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A Study of Mathematics Homework in Singapore Secondary Two Classrooms

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Abstract: Mathematics homework is an integral part of students' academic routine in Singapore. It is thus imperative for teachers to select meaningful tasks to foster and develop students' robustness in understanding. This study examines the nature and source of mathematics homework and students' perspectives about the role of mathematics homework in two Singapore Secondary Two classrooms in a school. It also examines five teachers' perspectives about the role of mathematics homework in the same school. Findings about the nature of the student homework assignments show that three different types of homework were assigned and four dimensions of understanding were encompassed within the assignments. However, the distribution of homework across the three types and four dimensions of understanding were of varying extent. From the students' perspectives about the role of homework, it served both short-term and long-term academic benefits. From the teachers' perspectives about the role of homework, they unanimously agreed that homework is important for their students and it allows students to practise, reinforce and consolidate what they have learnt in class.

Keywords: homework, perspectives, secondary two, student, teacher

Introduction

Homework refers to tasks given by school teachers to students which are intended to be carried out during outside-school hours (Cooper, 2006). In Singapore, as well as many other countries, students are given homework as part of their academic routine (Blazer, 2009). Considering the amount of time and effort devoted to homework, it is important that teachers set good

quality homework assignments with a clear purpose of serving academic objectives (Hong & Milgram, 2000; Blazer, 2009). Kaur (2011) studied the nature and source of mathematics homework in three Singapore Secondary Two classrooms and discovered the various types of homework assignments based on the works of Cooper (2001) and Hong & Milgram (2000). This has provided us with a basis to further research about specific aspects of homework such as the different dimensions of understanding (Usiskin, 2007) prevailing in the assigned work. Gaining deeper insights into the quality of mathematics homework that students are engaged in will undoubtedly help in the development of more meaningful and purposeful homework tasks. This study extends the work of Kaur (2011) by examining the different dimensions of understanding that mathematics homework is intended to develop or foster in the secondary school classroom.

It is timely to re-look at the nature and source of mathematics homework that mathematics teachers assign their students with the implementation of the revised Singapore Secondary Mathematics Syllabus in 2013. According to Usiskin's curriculum design principles (2007), for change to occur, new materials which enable the change must be implementable for use in classes. In order to influence the ways teachers teach and students learn to achieve academic objectives, specific learning experiences have been included in the revised mathematics syllabus and revised textbooks integrating both skills and processes have been written. Consequently, with the integration of learning experiences into lessons, it would seem only natural that new materials for mathematics homework be used to develop or foster the desired learning outcomes. It is henceforth significant to investigate how the revised materials for mathematics homework might support or constrain the further development of students' mathematical skills and processes.

Apart from investigating the nature and source of mathematics homework, it is also important for us to find out about the perspectives of the parties most directly involved in homework; the giver of homework, i.e., the teacher, and the receiver of homework, i.e., the students. The utility of homework depends to a large extent how meaningfully both the teacher and students are engaged in it. Hence their perspectives about the role of homework are essential for effective implementation and completion of homework. Kaur (2011) has found three-fold collective underlying beliefs of teachers about the role of homework as well as students' perceptions of six functions of

homework. This study also extends our knowledge of the perspectives of teachers and students about the role of homework in the teaching and learning of mathematics respectively.

Literature Review

Cooper (2006) defined homework to be teacher-assigned tasks to students which are meant to be completed outside school hours. Mathematics homework is a common practice and an integral part of education in Singapore and many other countries. In fact, Leung (2006) found that East Asian students did not devote more time than students in western countries on studying outside school hours or doing mathematics homework. Specifically for Singapore, the Trends in International Mathematics and Science Study (TIMSS) of 2011 (Mullis, Martin, Foy, & Arora, 2012) reported that 16% of the eighth grade participants reported spending 3 hours or more weekly on mathematics homework, 57% reported spending more than 45 minutes but less than 3 hours and 27% reported spending 45 minutes or less weekly on mathematics homework. The study also reported that extending instruction with homework does contribute to effective mathematics learning. There is thus much impetus to investigate how teachers can maximise the benefits of homework, considering the significant amount of time spent on it, as well as its reported utility in achieving effective learning. This investigation should begin with examining the nature of student homework assignments.

In order to examine the nature of student homework assignments, it is vital to understand why homework is assigned and the purpose they serve. Teachers assign homework for several reasons which include (a) enhancing classroom instruction (Cooper, Robinson, & Patall, 2006) and (b) other non-instructional purposes such as fostering parent-child communication (Gonzalez-DeHass, Willems, & Holbein, 2005; Hoover-Dempsey et al., 2001), fulfilling policy directives from school administrators (Auerbach & Collier, 2012; Hoover-Dempsey & Bassler, 1995), and disciplining students (Epstein & Van Voorhis, 2001). For the intention of this study which is related to mathematics learning, we will narrow the scope to look at how homework can enhance and extend classroom instruction beyond instructional hours.

