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Factors Contributing to Effective Mathematics Teaching in Secondary Schools in Brunei Darussalam

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Abstract

This study examined, ascertained and described the factors that influence the capacity of schools in providing quality Mathematics education, as perceived by school administrators and upper secondary Mathematics teachers in Brunei Darussalam. There were two methods of data collection used; namely, a pen-and-paper questionnaire and lesson observations of two teachers who were deliberately selected from the total sample of upper secondary teachers. The findings showed that teachers are at the heart of effective Mathematics education. However, the findings also revealed that there are negative factors affecting teachers' effectiveness in teaching Mathematics. An awareness of these factors can help increase a teacher's effectiveness if they are dealt with successfully.

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1. Introduction

Mathematics has always been a difficult subject for most students in government secondary schools in Brunei Darussalam (Ahmad & Shahrill, 2014; Ang & Shahrill, 2014; Daud & Shahrill, 2014; Hamid et al., 2013; Mahadi & Shahrill, 2014; Matzin et al., 2013; Mundia, 2010a, 2010b, 2012; Nor & Shahrill, 2014; Ong & Shahrill, 2014; Pungut & Shahrill, 2014; Salam & Shahrill, 2014; Sarwadi & Shahrill, 2014; Shahrill, 2009; Shahrill et al., 2013; Shahrill et al., 2014; Suhaili et al., 2014; Wahid & Shahrill, 2014; Yatab & Shahrill, 2014a, 2014b). This study

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investigated and examined a range of factors contributing to effective Mathematics teaching and learning strategies in the upper secondary classes, including the knowledge, beliefs, understandings and practices of Mathematics teachers, their qualifications, professional development and relevant personal experiences, and how these will impact student learning outcomes in the secondary school years.

Seah (2007) stated that effective teaching is undoubtedly the most important objective in school Mathematics education. Econometric analysis suggested that some teachers are dramatically more effective than others, and that these differences have lasting effects on student learning (Rivkin, Hanusahek & Kain, 2005). Likewise, Larson (2002) recognised that some Mathematics teachers are more effective than others. Even though effective teachers of Mathematics may tend towards student-discovery or teacher-directed pedagogical instruction, they share certain common traits in how they deliver Mathematics instruction. According to Maduabum (2009), much attention had been given to researching Mathematics teacher effectiveness. For, if the qualities of effective Mathematics teachers are identified, other Mathematics teachers can then aspire to the ideal.

2. Effective Mathematics teaching

As stated in the Australian Association of Mathematics Teachers' *Standards for Excellence in Teaching Mathematics in Australian Schools*, "Effective schools are only effective to the extent that they have effective teachers" (2006, p. 5). Because the term *effective* has been used in various ways in the research literature of the past decades, it is necessary to clarify how it is used in this review. According to Stanford (2001), teacher *effectiveness* is the degree to which a teacher achieves desired effects upon students. In other words, teacher effectiveness is how much and how well students achieve and demonstrate commitment and resilience in the face of adversity. In general, in terms of Mathematics instruction, best practice is typically thought of as a teaching strategy that generates the desired results and promotes deep student understanding (Stanford, 2001).

Larson (2002) recognised that some Mathematics teachers are more effective than others. Effective Mathematics teachers do certain things in common when delivering Mathematics instruction, whether they tend toward the student-discovery or the teacher-directed ways. Ingvarson et al. (2004) theorised that there are four main factors that influence the effectiveness of students' learning outcomes in Mathematics. These are:

- (a) The 'school enabling conditions' – conditions in the school where the students are located;
- (b) The 'teacher enabling conditions' – teachers' experiences and professional developments;
- (c) The 'capacity of the teachers' – the knowledge, beliefs and understanding of teachers; and
- (d) The 'teacher practice' – what teachers do in their classroom?

