15 female students) in SG3. Table 1 shows brief descriptions of each of the lessons analysed.

Table 1 Description of lessons in SG1 and SG3

School & Lesson code	Lesson Duration	Topic
SG1_L01	**00:54:30**	**Power of 10 and Standard form**
SG1_L02	**00:51:49**	**Power of 10 and Standard form (Cont'd) and Introduction to Use of Calculator**
SG1_L03	00:54:36	Use of Calculator (Cont'd) and Problem Solving Strategies
SG1_L04	**01:00:18**	**Congruency**
SG1_L05	**00:53:00**	**Congruent Figures (Cont'd) and Similar Figures**
SG1_L06	00:48:14	Class Test
SG1_L07	00:52:51	Similar Figures (Cont'd)
SG1_L08	00:53:50	Scales and Maps
SG1_L09	00:48:06	Corrections for Class Test
SG1_L10	**00:54:26**	**Scales on Maps (Cont'd)**
SG3_L01	**00:32:44**	**Revision of Linear Function**
SG3_L02	00:34:40	Pythagoras' Theorem
SG3_L03	00:33:26	Class Test 2
SG3_L04	**01:09:05**	**Corrections for Class Test 2**
		Pythagoras' Theorem (Cont'd)
SG3_L05	00:37:45	Pythagoras' Theorem
SG3_L06	**00:31:28**	**Applications of Pythagoras' Theorem**
SG3_L07	00:28:34	Trigonometrical Ratios
SG3_L08	**01:07:54**	**Use of Calculator and Solving Right-Angled Triangles Using Trigonometrical Ratios**
SG3_L09	**00:40:20**	**Finding the Value of an Angle with Trigonometrical Ratios**
SG3_L10	00:33:42	Practical Applications of Trigonometry

Data Analysis

Since the focus of the study was on teacher questions and how they reveal the teacher's

pedagogical goals, the research was solely dedicated to the questions posed by the teacher in the classroom. The intended investigation only made use of the videos captured by the teacher camera, and the transcripts for each of the ten lessons.

Teacher questions from the ten lessons in SG1 and SG3 were analysed based on the teacher question framework. During the process, it was realised that some of the lessons were redundant for the study as not all the lessons were suited for teacher question analysis. These lessons included class test or group quiz. These lessons were omitted. Hence, only five lessons from each school were analysed using the framework.

As the framework was being used on these lessons from SG1 and SG3, new sub categories were formed, thus refining the previous framework. The reason for new categories to emerge was because the teachers from these two schools had their own style in presenting questions to their students. New forms of teacher questions were being posed Hence, it was difficult to categorise these questions in the existing framework. The new categories are highlighted as follows.

Additional Classification of the different types of mathematical questions

Repetitive Questions

It was noted that at times the teachers from the three schools repeated their questions because the students did not understand the question at the first instance. Sometimes the teacher had to rephrase the questions for better understanding. As such, it was decided that the data would be incorrect if we were to count the same question twice. Hence these repeated questions were categorised as ***Type R*** questions and were not included in the analysis. One example was “What does M represent?” “*What does M represent?*” (SG3_L04)

There were also instances when the teacher repeated or revoiced the student question for reassurance or for other students to hear it as well, an example being “Why ah?” (SG1_L02)These questions were also not analysed and categorised as ***Type RSQ*** questions. ***Type RSA*** questions were those which are student answers and teacher repeated them for verification. An example was “A is the hypotenuse?” (SG3_L06)

Not Teacher Questions

Some of the teacher questions were not technically the teacher’s own questions. Examples of such questions included questions from the textbook or worksheet and they were merely recited by the teachers. Hence, these questions were categorised as ***Type NT*** questions and were not included in the analysis. One example was “So how much must he pay the company to clear the debt by the end of first year?” (taken from Mathematics textbook , pg 12 Q6, ex. 1c) SG1_L04.

The existing framework was then refined using these new additional categories and SG1 and SG3 were analysed. SG2 was revisited and re-analysed using then new boundaries of the framework. Type U questions were re-defined and categorised in the new framework and thus were excluded. It is also important to note that the schools’, the teachers’ and the students’ names are not mentioned in this paper, following CRPP’s Data Access Confidentiality Rules, and consistent with the agreement obtained from the participants regarding confidentiality and the reporting of data.