The instructional purpose of homework is multifaceted: (a) for practice, (b) for preparation, (c) for integration, and (d) for extension (Cooper, 2006). Based on the works of Cooper (2001) and Hong & Milgram (2000), Kaur (2011) has derived a coding scheme for the different types of mathematics homework given in three Singapore Secondary Two (Grade 8) classrooms.

The categories were:

1. Type I—review, practice and drill same-day content
2. Type II—amplify, elaborate and enrich previously learnt information
3. Type III—advance preparation for material to be learnt in subsequent lessons

Type I homework is the most common kind of assignment. Such review or practice and drill same-day content homework assignments serve to reinforce specific mathematical skills taught, in order to attain mastery. Type II homework requires students to transfer previously learnt skills and/or concepts and apply them to solve new problem(s). Lastly, Type III homework consists of new introductory or preparation materials to be covered in subsequent lessons.

Merely differentiating the types of homework assignments does not provide us sufficient information to investigate students' robustness and depth of understanding which is emphasised in the latest Singapore Secondary Teaching and Learning Mathematics Syllabus (MOE, 2012). The revised syllabus has advocated for a greater balance between skills and procedural fluency as well as conceptual understanding. A shift in an emphasis on the teaching and learning process for deep understanding of mathematical concepts calls for a ripple effect change in the nature of homework which largely serves to advance students' learning. As much as teaching and learning needs to be aligned with assessment (Thompson & Kaur, 2011) for students to achieve a multi-dimensional view of understanding, homework which is embedded in the cycle loop needs to provide students the opportunities to cultivate and foster such depth of understanding.

In order for mathematics homework to be meaningful so as to allow students to achieve deep conceptual understanding, not only must teachers be clear about the purpose of homework or how pupils are expected to engage with the tasks, effective homework tasks must be designed to stimulate and foster mathematical thinking and learning (Wieman & Arbaugh, 2014). According

to Staub and Stern (2002), it is important to pose structure-oriented type of tasks to students to construct learning opportunities for them to foster conceptual understanding. Such structure-oriented tasks are those that "require meaningful knowledge in terms of explicit knowledge of mathematical principles or the application of such principles". The other type of tasks is performance-oriented tasks which "require only factual knowledge, procedures or algorithms and outcomes of a procedures" (Staub & Stern, 2002). Henceforth, it is pertinent for us to explore and investigate more specific aspects of the types of homework to facilitate an improvement in the quality of homework assignments.

Recent works (Thompson & Kaur, 2011; Bleiler & Thompson, 2012; Wong, & Kaur, 2015) of researchers have examined how Usiskin's (2007) multi-dimensional approach to assess students' mathematical understanding can be used to examine the kinds of mathematical knowledge and skills in assessments. Assessment should be aligned with classroom instruction, and hence homework which serves to extend instruction should encompass what is being assessed. Even though homework plays a fundamental role in students' education in Singapore, there is paucity in research in how the quality of homework may be improved in terms of robustness of understanding. Usiskin's multi-dimensional approach can be used to ensure a balanced perspective of mathematical understanding. Specifically, it facilitates the examination of the kinds of mathematical knowledge and skills that mathematics homework is intended to develop or reinforce in the secondary school classrooms. This approach, known by the acronym SPUR, assesses students' understanding across four dimensions:

1. Skills-algorithm dimension—ranging from the carrying out of simple algorithms (mentally, with paper and pencil, or with technology) through the carrying out of algorithms with many decision-nodes to the invention of new algorithms
2. Properties—mathematical underpinnings dimension—ranging from the recognition and application of individual properties to more complex justifications to the writing of original proofs
3. Uses—applications dimension—ranging from the applying of operations of arithmetic in everyday problems to the use of more complex models to the invention of new applications for known

mathematics or the invention of new mathematics for given applications

4. Representation-metaphors dimension–ranging from concrete representations of abstractions through geometric representations (e.g., graphs and networks) of algebraic objects and logical relations and through algebraic representations (e.g., coordinates) of geometric objects to the invention of new representations (e.g., glyphs and box plots in the past twenty-five years) and metaphors (Usiskin, 2007, pp. 177–178)

Research has shown that fostering the development of skills proficiency, procedural fluency in conjunction with conceptual understanding enhances students' learning and achievement (NCTM, 2000; NMAP, 2008). In addition, the findings in Staub and Stern's (2002) study have shown how the use of structure-oriented mathematical tasks is valid for fostering students' conceptual understanding. Hence deliberate effort to incorporate mathematics homework which encompasses the four dimensions of understanding within a mathematical concept, topic or strand may help to create meaningful learning opportunities or experiences for students to improve in their robustness in understanding. After all, research has shown that homework of high-quality is positively associated with homework motivation and behaviour and that they facilitate effective learning (Dettmers, Trautwein, Ludtke, Kunter, & Baumert, 2010).

