LEARNING EXPERIENCES OF SINGAPORE'S LOW ATTAINERS IN PRIMARY MATHEMATICS

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This paper explores the learning experiences of 346 year four low attainers in mathematics from Singapore. The pupils were interviewed about their learning experiences related to mathematics lessons in school. An innovative method, using pictures as stimulus, was adopted to engage pupils to talk about their lessons. From the interview data it is apparent that there was a mismatch between how pupils were taught and preferred to be taught. Almost all the pupils experienced teacher-led whole class instruction during their mathematics lessons. A study of three teacher-led whole class instruction lessons showed that these lessons were not unique but had some commonalities. The mathematical tasks used during instruction were routine and repetitive. Teachers also did not stimulate the development of pupils' metacognition.

Background

In this paper the term "low attainers" refers to pupils who attain very much less in mathematics when compared to their contemporaries (Haylock, 1991) in the mainstream primary school. The use of this term does not make any judgment about the reasons for low attainment in mathematics. Low attainment in mathematics has been found to be a result of not a single factor but of the interplay of subject related difficulties, specific intellectual/behavioural characteristics of the pupils and pedagogical shortcomings (Haylock, 1991). The research reported in this paper is part of a larger research study that explores the factors related to low attainment of primary pupils in Singapore (Kaur & Sudarshan, 2010).

The research question

The research question that is addressed in this paper is one of the larger study's six research questions. The question is "What are the learning experiences of low attaining mathematics pupils in school?"

Review of literature

The review of literature in this paper is specific to the learning experiences of low attaining mathematics pupils. According to Reusser (2000) there is sufficient evidence in research on mathematics learning and teaching that most observed failures and substandard performances are due to deficiencies in the teaching and learning

environments rather than genetic factors. In his review of theoretical and empirical research from a cognitive instructional perspective, Reusser contends that an effective teaching environment positively impacts students' mathematics attainment levels regardless of grade levels or mathematical ability. His perspective of an 'effective teaching environment' for low attainers centres around adaptivity and empathy in teaching. He recommends the use of micro adaptation—moment-to-moment decisions of teachers aimed at tailoring instruction to the needs of different learners.

Direct structured instruction has also been found to be effective with students having difficulties in mathematics (Harris, Miller, & Mercer, 1995; Jitendra, & Hoff, 1996; Van Luit, 1994; Wilson, Majsterek, & Simmons, 1996). Direct instruction is systematic explicit instruction which is teacher-led (Jones, Wilson, & Bhojwani, 1997) and generally follows a fixed pattern of actions (Archer & Isaacson, 1989). Kroesbergen and Van Luit (2002) detail a typical direct instruction lesson as having three phases. In the opening phase the students' attention is gained, previous lessons are reviewed and the goals of the lesson are stated. In the main part of the lesson the teacher demonstrates how a particular task can be solved, following which the students and teacher work together on a few more similar tasks. When the students appear to have sufficient understanding of the tasks they are given new tasks to practise independently. The teacher monitors the students during such practice and provides feedback on completed tasks.

Cardelle-Elawar (1995) found that low achieving students showed metacognitive potential when stimulated by explicit individualized instruction and recommends that: i) special consideration should be given to each individual student's uniqueness, strengths and weaknesses; ii) these students need a supportive atmosphere in which errors and mistakes are considered a source of learning and not an occasion for punishment; iii) these students need more structure in the classroom; and iv) these students warrant a great deal of interaction between teacher and student. According to Watson (2001), these students are also able to make shifts in their thinking from the superficial features of mathematical tasks to forms of mathematical thought. She cites a specific example where students were able to shift from seeing fractions as congruent shapes to seeing fractions as quantities using the idea of areas to make the link. Watson asserts that low attainment is not the result of an inability to think but the lack of structured work that promotes higher order thinking among low attainers. Zohar and Dori (2003) also found that low achieving students can gain from teaching and learning processes that are designed to foster higher order thinking skills. They suggest that teachers should encourage students of all levels to engage in tasks that involve higher order thinking skills.

Methodology

Subjects

The subjects of the study are 346 year four pupils from nine primary schools in Singapore who qualified for participation. They were nominated by their respective schools, had parental consent for participation and took the mathematics benchmark tests of the study.

Instruments

Specific to the research question addressed in this paper, only instruments used to collect data from pupils and teachers on learning experiences of the pupils will be presented.

Pupils' interviews

From our interactions with the pupils and their teachers in the project we found that pupils lacked the language to talk about their learning experiences and about the actions of their teachers during mathematics lessons. So, to facilitate pupils' talk about their learning experiences, we adopted an idea from child psychiatry about using pictures as stimuli for interviews (Angold, 1976). We also found the pupils rather reserved in their oral communication with us when they were in a one-to-one interview setting. This observation led us to adopt a group interview format for our study. Pupils were interviewed in groups of four to five persons. During the interviews the researchers of the study used four pictures of mathematics lessons to stimulate talk amongst the pupils about how their mathematics teachers usually taught them in class and what their preferences for learning mathematics were. The four pictures shown in Figure 1 were used for the interviews.