As stated by Posamentier and Stepelman (1999), effective Mathematics teachers have a broad range of specific teaching strategies available to them. Determining the best strategies for a lesson is an important aspect of teachers' creative role in the classroom, and every teacher is a resource person who determines which classroom teaching strategies will be most effective. Studies have shown that there are many attributes of an effective Mathematics teacher, and many of these attributes are those that involve the learners. After all, effective teaching is reflective of effective learning. Posamenteier and Stepelman (1999) reported that effective Mathematics teachers helped develop their students' positive attitudes by being sensitive to their students' feelings, by valuing every student's contribution, by recognising students' needs for success, by involving students in their own learning, and by making Mathematics exciting and interesting. Seah (2007) speculated that effective teaching and learning might be a function of interactions between teachers and their students, between and amongst students, and between the class and its environment.

3. Methodology

3.1. Sample

This study involved seven government secondary schools in Brunei Darussalam. The school administrators of these schools participated in this study, and they consist of the principals, academic deputy principals, Mathematics Heads of Departments (or HODs), and upper secondary teachers. The upper secondary teachers in this context refer to those teaching from Year 9 to Year 11. Additionally, two classes of secondary school students ranging between 13 to 16 years of age participated in this study.

3.2. Instruments

Questionnaires were the primary means of collecting data from the school administrators, upper secondary teachers and upper secondary students. A group of researchers (Ingvarson et al., 2004) from the Australian Council of Educational Research (hereafter, referred to as ACER) had developed three different sets of questionnaires to gather information about effective Mathematics teaching and learning in Australian secondary schools. These questionnaires were adapted to suit the Brunei context, and were used to guide and gather the data needed for this study.

In order to gather information about the context in which Mathematics teaching was organised within the school, the school administrators had to complete a questionnaire which consisted of a 35-item inventory designed to extract the factors perceived to be influencing the effectiveness of Mathematics teaching and learning for Years 9 to 11 within the school. For teachers, a self-report questionnaire was developed to gather data about their approaches to Mathematics teaching. This questionnaire was based on the work of Cohen and Hill (2000) and the National Board of Professional Teaching Standards (2002). Information was gathered about the teachers' gender, level and the fields of study of their education, the number of years teaching, the amount, frequency and nature of professional development they had taken, the context in which they taught, and their teaching activities, practices and strategies.

Student responses to Mathematics teaching were also gathered using a questionnaire. According to Ingvarson et al. (2004), this questionnaire was developed as part of the *Victorian Quality Schools* project (Hill et al., 1996), and from other sources. This instrument provided information about the students' classroom teacher, about the attitudes of students to their Mathematics learning, and about their perceptions of Mathematics teaching. Students of two different classes with ages ranging from 13 to 16 years of age filled up this questionnaire, and the students came from the same socioeconomic status with the majority of them coming from a middle-class family background.

Meanwhile, field notes and video recordings provided data towards the case studies of two upper secondary classes, and the classroom observations were arranged to be as unobtrusive as possible. There was also personal communication with the teachers involved, through emails and informal interviews.

4. Results

4.1. School administrators beliefs

From the findings, school administrators perceived that Mathematics teachers played a significant role in the effectiveness of Mathematics teaching. Teachers needed to be well-qualified and well-trained in methods of teaching Mathematics in order to be effective. In other words, they need to be specialist Mathematics teachers who are enthusiastic about Mathematics, and are ready and willing to adapt their teaching practices and take on new approaches to teaching Mathematics so as to cater for students' individual needs. To do this, the teachers believed that they have a need for professional development in order to improve classroom practices. In addition, the teachers also needed support and high levels of professional community and accountability not only within the Mathematics department, but from other departments as well. A culture of openness and collegiality among teachers of Mathematics is also looked for, in order to enable them to gain more teaching expertise and Mathematics resources while also minimising faults in their teaching instructions. This result is consistent with that of Anthony and

Walshaw (2007) who found that, beyond the classroom, the immediate professional community has a marked effect on teacher effectiveness.