4 THE RESULTS AND ANALYSIS

After analysing the fifteen lessons from the three schools, it was found that a total of 2 682 verbal questions were asked. Out of these questions, 1 095 questions were

mathematical-related questions, while the remaining 1 587 questions were non-mathematical based questions. Table 2 shows the frequency counts of the total number of mathematical and non-mathematical questions asked during the fifteen lessons.

Table 2 The Total Number of Mathematical and Non-mathematical Questions asked in the three classrooms

Lesson (Duration)	Mathematical (M)	Non-mathematical (NM)	Total
SG1_L01 (55:41)	84	74	**158**
SG1_L02 (52:33)	79	108	**187**
SG1_L04 (1:00:20)	102	194	**296**
SG1_L05 (53:02)	88	130	**218**
SG1_L10 (54:26)	63	76	**139**
Total (4:43:33)	**416 (41.7%)**	**582 (58.3%)**	**998**
SG2_L01 (57:41)	52	47	**99**
SG2_L02 (57:11)	95	70	**165**
SG2_L03 (35:33)	43	49	**92**
SG2_L04 (56:36)	90	87	**177**
SG2_L10 (58:46)	84	123	**207**
Total (4:25:07)	**364 (49.2%)**	**376 (50.8%)**	**740**
SG3_L01 (33:01)	44	66	**110**
SG3_L04 (1:09:18)	75	140	**215**
SG3_L06 (31:38)	58	53	**111**
SG3_L08 (1:08:01)	74	194	**268**
SG3_L09 (40:38)	64	176	**240**
Total (4:02:36)	**315 (33.3%)**	**629 (66.7%)**	**944**

From table 3, it can be noted that 40.8% of questions asked were mathematical questions, while the remaining 59.2% were non-mathematical related. It is observed that certain lessons had more teacher questions. This could be due to the nature of the lesson. SG2_L01 was an introductory lesson and hence the teacher was presenting new concepts and skills to the students. Thus, the teacher did not ask many questions.

The non-mathematical questions were further divided into two categories, MR and NMR. Table 3 highlights the classification of these questions.

Table 3 **The Total Number of MR and NMR Questions Asked**

Lesson	Mathematics Related (MR)	Not Mathematics Related (NMR)	Total (NM)
SG1_L01	32	42	**74**
SG1_L02	30	78	**108**
SG1_L04	50	144	**194**
SG1_L05	54	76	**130**
SG1_L10	18	58	**76**
Total	**184 (31.6%)**	**398 (68.4%)**	**582**
SG2_L01	11	36	**47**
SG2_L02	11	59	**70**
SG2_L03	3	46	**49**
SG2_L04	26	61	**87**
SG2_L10	27	96	**123**
Total	**78 (20.7%)**	**298 (79.3%)**	**376**
SG3_L01	20	46	**66**
SG3_L04	23	117	**140**
SG3_L06	20	33	**53**
SG3_L08	44	150	**194**
SG3_L09	38	138	**176**
Total	**145 (23.1%)**	**484 (76.9%)**	**629**

It can be observed that 25.6% of the non-mathematical questions asked were in fact mathematics-related. These questions were related to the lesson or subject matter being taught during the lessons. However, these questions did not intend to test knowledge, application or any of the other skills. The remaining 74.4% of the non-mathematical questions posed in the classroom made no reference to the mathematical content being taught. These questions were mostly asked during the beginning of the lesson and just before the lesson ends, which includes both managerial and procedural questions

Table 4 shows the frequency counts of the total number of mathematical questions posed to the whole class, as compared to mathematical questions being posed to individual students during the fifteen lessons.