Picture A: Teacher-led whole class instruction	Picture B: Group work (pupils working on tasks without manipulatives)	Picture C: Individual working on task with manipulatives	Picture D: Group work (pupils working on tasks with manipulatives)

Figure 1: Pictures of mathematics lessons.

The prompts used for the interviews belonged to three categories, mathematics lessons, homework, and self. In this paper we only focus on the prompts related to mathematics lessons. The four pictures A, B, C and D were put on the table around which the pupils and interviewer sat for the interview session. The following prompts were used to engage pupils in talking about their mathematics lessons at school.

- Prompt 1: Which picture shows the way your mathematics teacher usually teaches you in class?
- Prompt 2: Which class do you want to be in? Why?
- Prompt 3: Which class don't you want to be in? Why?

Lesson observations

Nine schools participated in the project. The lesson of one teacher per school who welcomed the researchers to his/her class was observed. In one of the schools, two teachers volunteered and therefore a total of ten lessons were observed. The teachers taught mathematics to pupils participating in the project. Our lesson observations were

guided by the following main analytical questions that resulted from our theoretical framework. The questions are:

AQ1. What was the instructional sequence of the lesson like?
AQ2. Did the teacher tailor instruction to meet the needs of different learners?
AQ3. What were the characteristics of mathematical tasks used in the lesson?
AQ4. Was the classroom learning environment a supportive one?
If so, how did the teacher nurture such an environment?

Data and findings

In this section we first present the data and findings of the interviews according to the three interview prompts chronologically. Next we present our analysis of three of the ten lessons that were observed as part of the project. We have selected these lessons as they typify teacher-led whole-class instruction which almost all pupils experienced during mathematics lessons.

Interview data and findings

Ninety-eight percent of the pupils interviewed said that their teachers always used teacher-led whole class instruction during mathematics lessons. Figure 2a shows the preference of the pupils with regard to the type of instruction they desired. The highest percentage (40%) of the pupils said that they preferred to work in groups on mathematical tasks with manipulatives during mathematics lessons.

Figure 2b shows the preference of the pupils with regards to the type of instruction they disliked. More than half of the pupils (62%) preferred not to be in a class where they would have to work by themselves on a task with manipulatives.

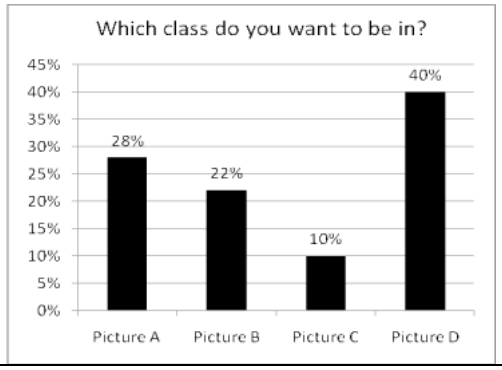

Figure 2a. Responses to prompt 2

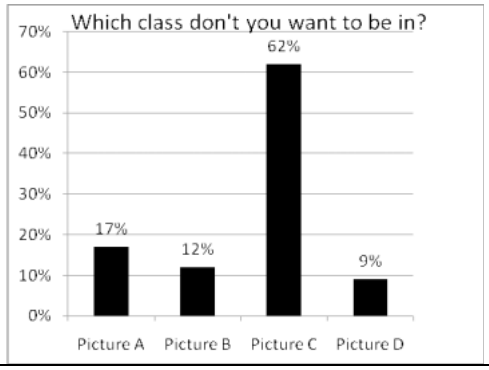

Figure 2b. Responses to prompt 3

From Table 1 below, it is apparent that pupils found: a) interacting with peers a fun and good way to learn; and b) the "hands-on" experience gratifying and meaningful in learning. It is also apparent from Table 2 that pupils: a) lacked the confidence to attempt tasks without the support of peers and teachers; and b) felt bored and lonely working by themselves.

Table 1. Sample of pupils' responses to the 'Why" of "Which class do you want to be in?"

Sample responses for Picture D - Group work (pupils working on tasks with manipulatives):
S038: "Discuss with a group, tell each other the answer and find out which is the correct answer". S057: "When we do the activity, we can feel that maths is fun". S105: "More fun to work with a group and can discuss with friends if I am not sure". S234: "I feel happy when I can do things to help me understand and improve". S537: "We can see how things happen and touch things".

Table 2. Sample of pupils' responses to the 'Why" of "Which class don't you want to be in?"

Sample responses for preference Picture C – Individual working on task with manipulatives:
S074: "Work alone may not know how to do and then do the wrong thing". S084: "It is boring and lonely when doing by ourselves". S197: "If alone cannot study well, cannot ask anybody about the activity". S453: "Scared if I don't understand what teacher wants". S528: "Don't want to do things alone. With other people we can do better".