From the data analysis, it is also apparent that negative factors exist and interfere with the Mathematics teachers' effectiveness, and many of these factors are instigated by the schools' administration. Firstly, the teachers found it hard to obtain appropriate curriculum materials and resources from their schools. Secondly, there were limited quality computer software as well as computers for students' use. Thirdly, there was a shortage of teachers who can provide leadership at departmental level in the school. Lastly, teachers lack the time required to plan, design and review Mathematics programmes in their schools. In order to overcome these drawbacks, teachers will need support in various forms from the school administrators and from the Ministry of Education. As stated by one of the Mathematics HOD, *"Until LCD projectors are permanently set up in every classroom, many teachers still are reluctant to explore teaching methods using ICT because of the hassle involved of setting up"*. This showed that the schools still need financial and technical support in order for teachers to readily use resources that are deemed to make teaching approaches more effective. The third issue discussed above was also addressed by one of the principals, who said *"[There is a] Shortage of teachers especially with the new ruling for maternity leave (105 days-1 term). Relief teachers are sometimes not supplied [by the Ministry of Education] and there are cases when relief teachers are not competent enough to teach the level. Teachers lose focus with many activities / programmes [held] externally."* A deputy principal also said, *"The teaching of Mathematics at primary level should also be taken into account. Shortage of Mathematics teachers is a big issue nowadays!"*

Why teachers find it hard to find time to plan and design more effective teaching approaches may be due to several factors: (1) They already have heavy teaching loads in addition to being a relief teacher for their colleague(s) who are on maternity leave; (2) They have to conduct extra classes in the afternoon for students who will sit for the 'O' Level examinations, on top of fulfilling the 100-hours professional development sessions within and outside their school as requested by the ministry; and (3) Teachers have to coach and take care of students who are participating in annual events and programmes organised by the school, the Ministry of Education, or other organisations. The first factor was addressed by one of the Mathematics HOD who said, *"Teachers are burdened with heavy teaching loads."* The results also reveal that schools' administrators need to work harder on improving the conditions that would make teachers' Mathematics instructions more effective. Computers were still not readily available for students' use in the classrooms, and quality educational software was not easily available for teachers' use. Teachers also need more support from the school administrators and the respective departments in the ministry in terms of concrete materials for Mathematics teaching and adequate training for teachers to use the teaching resources effectively. One individual commented that the factors that he/she believes are influential in the effectiveness of Mathematics teaching and learning are *"teachers' professional developments, times for teaching and learning, availability of teaching aids, computers, OHP, etc"*.

Other negative factors believed to impact the effectiveness of Mathematics teaching originated from the teacher's and student's points of view. Some Mathematics teachers had difficulties in seeing the students' difficulties in learning Mathematics. This may partly be due to the fact that some students prefer to be passive learners and refuse to participate in classroom discussions. Some students also had negative attitudes and a lack of interest in Mathematics as a compulsory subject. Furthermore, the lack of parental support for students to do well in Mathematics may have hindered them to achieve positive learning outcomes. As was said by one of the principals, *"Variations in family background [also play a role here]. Majority of the students come from disadvantaged families and the parents are not being supportive towards their children's' education. The students have poor command of English and therefore have difficulties in understanding various Mathematics concepts, e.g., problem solving, word problems, especially weaker students"*. Parents and students need to be constantly reminded of the importance of Mathematics in students' life and for the students' future. To do this, teachers may have to work collaboratively with parents to ensure that parents also take responsibilities to support and educate their children in the importance of Mathematics in real life.

4.2. Teacher level

A questionnaire was administered for all upper secondary Mathematics teachers involved. There were 55 teacher respondents, with three times as many female respondents than males. There were three issues raised; teachers'

professional developments (hereafter referred to as PD), the school context, and the teachers' teaching practices. A majority of the teachers revealed that their PD experiences in the past three years had not truly affected their teaching. While adequate time for PD is essential, studies show that more time does not guarantee greater effectiveness as a Mathematics teacher. This is in accordance with our earlier observations that most PD experiences only affected teachers to a minor extent. Resnick (2005) suggested that, to be effective, PD must provide teachers with a way to directly apply what they learn to their teaching. However, most teachers received less effective forms of training.