The intended effectiveness of homework requires the participation of students. Research has shown a positive association between students' attitudes towards homework and homework completion (Cooper et al., 1998; Xu, 2008). Thus it is necessary to understand what students' views of homework encompass to boost homework completion. Students' perceived functions and usefulness of mathematics homework can be found in some research works (MacBeath & Turner, 1990; Tam, 2009; Kaur, 2011). Of keen interest for this study in the context of Singapore would be Kaur's findings (2011) regarding students' perceived functions of homework. The students in Kaur's study were from three Secondary Two (Grade 8) classrooms. Their six perceived functions of homework include:

1. Improving/enhancing understanding of mathematics concepts
2. Revising/practicing the topic taught
3. Improving problem-solving skills

4. Preparing for test/examination
5. Assessing understanding/learning from mistakes
6. Extending mathematical knowledge (p. 200)

Besides understanding how students perceive the role of homework, it is also constructive for us to find out how teachers view homework as they play an important role in scoping the academic requirements for mathematics homework as part of students' learning. Knowing teachers' perspectives about the role of homework will possibly help us gain insights into the nature of the homework that they assign. In fact, teachers' pedagogical content beliefs are shown to have an impact on the tasks that they select for students' learning (Staub & Stern, 2002). Research has shown that good quality homework assignments not only relate directly to classroom work, but also extend students' learning beyond the classroom (Cooper, 2001). In Singapore, it can be inferred from Kaur's study (2011) that teacher-assigned homework was related to ongoing classroom work. Considering an emerging change in the teaching and learning process in Singapore mathematics classrooms, the nature of mathematics homework which seeks to support and advance students' learning should reflect modifications. The quality of homework assignments seems to be associated with and perhaps stems from teachers' perspectives about the role of homework.

Cooper (2006) has provided us with a comprehensive list of reasons why teachers assign homework. Based on teachers' perspectives, homework serves several purposes and can help their students:

1. review and practice what they've covered in class;
2. get ready for the next day's class;
3. learn to use resources to find information about a subject;
4. explore subjects more fully than classroom time permits;
5. extend learning by applying skills they already have to new situations; and
6. integrate their learning by applying many different skills to a single task. (p. 80)

In addition, homework can also help students cultivate good study habits such as independent learning as well as to develop positive attitudes like self-discipline which includes time-management and responsibility (Cooper, 2006).

Kaur's findings (2011) on the collective perspectives of three teachers in Singapore about the role of mathematics homework resonate with some of the points in Cooper's study (2006). Firstly, the key underlying belief 'practice makes perfect' of the three teachers ties in with the first point of Cooper's list. This perspective is consistent with the finding that Type I homework which was meant to review, practice and drill same-day content, is the commonly given type of homework. Secondly, one teacher's view that homework is an extension of a lesson reflects Cooper's fifth point. This same teacher had assigned relatively more Type II homework which was meant to amplify, elaborate and enrich previously learnt information. These teachers' perspectives about the role of homework seem to have a direct impact on the mathematics homework they assign. Thirdly and also lastly, the perspective that homework helps students to foster a sense of responsibility towards their learning is also aligned with Cooper's study (2006) which found that homework can help students cultivate positive attitudes and encourage them to be responsible.

Kaur's study (2011) had exposed both teachers' and students' perspectives about the role of mathematics homework. This acts as a basis for an extension of knowledge regarding these key stakeholders' perceptions of mathematics homework.

The Study

This study extends the work of Kaur (2011) which is related to mathematics homework in Singapore classrooms. It uses the classifications of Cooper (2001) and Hong and Milgram (2000) and the framework of SPUR (Usiskin, 2007) to examine the kinds of mathematical knowledge and skills that mathematics homework is intended to develop or reinforce in mathematics classrooms of a secondary school. In examining the role of homework from the perspectives of both teachers and students, it also investigates how homework affords or constrains the learning of mathematics. The qualitative data are analysed using qualitative analysis tools.

This study seeks to answer the following research questions:

- a) What are the types and sources of mathematics homework assigned in Singapore Secondary Two (Grade 8) classrooms?
- b) What are the dimensions of understanding represented in the mathematics homework of Singapore Secondary Two (Grade 8) classrooms?
- c) What are the perspectives of students about the role of homework in the learning of mathematics?
- d) What are the perspectives of teachers about the role of homework?

The sample

The subjects of the study are two intact classes of Secondary Two (Grade 8) students and five mathematics teachers from the same secondary school in Singapore. The choice of Secondary Two (Grade 8) students is the same as the students chosen for Kaur's study (2011). The students in this study were all from the Express Stream, which is a four-year course leading up to the General Certificate of Education (GCE) O-level national examination. One class is taught by the teacher-researcher (T1) with six years of teaching experience while the other class is taught by another teacher (T2) with three years of teaching experience. This study is qualitative in nature and the choice of T2 is random. A total of 70 out of 80 students participated in the journal writing task in this study: 36 out of 40 were from the class of T1 and 34 out of 40 were from the class of T2. Furthermore, five teachers, including T1 and T2, teaching the same cohort of Secondary Two mathematics classes have also participated in this study. All students and teachers in this study formed a case (Berkowitz, 1996), and no attempt will be made to compare and contrast the data collected.