Table 4 **The Number of M Questions Directed at the WC and IS**

Lesson	Individual Students (IS)	Whole Class (WC)	Total (M)
SG1_L01	20	64	**84**
SG1_L02	10	69	**79**
SG1_L04	68	34	**102**
SG1_L05	35	53	**88**
SG1_L10	3	60	**63**
Total	**136 (32.7%)**	**280 (67.3%)**	**416**
SG2_L01	10	42	**52**
SG2_L02	3	92	**95**
SG2_L03	0	43	**43**
SG2_L04	9	81	**90**
SG2_L10	47	37	**84**
Total	**69 (19.0%)**	**295 (81.0%)**	**364**
SG3_L01	12	32	**44**
SG3_L04	18	57	**75**
SG3_L06	27	31	**58**
SG3_L08	25	49	**74**
SG3_L09	27	37	**64**
Total	**109 (34.6%)**	**206 (65.4%)**	**315**

From table 4, it can be observed that majority of the questions, 71.3%, were posed to the whole class. Only 28.7% of the mathematical questions were posed to individual students. It was observed that more questions were posed to individual students during certain lessons like SG1_L04 and SG2_L10 than to the whole class. The possible reason for this result could be attributed to the nature of the lesson held and the possible instructional goals and lesson objectives.

The next table, table 5, highlights the number of times the different types of questions were being asked during the fifteen lessons. The question types are categorised and summarised as follows.

Table 5: The Frequency Counts of the 6 Types of Mathematical Questions

Lesson	Question Types						Total (M)
	0	**1**	**2**	**3**	**4**	**5**	
SG1_L01	24	23	7	3	23	4	**84**
SG1_L02	24	16	14	6	17	2	**79**
SG1_L04	33	48	3	11	6	1	**102**
SG1_L05	21	40	13	2	11	1	**88**
SG1_L10	19	17	9	2	12	4	**63**
Total	**121**	**144**	**46**	**24**	**69**	**12**	**416**
	(29.1%)	**(34.6%)**	**(11.1%)**	**(5.7%)**	**(16.6%)**	**(2.9%)**	
							Total (M)
SG2_L01	7	24	6	2	10	0	**52**
SG2_L02	6	48	14	6	19	2	**95**
SG2_L03	8	13	9	1	12	0	**43**
SG2_L04	14	49	9	6	12	0	**90**
SG2_L10	6	40	23	6	9	0	**84**
Total	**41**	**177**	**61**	**21**	**62**	**2**	**364**
	(11.3%)	**(48.6%)**	**(16.8%)**	**(5.8%)**	**(17.0%)**	**(0.5%)**	
							Total (M)
SG3_L01	10	30	0	2	1	1	**44**
SG3_L04	25	35	5	2	5	3	**75**
SG3_L06	16	26	4	8	3	1	**58**
SG3_L08	19	39	7	6	2	1	**74**
SG3_L09	13	30	13	4	3	1	**64**
Total	**83**	**160**	**29**	**22**	**14**	**7**	**315**
	(26.4%)	**(50.8%)**	**(9.2%)**	**(7.0%)**	**(4.4%)**	**(2.2%)**	

Legend **Type 0: Agreement** **Type 1: Factual (Short)** **Type 2: Factual (Long)** **Type 3: Justification** **Type 4: Evaluation** **Type 5: Conjecture**

Table 5 clearly shows how often a certain type of question is being used by the teacher. The table obviously shows that type 1 (lower-order) questions, are far more popular than type 5 (higher-order) questions. 43.9% of the questions posed were factual recall questions (Type 1), while only 1.9% of the questions posed required critical thinking skills (Type 5). This evidence supports research reviews that a greater number of teacher questions require simple recall (Gall, 1984) and (Wilen, 1986).

The second largest category of questions was agreement questions which made up of 22.4%. It is also observed that there is a relatively high percentage (13.2%) of opinion/ judgement questions (Type 4), being asked during the fifteen lessons.

The behaviour of the teachers after a question is asked was analysed. The analysis of the post-questioning behaviour was intended to identify the number of questions to which the teacher actually expected answers. Moreover, if answers were given, who provided the answers to the questions? Was it the teacher or the students or was there no answer given? The table below analyses the statistics for this outcome.