Analysis of lessons observed

Each lesson was observed by at least two researchers. Following the observation, a reflection of the lesson was guided by the analytical questions that provided the theoretical lens for analysis. The main aspects of the lessons on which the researchers concurred are presented in Table 3.

Discussion and concluding remarks

From the interview data of the pupils in the study, it is apparent that 98% of pupils are taught mathematics in classrooms where teacher-led whole class instruction is the norm. But, teacher-led whole class instruction was the preference of only 28% of the pupils in the study. Forty percent of the pupils preferred to work in groups on mathematical tasks with the help of manipulatives. They found interacting with peers a fun and good way to learn, and the "hands-on" experience gratifying and meaningful in learning. From the above findings the apparent mismatch between how teachers teach these pupils and how these pupils would like to be taught in mathematics lessons may partially explain the low attainment in mathematics of these pupils. This finding reinforces that of Reusser (2000) that most observed failures and substandard performances are due to deficiencies in the teaching and learning environments rather than genetic factors.

The three lessons observed depicted teacher-led whole class instruction. All had three phases but there was variation between corresponding phases across the lessons (see Table 3). Although all teachers stated the goal of their lesson, only Teacher A reviewed the last lesson before embarking on the present one. In the main phase, although all the teachers demonstrated how to solve particular tasks, only Teacher A went on to do more tasks similar to the particular ones with inputs from pupils, before setting them new tasks to work on individually during the consolidation phase.

Table 3. Analysis of the three teacher-led whole class instruction lessons.

Analytical Question	Teacher A (School 3) Topic: Time [duration]	Teacher B (School 7) Topic: Symmetry	Teacher C (School 5) Topic: Tessellation
AQ1	i) Introductory phase: review of past lesson and use of real life contexts to arouse pupils' interest ii) Main phase: development of concept and application of knowledge (adequate examples worked on the board with inputs from pupils) iii) Consolidation phase: pupils worked individually on new tasks, while teacher provided between desk instruction and feedback on completed tasks.	i) Introductory phase: mentioned that the past lesson completed the topic time. Stated the goal of the present lesson. ii) Main phase: demonstration of concept using manipulatives, video clips and cut-outs of alphabets, followed by "hands-on" work by pupils in groups—identifying the lines of symmetry of the alphabet. iii) Consolidation phase: pupils worked individually on similar tasks without assistance from teacher or peers.	i) Introductory phase: mentioned that lesson was on a new topic—tessellations. ii) Main phase: demonstration of the concept of tessellation via examples and non-examples. Pupils worked in groups with unit shapes to make tessellated patterns. Pupils showed the class their patterns and teacher encouraged peer evaluation. iii) Consolidation phase: pupils worked in pairs and again were given unit shapes to make tessellated patterns.
AQ2	No apparent attempt	No apparent attempt	No apparent attempt
AQ3	Routine and repetitive.	Routine and repetitive.	Routine and repetitive.
AQ4	Supportive. Encouraged pupils to ask questions, welcomed mistakes and praised pupils for participation.	Supportive. Encouraged pupils to talk to peers about their work, welcomed mistakes and praised pupils for completing their work on time.	Supportive. Encouraged pupils to comment on their peers answers and praised pupils for their attempts.

While pupils were working on the new tasks, Teacher A provided between-desk instruction and feedback on completed tasks. However, for Teachers B and C during the main phase, pupils did tasks similar to those the teachers had demonstrated but in groups. Following this Teacher B assigned pupils individual work on similar tasks devoid of any assistance from peers or teacher, while Teacher C got pupils to do pair work on tasks similar to those they did during group work. From the instructional sequences of the three teachers, it is apparent that the lesson of Teacher A is similar to that advocated by Kroesbergen and Van Luit (2002). Hence it may be said that although almost all the pupils were experiencing teacher-led whole class instruction during their lessons, the variation between the types of such instruction may not be addressing the needs of the low attainers. Furthermore, teachers made no attempt to tailor their instruction to meet the needs of different learners.

The tasks used by the teachers were routine and repetitive, and it appears that teachers made no attempt to engage pupils in higher order thinking. This practice is at odds with the findings of Watson (2001) and Zohar and Dori (2003) who found that low attaining pupils are capable of making shifts in their thinking and improving in their mathematics attainment when challenged with higher order thinking tasks. In the three classrooms, the learning environments were conducive, teachers were welcoming of

mistakes, praising pupils for good effort, encouraging pupils to ask questions and engage in peer evaluation. However, the main focus was the use of correct procedures to solve mathematical tasks. Errors made by pupils were not used as springboards for reflection. Also questions asked by pupils were not exploited to engage the class in critical thinking. Hence it may be said that although the learning environment could have stimulated the metacognitive potential of the pupils it was not harnessed. This was yet another setback as Cardelle-Elawar (1995) found that low achieving pupils benefited from metacognitive training.

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