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STUDENTS' BELIEFS ABOUT LEARNING MATHEMATICS: SOME FINDINGS FROM THE SOLOMON ISLANDS

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Abstract

Students' beliefs and attitudes can impact on their mathematics learning and performance. Yet, there appears to be minimal literature that deals with the educational implications of this dimension. This paper focuses on the beliefs of Year 12 Solomon Islands students in mathematics learning. The students' beliefs are analysed and themes identified. While most students were in agreement about the beliefs in doing mathematics, there were variations in the students' self-efficacy beliefs. The findings are interpreted in relation to recent writing about students' beliefs towards learning mathematics. The paper will consider the issues arising out of the study and offer suggestions for meeting these challenges.

Keywords

Beliefs, attitudes, mathematics learning, secondary school students, Solomon Islands, implications

Introduction

Mathematics dominates almost every field of our modern society. Every day, citizens all over the world are faced with a complex array of mathematics—from mathematics of business and employment to risks of household accidents. Having a sound understanding of mathematics can help solve some of the problems that we face in our personal and public lives. However, research revealed that the many students believed mathematics to be the most difficult and challenging subject (Ashaari, Judi, Mohamed, & Wook, 2011; Nardi & Steward, 2003). For instance, the findings in Malaysia revealed that the majority of the students found the subject difficult due to their lack of mathematical knowledge, skills and processes (Ashaari, et al., 2011). In many cases, students had the ability to be successful in mathematics, yet believed that they were incapable of success due to obstacles in developing conceptual understanding in mathematics (Beghetto & Baxter, 2012; Tambychik & Meerah, 2010). Students' negative beliefs contribute to many of the difficulties they face in learning mathematics. These negative conceptions diminish students' interest and may have a major impact on their learning and performance (Amirali, 2010; Whitin, 2007).

Mathematics educators (Leder & Grootenboer, 2005; White, Way, Perry, & Southwell, 2006) claim that students' beliefs shape their cognitive and affective elements in learning mathematics. Given the complex ways in which mathematical beliefs, attitudes, skills, and knowledge are intertwined, assessing students' beliefs and attitudes can provide valuable information. The results can be used to guide the development of a classroom environment conducive to growth in positive beliefs and attitudes and in addressing counterproductive beliefs (Tarmizi & Tarmizi, 2010; Whitin, 2007).

The importance of the affective domain in mathematics learning has led to calls for a greater emphasis on this dimension in curricular documents. *Principles and Standards for School Mathematics* (National Council of Teachers of Mathematics, 2000) outlines a range of beliefs and attitudes about mathematics that contribute to productive problem solving and communication. Although the latest curriculum document in the Solomon Islands (Ministry of Education and Human Development, 2010) promotes the development of positive beliefs and attitudes, there is limited

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research on how high school students' view their mathematics learning. This study aimed to address this shortcoming.

The following research questions guided this study:

1. What beliefs and attitudes do selected senior high school students have towards their mathematics learning?
2. What factors do students think have impacted on their beliefs and attitudes towards learning mathematics?

The data reported in this paper comes from the above study (Kele, 2014) and addresses the first research question.

Literature review

According to Leder, Pehkonen and Torner (2002), beliefs constitute individual's knowledge about their opinions, facts, hypothesis, perspectives, conceptions and ideas. Goldin (2002) claimed that beliefs are internal representations whereby individuals attribute truth and validate information based on what they believe, and these beliefs are usually stable. Additionally, beliefs are inbuilt within individuals and can be difficult to change (Ertmer & Ottenbreit-Leftwich, 2010; Schommer-Aiken, 2004). This resonates with views expressed by Sparrow and Hurst (2010, p. 19) who claim that, "once a cycle of negativity is established, it becomes difficult to break it with a positive emotive response". Despite beliefs being stable and intact, Pehkonen and Pietilä (2003) suggested that they are open to change; it depends on the individual's decision to accept such change and adapt to a new set of beliefs.

From the above definitions, beliefs are powerful and can influence individuals' behaviour (Op't Enyde, De Corte, & Verschaffel, 2006) towards their learning. In this study, belief is about making personal meanings and preferences constructed from experiences that individuals consider to be true.

Generally beliefs produce negative consequences (Mason & Scrivani, 2004) for learning and are difficult to change. Therefore, as mathematics educators we need to consider the beliefs of students towards their mathematics learning. Students' beliefs about learning mathematics, their self-efficacy beliefs and their beliefs about utility of mathematics are discussed below.

Students' beliefs about learning mathematics

Students' beliefs about learning mathematics may have a substantial impact on their interest and motivation in mathematics. These beliefs may be assumed to mean how students make sense of mathematics and how they perceive it in a social learning context.

Learning mathematics as sense-making

Sense-making in learning involves constructing meaning, interpreting, reasoning and reflecting ideas from information provided by the teacher and the textbook. Understanding, perseverance, curiosity, confidence and flexible thinking are hallmarks of sense making (Whitin, 2007). In short, having a sound understanding of the concepts, content and processes is vital for making sense of mathematics.

Young-Loveridge and Mills (2010) explored the beliefs, values and attitudes of 64 students in year 5/6 (9 to 11 years-olds) towards their mathematics learning in New Zealand. The authors found that the majority of the students (95%) thought that when working on mathematics problems it was important that their answer made sense to them. In addition, the boys held more positive (100%) views about answers making sense than the girls (91%) did, and a higher proportion of the girls (67%) than boys (61%) believed that knowing why an answer was correct was as important as getting the right answer.

According to Francisco (2013) providing justifications backed by mathematical reasoning is one of the key features for making sense of mathematics. For instance, one student in Francisco's study mentioned that it was not enough just to come up with a solution to a mathematical problem without explaining the strategies for getting the answer. Presenting strategies to justify their own work to their classmates was also an important finding from Young-Loveridge's study (2005). Twenty of the 27 students interviewed in the study had positive beliefs about explaining their own strategies to others.