The instruments

Data on students' perspectives about the role of homework in their learning, was gathered using a mathematics journal (shown in Appendix A). The open-ended prompt of the journal was "In what ways does the homework for mathematics given by [name of teacher] help you in the learning of mathematics?" A survey was used to gather data on teachers' perspectives about homework as they are the key drivers of successful homework implementation and completion. The teacher survey comprised seven open-ended response items. The items are as follows:

1. Do you think mathematics homework is important for your students? Why?
2. Where do you usually take your homework questions from?
3. How often do you give your students homework?
4. How much homework do you give each time (average time required to complete)?
5. Do you mark all the homework assignments? Why?
6. What kind of feedback do you give your students after marking their assignments?
7. Besides traditional homework (Practice questions from textbooks and past examination papers), do you assign your students alternative forms of homework? Why?

Item 1 is instrumental in helping us find out teachers' perspectives about the role of homework, depending on how much emphasis they placed on homework as well as their rationale for assigning or not assigning homework. Items 2 to 7 help us understand teachers' practices in homework and allowed us to formulate ideas about what they really mean when they think homework is important or not important and how the homework process is carried out to validate the level of importance placed on homework.

The procedure

The student journal writing task on the usefulness of mathematics homework was administered to 70 students from two intact classes administered as part of their out of class mathematics work. In addition, the mathematics homework assignments for the first semester of the school year in 2015 of three students from each class were chosen for this study. The criterion for selection was based on the mathematics teachers' assessment of the students' work, specifically a set of high-, average- and poor- quality work from each class. This is to check for that the students consistently completed their homework. The set of high-quality work for each of the two classes was used for coding of items using the SPUR multi-dimensional approach. Five mathematics teachers teaching the same cohort of Secondary Two mathematics classes completed the teacher survey regarding their views about the role of homework in their own time.

Results and Discussion

In this section, the student homework assignments, student journals and teacher surveys are analysed and discussed. A list of four research questions to be answered from the analysis of the data in this section are “What are the types and sources of mathematics homework assigned in Singapore Secondary Two (Grade 8) classrooms?”, “What are the dimensions of understanding represented in the mathematics homework of Singapore Secondary Two (Grade 8) classrooms?”, “What are the perspectives of students about the role of homework in the learning of mathematics?” and “What are the perspectives of teachers about the role of homework?”

For an in-depth analysis of the data on the student homework assignments, we adopted the framework analysis (Ritchie & Spencer, 1994), to explore the nature of the homework. The topics/chapters of the homework assignments given by both T1 and T2 to their classes for the first semester of the school year in 2015 are shown in Table 1.

Table 1

List of topics, textbook chapter titles and textbook sections for student homework assignments

| Topic | Textbook Chapter Title (Chapter No.) | Textbook Section |
|-------|--------------------------------------|------------------------|
| 1 | Proportion (1) | 1.1 Map Scale |
| | | 1.2 Direct Proportion |
| | | 1.3 Inverse Proportion |
| | Congruence and Similarity (6) | 6.4 Scale Drawing |

| | | | |
|-----|--|-----|--|
| 2 | Expansion and Factorisation of Algebraic Expressions (2) | 2.1 | Quadratic Expressions |
| | | 2.2 | Expansion of the Product of Algebraic Expressions |
| | | 2.3 | Factorisation of $ax^2 + bx + c$ |
| | | 2.4 | Special Products of Algebraic Expressions |
| | | 2.5 | Factorisation by Using Special Products of Algebraic Expressions |
| | | 2.6 | Factorisation by Grouping Terms |
| 3 | Pythagoras' Theorem (7) | 7.1 | Pythagoras' Theorem |
| | | 7.2 | Application of Pythagoras' Theorem |
| | | 7.3 | Converse of Pythagoras' Theorem |
| 4 | Mensuration of Pyramids, Cones and Spheres (9) | 9.1 | Pyramids |
| | | 9.2 | Cones |
| | | 9.3 | Spheres |
| 5 | Linear Equations in Two Variables (5) | | Linear Equations in Two Variables |
| | | | Solving Simultaneous Linear Equations in Two Variables by |
| | | 5.1 | Graphical Method |
| | | 5.2 | Solving Simultaneous Linear Equations in Two Variables by |
| | | 5.3 | Substitution Method |
| | | 5.4 | Solving Simultaneous Linear Equations in Two Variables by |
| 5.5 | Elimination Method | | |
| | | | Solving Problems Using Simultaneous Equations |
| 6 | Quadratic Functions and Equations (4) | 4.1 | Graphs of Quadratic Functions |
| | | 4.2 | Solving Quadratic Equations by Factorisation |
| | | 2.4 | Quadratic Formula* |
| | | 4.3 | Applications of Quadratic Equations |
| 7 | Congruence and Similarity (6) | 6.1 | Congruence |
| | | 6.2 | Similarity |

Note. The topics determine the sequence in which the lessons were taught, and they are different from the sequence of the chapters found in the textbooks. The textbook homework assignments were largely taken from two Secondary Two mathematics textbooks (Chow, 2014a, b), with only one taken from a Secondary Three

mathematics textbook (Chow, 2015). *This textbook section, 2.4 Quadratic Formula, is found in Secondary Three mathematics textbook (Chow, 2015). Topic 7 or chapter 6 was taught in the second semester of the school year in 2015. However, an online quiz based on the topic was set as June holidays homework in the first semester.