One individual claimed that they *"need continuous professional development on teaching Mathematics and Mathematics as the subject with respect to our country and religion"*. In order to make PDs more successful in the future, Resnick (2005) suggested that policymakers should first make sure that adequate time is allocated to PDs that has a focus on the subject matter that teachers will be teaching, and to align teachers' learning opportunities with their real working experiences as well as using actual curriculum materials and assessments. It was also suggested that schools have reliable systems for evaluating the impact of PD on teachers' practices and student learning.

The result discloses that the teachers' main problems in Mathematics teaching were in getting students more interested in the subject and in maintaining the students' discipline especially in large classes. One individual stated, *"Students' interest in learning Mathematics is the main problem as well as students' poor Mathematics background"* and another commented *"Most students of Years 9 and 10 those I taught this year got very weak foundation of basic Mathematics skills especially simplifying algebraic expression, equation and several word problems due to their literacy skills"*. One of the teachers believed that *"the students hated Mathematics so much and the results are very bad"*. One respondent also commented regarding the problems raised by students by saying *"Students' attitudes towards learning [and]. Students' mindset [are the few factors influencing the effectiveness of Mathematics teaching and learning]. Some thought that they never passed any Mathematics test or exams, so they do not want to try again"*. Schools also need to lessen the external classroom interruptions such as frequent announcements, assemblies, and other school activities. One individual commented that he/she believed that *"work that was not related to teaching, e.g., activities, administration work, etc."* poses a problem for effective Mathematics teaching. Another hindering factor was that teachers were always using less challenging problems and avoided the more challenging problems to save teaching time and to prevent the possibility of their students from becoming demotivated in learning Mathematics. Another possible explanation for this may be that students were unable to cope with these high order thinking tasks as they were already accustomed to being 'spoon-fed' by their teachers for as long as they could remember. From our experiences, many students in Mathematics classes mainly waited for their teachers to give the solution to a problem without even trying in an attempt to avoid failures or wrong answers.

4.3. Student level

The students' responses provided information regarding their attitudes and their perceptions of Mathematics teaching. Most of the students felt strongly motivated to learn Mathematics, and believed that the Mathematics they learn at school was useful to them and will also be useful to help them get a job in the future. They also revealed that they enjoy being at school, and that it is worth trying hard at Mathematics for they want to get good Mathematics results. Furthermore, they were sure that they could learn Mathematics. Most students felt strongly that their teacher knew them well; specifically, that teachers knew how to explain Mathematics to them, were able to show them how Mathematics may help them in real life, and made them feel that they could learn Mathematics. Furthermore, they perceived that their teachers used a variety of methods for teaching Mathematics, helped them to think for themselves in Mathematics, and tried to help everyone to do well in Mathematics. There were only two negative concerns that most students said about their Mathematics teachers. Firstly, that their teachers did not use computers in Mathematics classes to help them learn. Secondly, teachers rarely involved the students' parents in their Mathematics learning. The possible reason to the former issue may be due to the limited availability of quality computer software as well as computers for students' use in schools. The latter issue may be due to teachers' lack of time in schools as well as lack of parents' support and involvement in their children's learning.

4.4. Classroom observations

The Mathematics classroom of Ms Dania, who was regarded by her HOD as the most effective Mathematics teacher in her school, was unobtrusively observed for three consecutive lessons within the one week, in which each lesson lasted for at least an hour. A Mathematics topic on Functions was completely covered during the three lesson observations. Thus, this presented us with an opportunity to observe how the teacher introduced, carried out, and how concluded the main content of the lesson. From the first lesson until its conclusion, five principles of best practices were prominently observed in Ms Dania's classroom, which are: teacher knowledge, mathematical language, mathematical communication, worthwhile mathematical tasks and an ethic of care. However, 'arranging for learning' was not evident in her class, as a result of her students' preference towards working independently rather than in groups, as well as the individual seating arrangement of the classroom layout.