Table 6 Analysis of post-questioning behaviour

Lesson	Answers Expected (Y/N)	Answers Provided (N/T/S)
SG1_L01	55 (Y), 29 (N)	31 (N), 52 (S), 1 (T)
SG1_L02	48 (Y), 31 (N)	35 (N), 42 (S), 2 (T)
SG1_L04	55 (Y), 47 (N)	49 (N), 46 (S), 7 (T)
SG1_L05	42 (Y), 46 (N)	45 (N), 36 (S), 7 (T)
SG1_L10	32 (Y), 31 (N)	32 (N), 27 (S), 4 (T)
Total	**232 (Y), 184 (N)**	**192 (N), 203 (S), 21 (T)**
SG2_L01	32 (Y), 20 (N)	18 (N), 25 (S), 9 (T)
SG2_L02	26 (Y), 69 (N)	35 (N), 36 (S), 24 (T)
SG2_L03	28 (Y), 15 (N)	14 (N), 22 (S), 7 (T)
SG2_L04	31 (Y), 59(N)	37 (N), 47 (S), 6 (T)
SG2_L10	52 (Y), 32 (N)	27 (N), 45 (S), 12 (T)
Total	**169 (Y), 195 (N)**	**131 (N), 175 (S), 58 (T)**
SG3_L01	19 (Y), 25 (N)	21 (N), 17 (S), 6 (T)
SG3_L04	28 (Y), 47 (N)	37 (N), 26 (S), 12 (T)
SG3_L06	28 (Y), 30 (N)	27 (N), 24 (S), 7 (T)
SG3_L08	33 (Y), 41 (N)	28 (N), 32 (S), 14 (T)
SG3_L10	30 (Y), 34 (N)	23 (N), 28 (S), 13 (T)
Total	**138 (Y), 177 (N)**	**136 (N), 127 (S), 52 (T)**

Table 6 highlights the total number of questions to which the teachers expected an answer. It can be noted that though the teachers did not expect answers for 556 questions, answers

were not provided for 459 questions. The answers for the remaining 97 questions were provided by the teacher, as he/she did not expect the students to answer.

The table also indicates whether the teacher or the students provided the answers most of the times. Out of the 1 095 mathematical questions posed, 459 questions were not answered at all. These questions may include agreement questions or questions that were repeated by the teacher more than once. It can also be observed that out of the remaining 636 questions asked, 79.4% of the questions were answered by the students.

5 DISCUSSION

Many researchers believe that the most common communication behaviour used by teachers is questioning. From the case study, it is evident that the teachers made frequent use of questions in their classroom. What pedagogical goals can be inferred from these teachers' questions? Moreover, what correspondence is there between the teachers' pedagogical goals and the goals of the Singapore mathematics curriculum? This discussion is intended to answer both of these questions.

According to the framework of the Singapore mathematics programme, (NIE Team, 2001), the learning of mathematics at all levels involves more than the basic acquisition of concepts and skills. Based on the Singapore curriculum, the main pedagogical goals would be Mathematics problem solving and thinking skills in the development of concepts and procedures.

Analysis of the data suggests that the teachers in the case study have addressed mathematics problem solving and thinking skills during questioning. However, they have focused more on fact-based questions rather than concept- and rule-based questions. The

discussion that follows highlights the extent to which the teachers' questions were consistent with the Singapore mathematics curriculum.

Research has reported that teachers mainly ask their students low-level questions in the classroom (Suydam, 1985). The results of my analysis show that 78.7% of the mathematics questions asked required only agreement, recall of facts or description of procedures. According to Cole and Chan (1994), a large proportion of lower-order questions are asked by teachers, and Ellis (1993) also argued that practice consistently demonstrates that lower-order questions are asked by teachers in the classroom. However, 21.3% of the teacher's mathematical questions were concerned with justification (Type 3), evaluation (Type 4) or conjecture (Type 5). From this, it appears that about a little more than 20% of the teacher's mathematical questions could be classified as requiring higher-order thinking skills. This percentage is expectedly low.

McCullough and Findley (1983) believe that it is important to include questions on both concrete and abstract levels. According to Dantonio and Beisenherz (2001), questions have to stimulate and guide student thinking to higher levels. Several researchers have also recommended that teachers use both lower-order and higher-order cognitive questions in their lessons.

In the fifteen lessons observed, students were expected to recall facts, as more factual (short) questions (Type 1) were posed. This indicates that the teachers' pedagogical goal was to test on factual recall.

However, it was interesting to identify that 21.3% of the mathematical questions asked by the teachers were higher-order questions. The teachers posed 13.2% of type 4 questions. This category was made up of questions seeking student's evaluation and judgement. The

relatively high percentage suggests that the teachers' pedagogical believes were to test on both concepts and skills by asking higher-order questions to increase student achievement gains.