Table 2 shows the results of the analysis of the types of homework. All three types of homework were assigned by the teachers though with varying frequency. T1 and T2 assigned Type 1 homework after very topic they taught. This shows that teachers used homework to review, practice and drill same-day content (Cooper, 2001, 2006; Hong & Migram, 2000). T2 assigned Type II homework more often than T1. T2 appears to be more desirous to amplify, elaborate and enrich previously learnt information by students in her class. Both teachers assigned the same Type III homework for topics 3 and 7 as the specific assignments were unique for all secondary two students in the school. It appears that the school has adopted as part of their instructional plans, work such as Type III homework to engage students in exploring knowledge by themselves prior to classroom instruction of the same by the teacher.

Table 2

Types of homework assignments

| Topic | Teacher 1 (T1) | | | Teacher 2 (T2) | | |
|-------|------------------|----|-----|------------------|----|-----|
| | Type of homework | | | Type of homework | | |
| | I | II | III | I | II | III |
| 1 | √ | √ | – | √ | – | – |
| 2 | √ | √ | – | √ | √ | – |
| 3 | √ | √ | √ | √ | √ | √ |
| 4 | √ | √ | – | √ | √ | – |
| 5 | √ | √ | – | √ | – | – |
| 6 | √ | √ | – | √ | – | – |
| 7* | – | – | √ | – | – | √ |

Note. Type I review, practice and drill same-day content, Type II amplify, elaborate and enrich previously learnt information, Type III advance preparation for material to be learnt in subsequent lessons.

* Topic 7 was taught in the second semester of the school year in 2015. However, an online quiz based on the topic was set as June holidays homework in the first semester.

Table 3 shows the sources of the student homework assignments. The homework given by both teachers were either from the textbooks or other sources which included past year examination papers, a past year school group-work task, assessment books and an online portal. This finding shows that teachers were guided in their choices of homework tasks by the textbook used for instruction and also tasks from sources that helped prepare students for their forthcoming examinations both school based and national level. The student homework assignments given by both teachers were studied and categorised across four dimensions: (S) Skills, (P) Properties, (U) Uses and (R) Representations. The coding of items based on Usiskin's (2006) SPUR multi-dimensional approach was carried out solely by the teacher-researcher.

Table 3

Source of student homework assignments

| Topic | Teacher 1 (T1) | | Teacher 2 (T2) | |
|-------|----------------|--------|----------------|--------|
| | Source | | Source | |
| | Textbooks | Others | Textbooks | Others |
| 1 | √ | √ | √ | – |
| 2 | √ | √ | √ | √ |
| 3 | √ | √ | √ | √ |
| 4 | √ | √ | √ | √ |
| 5 | √ | √ | √ | – |
| 6 | √ | √ | √ | – |
| 7* | – | √ | – | √ |

Note. * Topic 7 was taught in the second semester of the school year in 2015. However, an online quiz based on the topic was set as June holidays homework in the first semester.

Table 4 shows the results of the analysis of the dimensions of understanding found in the homework given. From Table 4, it is apparent that both teachers placed emphasis on all of the four dimensions though with varying degree. It is apparent that teachers were skewed towards developing skills (procedural knowledge) and understanding (conceptual understanding). This could be due to the lack of emphasis placed by the assessment frameworks on explicit

articulation of properties and representations and thus the knowledge of the teachers about them.

Table 4
Dimensions of understanding of homework assignments

| Topic | Teacher 1 (T1) | | | | Teacher 2 (T2) | | | |
|-------|----------------|---|---|---|----------------|---|---|---|
| | Dimensions | | | | Dimensions | | | |
| | S | P | U | R | S | P | U | R |
| 1 | √ | √ | √ | √ | – | √ | √ | √ |
| 2 | √ | – | √ | – | √ | √ | √ | √ |
| 3 | √ | √ | √ | – | √ | √ | √ | √ |
| 4 | √ | – | √ | – | √ | √ | √ | – |
| 5 | √ | √ | √ | √ | √ | – | √ | √ |
| 6 | √ | – | √ | √ | √ | – | √ | – |
| 7* | √ | √ | – | – | √ | √ | – | – |

Note. (S) Skills, (P) Properties, (U) Uses, (R) Representations

* Topic 7 was taught in the second semester of the school year in 2015. However, an online quiz based on the topic was set as June holidays homework in the first semester.

For the data from the student journals and the teacher surveys, we adopted an inductive approach and carried out content analysis (Weber, 1990) to investigate students' and teachers' perspectives about the role of mathematics homework. The qualitative analysis was intra-case, as all students and teachers formed a case (Berkowitz, 1996), and no attempt was made to compare and contrast the data collected.