4.5. Factors contributing to effective Mathematics teaching

The most important factors that contributed to effective Mathematics teaching of upper secondary Mathematics teachers in Brunei seemed to stem from the Mathematics teachers themselves, whereas the school context or the school administration only seems to impact teaching effectiveness to a minimal extent. In other words, effective Mathematics teaching must be accompanied by teachers' deep knowledge of the subject matter, their understanding of what optimises students' learning, and their best instructional classroom practice. This finding is consistent with that of Sanders and Rivers (1996), who found that teacher effectiveness is the dominant factor influencing student academic growth. This finding also supports previous research by Stronge (2010), who has illuminated that the quality of teachers is so extraordinarily important to the lives of students. Teachers do matter most when it comes to school improvement and student learning, and that, among multiple factors within schools, "There is no more powerful influence on student success than the teacher" (Stronge, 2010, p. xiii). Findings extracted from students in this study have also reported that their teachers' teaching practice has a consistently important effect on the affective outcomes of their Mathematics learning.

5. Conclusions

In the quest for schools to become more effective through producing more effective Mathematics teachers, some predicaments were encountered. Some teachers stated that many of the students in the upper secondary level have a weak foundation of basic Mathematics skills. Some teachers also suggested that students' interest in learning Mathematics was the main problem. One teacher had even boldly asserted that many students hated Mathematics. A few teachers mentioned the importance of continuous PD on teaching Mathematics, but the findings of this study suggested that the teachers' PD experiences were not very influential in making positive changes on either the teachers' practices or their beliefs. It is clear from the study that effectiveness of classroom instruction originates from the teacher. Mathematics teachers have to be well-prepared, well-versed, and thoroughly supported for changes in the curriculum and instructional strategies to occur. A particular pedagogy observed in the exemplar teacher that stood out from the rest was the teacher's questioning abilities. The teacher was not only an explainer (the teacher justified what to do by explaining how and why the procedure works), she was also a questioner (the teacher asks questions that enabled learners to develop the procedure themselves). Suffolk (2007) implied that the explainer is teacher-centred whilst the questioner is learner-centred. On the other hand, Wong (2007) argue that the teacher needs to be the central figure in the Mathematics classroom, and not the students. It is the teacher who designs learning activities, which are the key to understanding. The teacher needs to lead the classroom and its learning activities (Tsang et al., 2014). Therefore, one characteristic of effective classrooms might be teacher-led, yet student-centred. As Khalid (2009) has put it, effective teaching requires teachers to decide "what aspects of a task to highlight, how to organize and orchestrate the work of students, what questions to ask students having varied levels of expertise, and how to support students without taking over the process of [mathematical] thinking for them" (p. 176).

What school administrators can do to support student learning is to support the teachers. Specifically, they need to be more supportive by providing the resources that teachers need in order to plan their lessons effectively, without limiting access to facilities such as the internet, LCD projectors, visualizers and so on. They must not only encourage teachers to explore new teaching ideas and innovations but also facilitate the teachers in getting Mathematics resources for the school. Although there is no fixed rule for good practices, some of the indicators can be put forth towards creating better practices. As prerequisites for an effective Mathematics lesson, we would suggest that teachers must be competent in the subject content knowledge, possess good pedagogical skills especially questioning, and have a good relationship with their students (Kani et al., 2014; Omar et al., 2014; Salam & Shahrill, 2014; Shahrill, 2009, 2013a, 2013b; Shahrill & Clarke, 2014; Shahrill, Kani & Nor, 2013; Shahrill & Mundia, 2014). Furthermore, as change in the real world is inevitable, it is therefore vital for Mathematics teachers to constantly learn and update their instructional practices so as to promote and equip students with the required mathematical understanding to meet the challenges of the 21st century.

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