Cole and Chan (1994) suggested using lower-order questions early in the lesson and to follow these by higher-order questions as the lesson progresses. The teachers in the study did display this feature as more fact-based questions (Type 1) were being posed at the beginning of the lesson, and as the lesson progressed, evaluative questions (Type 4) were posed. Hence, the practice to proceed from the simple to complex was satisfied in all fifteen lessons.

According to Wood and Turner-Vorbeck (2001), students are required to give reasons for their thinking and ideas for '*why*' questions. In the study, the teachers questioned students about how they solved problems and asked them to clarify their thinking and give reasons. Alongside with these types of question, the teachers also asked questions that required responses that gave justification. This is supported by the 6.1% of justification questions (Type 3) that were posed in the classrooms. The teachers asked these questions to encourage the students to rely on their own mathematical reasoning as they searched for solutions. This is based on observing the teachers when they asked this type of question. The teachers asked a procedural question. Students gave their responses. At this point, the teacher does not proceed on. Instead, she asked the students to justify their answer. This can be observed in SG3_L09. (i.e. "Because the tangent and sine not the same. *Why* they are not the same?)

In the Singapore mathematics curriculum framework, the first component is concepts. They refer to basic mathematical knowledge needed for problem solving. The second

component includes skills that students are encouraged to use during problem solving. The use of concepts and topic-related manipulative skills were required when students were asked to answer factual (short) questions (Type 1) posed by the Singapore teacher.

The third component being processes, to the thinking add heuristics involved in mathematical problem solving. This was utilised when students were expected to answer factual (long) (Type 2) and justification (Type 3) questions posed by the teacher. The fourth component is attitudes and this was displayed as the teacher asked students questions and expected them to present them on the whiteboard. Students showed great interest and participation. Metacognition was exercised when students answered type 4 and 5 questions, as they had to give their opinions. Such questions constituted 21.3% of mathematical questions. The teachers also employed questions that were directed toward evaluating students' thinking, and gave them the opportunity to communicate their reasoning processes. It is surprising to note that 13.2% of the questions asked belonged to evaluative questions (Type 4).

The teachers were able to use questions to promote students' thinking and enable them to learn mathematics to their true potential. This is based on the relatively high percentage of higher-order questions posed in the classroom. Students' true potential was also displayed when individual students presented their answers to the given problems on the whiteboard. Furthermore, during the study, other questioning behaviours of the teachers were also observed.

However, analysis of the teachers' questioning in the study showed that they did not have a planned structure in questioning. Often, the teachers wrote down questions on the board or asked questions spontaneously. Hence, 'without a strategy, a discussion can become a

series of single questions, lacking cohesion and purposeful sequence' (Wilen, 1991, p.11). In conclusion, for questioning to be effective, proper planning and structuring of the kinds of questions asked is essential. It was observed that there was no proper structure in the way the teacher asked the students questions. Before deciding on what questions to ask in a mathematics classroom, teachers should firstly acquire pedagogical content knowledge of mathematics. They should be clear regarding the intended pedagogical goals, and only after that should they start to plan their lessons. Teachers should also remember that while planning, they should not only dwell on asking one type of question (Rowan & Robles, 1998). Instead, they should ask a variety of question types that are consistent with prescribed goals.

It is also understood that questions engage students in the learning process by getting them to think through and problem-solve with materials the teacher has provided. One of the major concerns of teachers today is the impact their questions have on their students' learning outcome and achievement. Hence, through this study, we have identified specific questioning techniques and behaviours of three Singapore teachers. The high percentage of low-cognitive-level questions asked in the classrooms was evident. Furthermore, the teachers also made extensive use of agreement questions which did not require much thinking.

6 FUTURE DIRECTIONS

The study has highlighted the tendency of a teacher to dwell on lower-order questions. Many teachers are aware of their pedagogical goals, but often when they are in the classroom, they do not practice what they plan to do. However, this study only focuses on

three teachers, in a particular country. The project can be progressed further if the same case study is compared to teachers in other countries, under the similar situations. By doing so, concrete results can be drawn for research. Furthermore, research could also be conducted into students' learning outcomes, given the questioning techniques used by the teacher.

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