70 students from two intact Secondary Two (Grade 8) classes completed the journal writing task with the open-ended response item “In what ways does the homework for mathematics given by [name of teacher] help you in the learning of mathematics?” Their responses were studied and analysed to ascertain students' perspectives about the role of mathematics homework, particularly the six perceived functions of mathematics homework (Kaur, 2011) and beyond. The coding of the students' responses about the role of homework was done solely by the teacher-researcher. As with Kaur's study (2011), the students in this research are also Secondary Two students. The descriptors of the six functions of homework used by Kaur (2011) are shown in Table 5. Students' responses are coded based on matching with the functions if possible. All 70 students have reflected in their journals at least one of the six functions of homework.

Table 5

Descriptors of the functions of homework

| Functions | Descriptors |
|--|--|
| Improving/ enhancing understanding of mathematics concepts | Help to improve understanding on the subject/better understanding of maths/understand topic taught/understand well the subject/help in understanding the concepts better/improve maths/better understanding/understand more about the topic taught/further understand formulas and concepts taught |
| Revising/ practising the topic taught | Help to revise daily/practice topic taught/recap the topic taught/practice in areas that are unfamiliar/not good at/ practice makes perfect/revise works/revise and practice topic taught/practice methods taught/practice on the type of questions for that topic/as a revision/give ample practice/practice is important in mathematics/refreshes memories so that can remember better/remember the method of solving problems |
| Improving problem- solving skills | Become more fluent in doing sums through practice/able to solve problems/help to master the skills of mathematics/learn how to apply formulas in different questions/able to do higher order questions and assignments/reinforce the ways of solving the questions/familiarize formulas taught/help to understand the formulas and put in good use/learn how to solve a problem using different approaches |
| Preparing for test/exam | Practice for the tests/know what kind of questions are coming out for exams/will not panic if some challenging questions come out for exam |

| | |
|---|--|
| Assessing understanding/ learning from mistakes | Able to learn from mistakes made in the homework/assess how much have learnt about the topic taught/act as a gauge to see whether can understand the concepts taught/help to see whether understand the lessons/assess level of understanding through practice/assess level of understanding on how to apply certain formulas to some questions/it would determine whether we understand the topic or not. If not, we are 'forced' to learn it in order to do the questions/challenge our mind so when confronted with easier questions able to do with ease |
| Extending mathematical knowledge | Exposes to different types of questions/overview of the setting of questions/exposes to how different types of questions are being phrased/broadens knowledge/learn new methods on how to do the questions/exposes to more challenging questions |

Note. The descriptors of the six functions of homework are used by Kaur's study (2011).

The content analysis of some of their responses and the corresponding functions are shown in Table 6 for T1's class and Table 7 for T2's class. They are illustrative examples from the students' responses.

Table 6
Content analysis of some T1's students' responses and their corresponding functions

| Student ID | Response | Function |
|------------|---|---|
| SG1-29 | It helps in <i>better understanding the topics</i> we were supposed to learn and master. | Improving/enhancing understanding of mathematics concepts |
| SG1-25 | [Name of teacher] always gives us work based on what we learn on that day so that we get to <i>revise and practice what we did in her lesson earlier that day</i> . | Revising/practising the topic taught |
| SG1-S1 | I get to <i>practice the different formulas taught</i> in class and <i>understand how to use them better</i> . | Improving problem-solving skills |
| SG1-S8 | The homework also <i>prepares me for the examinations as I know what kind of questions will appear</i> . | Preparing for test/exam |
| SG1-S27 | When I make mistakes, [name of teacher] will go through the steps one by one slowly. This helps <i>me learn my</i> | Assessing understanding/learning from mistakes |

| | <i>mistakes</i> and I will not make them again. | |
|---|--|---|
| SG1-S34 | With the homework given, I have <i>discovered different methods and terms of math</i> which gives me better confidence and courage when learning math. | Extending mathematical knowledge |
| Table 7 <i>Content analysis of some T2's students' responses and their corresponding functions</i> | | |
| Student ID | Response | Function |
| SG2-S20 | Firstly, it is <i>to enhance our understanding of a certain concept</i> . | Improving/enhancing understanding of mathematics concepts |
| SG2-S4 | As ' <i>practice makes perfect</i> ', it also helps me prepare for many upcoming quizzes and exams. | Revising/practising the topic taught |
| SG2-S7 | And some question with the light bulb beside the question are usually <i>problem sums which requires higher order thinking</i> , hence, I will learn more outside the classroom. | Improving problem-solving skills |
| SG2-S13 | Doing all these practices makes <i>me get ready and prepared for upcoming tests or exams</i> . | Preparing for test/exam |
| SG2-S23 | It allows me <i>to learn from my mistakes</i> so that during exam, the same mistakes would not be done again. | Assessing understanding/learning from mistakes |
| SG2-S27 | The homework for Mathematics given by [name of teacher] <i>exposes me to a repertoire of questions types for the various topics</i> . | Extending mathematical knowledge |

The aforementioned six functions of the role of homework as perceived by students were inadequate to code all the students' responses. This is because the pre-existing codes encompassed solely the immediate learning achievement and goals of doing homework. Apart from the short-term academic benefits of doing homework, in their responses to the journal writing task about the role of homework, some students have described how

homework has helped them in the long term. As such, new functions of homework emerged based on the students' journals and hence new codes were generated. In addition to the pre-existing six short-term functions, some students have identified three long-term academic benefits of homework. They include: (1) improved attitude toward mathematics, (2) more independent problem solving and (3) confidence building.

Table 8 shows the content analysis of students' responses and the inferences drawn regarding the different classifications of long-term academic benefits.

Table 8

Content analysis of some students' responses and their corresponding inferred functions

| Student ID | Response | Function |
|------------|---|---|
| SG1-S5 | Through homework, it can also <i>teach us to enjoy Math and instil more of our interest into it.</i> | Long-term academic benefit–Improved attitude toward mathematics |
| SG2-S9 | Also, the homework given in class, although coming in big amount, does allow me to be really <i>get interested in such topics</i> like Pythagoras' theorem and the converse of Pythagoras' theorem. | |
| SG1-S16 | The homework given helps me <i>apply what I have learnt</i> that day and <i>I learn how to answer the questions by myself.</i> | Long-term academic benefit –More independent problem solving |
| SG1-S19 | The homework given gives us <i>extra practice of the topic without any help</i> so that we will be able to understand the topic better and be able to answer questions based on the topic, in tests or exams. | |
| SG1-S37 | With the homework given, I have discovered different methods and terms of math which <i>gives me better confidence and courage when learning math.</i> | Long-term academic benefit–Confidence building |
| SG2-S9 | It makes me fully understand the topic at hand after times of practice and only then, would I know how to <i>confidently deal with questions or topics</i> that I'm not really good at–Algebra. | |

SG2-S33 After doing more homework I will *tend to*
feel more confident in that certain topic.

Five teachers who taught the same cohort of Secondary Two mathematics classes completed the teacher survey regarding mathematics homework. The coding of the teachers' responses about the role of homework was done solely by the teacher-researcher. The survey questions concern (a) the teachers' perspectives about the importance of homework; (b) the source of homework; (c) the frequency and amount of individual assignments; (d) the grading of homework assignments; (e) the kind of feedback given for homework assignments; and (f) alternative forms of homework.

(a) ***Teachers' perspectives about the importance of homework.***

The first question of the teacher survey to ascertain teachers' perspectives on the role of homework was:

“Do you think mathematics homework is important for your students? Why?”

All five teachers unanimously think that mathematics homework is important for their students. Table 9 shows the content analysis of the reasons the teachers gave for explaining why homework is important for their students and the inferences drawn. The complete responses of the teachers are shown in the table. The three functions of homework from the perspective of the teachers (Kaur, 2011), which were inferred from the data were as follows:

1. “practice makes perfect”;
2. An extension of the lesson during which students are engaged in individual seatwork;
3. To cultivate a sense of responsibility towards their learning.

Consistent with previous studies (Kaur, 2011; MacBeath & Turner, 1990), it can be observed from the teachers' survey data that “practice makes perfect” is a predominant reason why all five teachers assign their students homework.

(b) ***The source of homework.***

All five teachers usually take their homework questions from textbooks. In addition, the teachers also give homework from other sources which include

assessment books, past-year school examinations questions and O-level national examinations questions.

(c) The frequency and amount of individual assignments.

On the average, the teachers assign homework 2 to 4 times a week. The duration of each piece of assignment ranges from 20 minutes to an hour.

Table 9

Content analysis of the teachers' responses regarding importance of homework

| Teacher | Response | Inference |
|---------|---|---|
| T1 | Yes, homework is important for students' learning for several reasons. First, homework <i>extends students' learning beyond classroom</i> (see inference 2) and helps them to <i>reinforce what was taught in class</i> (see inference 1). Homework serves as a <i>consistent practice</i> (see inference 1) to help students prepare for tests and examinations. | (1) "Practice makes perfect" (2) An extension of the lesson during which students are engaged in individual seatwork |
| T2 | Yes, I think homework is important for my students as homework helps to <i>reinforce their concepts learnt in class</i> (see inference 1). It also allows me to check on their understanding of that topic. As maths concepts are interlinked, by doing their homework, students are <i>revising</i> (see inference 1) and making sure they understood the concepts before moving on to the next topic for the next lesson. It also <i>builds independence and self-discipline</i> (see inference 3) in students when they do their homework. | (3) To cultivate a sense of responsibility towards their learning |
| T3 | Yes. You <i>need to practise Mathematics questions</i> (see inference 1) to understand the different methods / ways to solve the questions. | |
| T4 | Yes, because it helps them to <i>consolidate what they have learnt from the lessons on that topic</i> (see inference 1). The questions selected should also meet the objectives of the lessons being taught. | |
| T5 | Yes, I do think that mathematics homework is important for my students. It is created to help | |

students prepare to learn new mathematical concepts, *practice those that have already been taught* (see inference 1), and explore other math skills. Mathematics homework helps to *reinforce the lessons a student had learnt during the school day* (see inference 1).

(d) *The marking of homework assignments.*

All five teachers marked students' written assignments. Table 10 shows the content analysis of the reasons the teachers gave for grading written homework assignments and the inferences drawn. The collective reasons which were inferred from the data were as follows:

1. checking for students' understanding of mathematics concepts;
2. identifying students' weaknesses/mistakes/misconceptions;
3. rectifying common mistakes/misconceptions.

(e) *The kind of feedback given for homework assignments.*

T1, T2 and T3 practised giving students a score or grade for homework assignments. In addition, all five teachers gave written comments, particularly for mistakes/misconceptions in students' work. Moreover, T4 and T5 mentioned giving general verbal feedback to the whole class.

(f) *Alternative forms of homework*

All the Secondary Two students were given a journal writing task as homework in groups during the first semester of the school year in 2015. T4 occasionally tasked students to consider a particular method in answering a question and to explain the reasoning during the next lesson. T5 did assign students readings from teacher-chosen websites and thereafter journal writing based on what they have learnt from the websites.

Table 10
Content analysis of the teachers' responses regarding grading of homework

| Teacher | Response | Inference |
|---------|--|--|
| T1 | It is important to <i>affirm correct understanding</i> (see inference 1) and <i>point out mistakes students make</i> (see inference 2) so that they can <i>rectify their errors</i> (see inference 3) through corrections. | (1) Checking for students' understanding of mathematics concepts |
| T2 | For foolscap* qns, I will mark to <i>check for their understanding</i> (see inference 1) and <i>identify common mistakes/misconceptions</i> (see inference 2). | (2) Identifying students' weaknesses/mistakes/misconceptions |
| T3 | <i>Some errors can be spotted</i> (see inference 2) and <i>feedbacks will be given to students on how to avoid certain mistakes</i> (see inference 3). By marking the homework, it will help me to <i>understand some areas where the students need help in</i> (see inference 2). | (3) Rectifying common mistakes/misconceptions |
| T4 | <ul style="list-style-type: none"> To see if students have <i>understood how to solve a problem</i> (see inference 1) <i>Gives me feedback on what they can/cannot do</i> (see inference 2) | |
| T5 | The main purpose of marking students' assignment is to <i>see how well each individual student fare (sic) and whether they know how to apply what they had learnt</i> (see inference 1) during the day to solve the questions in their homework. I am also looking into how students present their solutions or how they use different ways of approach to solve the questions. Lastly, it is to <i>look for common errors or misconceptions</i> (see inference 2) so that I can <i>address and rectify the issues</i> (see inference 3) | |

in the class or to the individual students.

Note. *T2 assigned questions taken from textbooks on foolscap paper.

Limitations

Firstly, considering the limited quantity of data collected from five teachers and 70 students in a school, generalisations cannot be made from this study. Given the insufficient level of conclusiveness, the findings in this study may only be used to guide new research initiatives.

Secondly, the coding of items for the nature of homework based on the three-type coding system as well as the SPUR multi-dimensional approach coding was carried out solely by the teacher-researcher. Additionally, the coding of students' and teachers' responses about the role of homework was also done by the teacher-researcher. The reliability of the data coding could be improved with having two or more raters.

Conclusion

In this study, homework is perceived to be instrumental in extending and enhancing students' learning beyond instructional hours. Recalling part of the first principle of teaching which states that "Teaching is for learning; learning is for understanding...", it is foremost crucial to be reminded of the emphasis to foster students' understanding in their learning. Appropriate homework tasks should be selected to foster students' deep understanding. These tasks should not only allow students to think deeply about the key ideas but also to link students' experience in order for them to be able to make sense of the knowledge they possess (Hiebert et al., 1996).

The findings about homework assignments in this study have shown that homework was regularly assigned by the two teachers, T1 and T2, primarily from the textbooks. The homework assignments were mainly of Type I and Type II and the textbook exercise questions were predominantly categorised under the skills and uses dimensions of understanding. Considering the skew

in the types of and dimensions of understanding of homework given, further research could possibly explore a more balanced and quality homework practice. Good practice makes perfect and hence it is vital for students to be engaged in meaningful homework tasks to improve their robustness in understanding.

This study has also shown how both students and teachers have viewed homework as a powerful tool to enhance learning. The positive responses from students about the various functions of homework ascertain the meaningfulness of students doing homework. In addition to the six short-term benefits of homework found in Kaur's study (2011), some students have identified three long-term academic benefits of homework. They include: (1) improved attitude toward mathematics, (2) more independent problem solving and (3) confidence building. Hence, it is critical that teachers select meaningful homework tasks to enhance students' learning effectively. The common teachers' sentiment that 'practice makes perfect' is the main reason for them assigning homework. In fact, it is the case of good practice that makes perfect. Having understood from this study how different nature of homework serves different purposes, it is important for teachers to decipher what comprises good practice for quality homework. It is therefore significant for teachers to be more conscientiously aware of the materials given as mathematics homework and seek to strike a greater balance in the types of and the dimensions of understanding in student homework assignments. Due to the limited sample size of this study, it is not possible to make any generalisations. However, it could serve to provide a basis for future research.

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