Social processes in learning mathematics

Social-constructivists believe learning often takes place in social interactions (Jones, Jones, & Vermette, 2010) in which students actively construct their own mathematical knowledge (Lau, Sing, & Hwa 2009). In developing students' mathematical knowledge, it is likely that the teacher and students are part of shared learning to communicate mathematical ideas (Blankstein, 2012).

Students' learning of mathematics occurring during social interactions can promote positive beliefs. Students' beliefs about learning mathematics as a social process was illustrated by Young-Loveridge and Mills's (2010) study. The findings from one of the statements from the questionnaire: *I talk about my ideas in mathematics in a group or with a partner*, revealed that the majority of students (84%) reported that they communicated their mathematical ideas in-group or with their peer(s). The authors affirmed that students had positive views about sharing mathematical ideas with other people. Students recognised that their involvement in small group discussions with other students helped develop their mathematical thinking.

Research indicates that students' views about mathematical processes may vary as a function of socioeconomic status (SES). For example, one study found that some students (mostly low SES) viewed mathematics learning as a private rather than a public activity (Young-Loveridge, Taylor, Sharma, & Hawera, 2006). In contrast to this, others (from medium or high SES schools) recognised the value of mathematical discourse as a tool to construct new understandings (Young-Loveridge, 2005), perhaps because they had engaged in public explanations, questioning and challenging ideas as part of their normal classroom practice.

Students' self-effacy beliefs

The belief about self refers to "student's self-concept and to their confidence and causal attributions in relation to mathematics" (Op't Eynde, De Corte, & Verschaffel, 2002. p. 18). According to McLeod (1994) students' beliefs about the self can be categorised under two areas: academic self-concept beliefs and self-efficacy.

Academic self-concept beliefs

Academic self-concept is an individual's perception of himself/herself (Bong & Skaalvik, 2003) in relation to a learning situation. Research studies showed students with positive self-concept beliefs tended to develop academic motivation, put more effort into their mathematics learning and achieved good results (Marsh, Trautwein, Lüdtke, Köller, & Baumert, 2005; Valentine, Dubois, & Cooper, 2004). Students who saw themselves as successful tended to remain persistent and performed at the expected level of their achievement (Fryer & Elliot, 2012).

However, from negative experiences of learning, some students believed they had low mathematical ability and that their performance was far below that of the high achieving students (Garcia, 2012). These students often found mathematics to be a very difficult subject and attributed their poor performances to a lack of confidence, effort and ability, and to a lack of strategies to successfully complete tasks.

Self-efficacy

Bandura (1983) defines self-efficacy as one's capabilities to organize and execute the course of action required to produce a desired outcome. Self-efficacy requires students to reflect on their skills and capabilities and to gain confidence to successfully accomplish a particular task (Bong & Skaalvik, 2003; Zimmerman, 2000).

Gafoor and Ashraf (2012) argued that everybody has skills and cognitive knowledge but they must be able to use them appropriately to accomplish tasks. According to Marchis (2011) extremely high self-efficacy can be detrimental to students' learning mathematics. Knowing that they have more confidence and capability to know everything, they will be more prone to put less effort into their learning. Hence, the sense of complacency and procrastination can interfere with a student's ability in such cases. Students with very low self-efficacy belief tended to judge themselves to be incompetent for they considered themselves incapable and lacking mathematics knowledge. Bandura (1983) pointed out that these students might run a high risk of potential threats of anxiety and might experience disruptive arousal which will lower their sense of self-efficacy when trying to perform the task skilfully. In addition, Schink, Neale, Pugalee and Cifarelli (2008) attested that less confident students may avoid doing mathematical tasks, whereas those that feel self-efficacious are more willing to participate.

Utility of mathematics

Students who believe in the utility of mathematics perceive it as useful and relevant for present and future lives. Students in both Kloosterman's (2002) and Amirali's (2010) studies showed that they believed that mathematics learnt in school had an important function in the real-world situation. For instance, 34 participants in Year 9 and Year 10 (age range from 14–16 years old) high school students explained that mathematics was helpful for individuals in a society.

The above findings resonates with the findings of Boaler (2002) who stated that students perceived their mathematical knowledge was an important tool for solving everyday problems that required mathematical thinking. Some older students in the Boaler study believed that they expected to apply mathematics knowledge in jobs, sports and banks. However, in Schoenfeld's (1992) study students believed that mathematics learnt in school had little or no relevance with the real world.

It must be noted that most of the studies discussed above were conducted in western countries. It would be interesting to find whether beliefs discussed in literature are artifacts of western culture or they vary across cultures. This study aimed to address this issue.

Method

A mixed-method approach is defined as the "class of research where the researcher mixes or combines quantitative and qualitative research techniques, methods, approaches, concepts or language into a single study" (Johnson & Onwuegbuzie, 2004, p. 17). It is commonly used in mathematics education research because of its remarkable gains of systematically combining quantitative and qualitative research approaches and techniques into a particular study (Cohen, Manion, & Morrison, 2011; Johnson & Christensen, 2008; Lankshear & Knobel, 2004). Hence, the approach provides more comprehensive evidence for studying a particular research problem than either using quantitative or qualitative research alone. For example, researchers have gathered and quantified results of surveys on mathematics tasks in large numbers but have also conducted interviews with smaller number of students. Hypotheses generated about why students were answering survey questions in particular ways were validated in detailed interviews (Kalinowski, Lai, Fidler, & Cumming, 2010).

A mixed-method approach allowed the researcher to choose from a range of data gathering strategies. Three methods of data generation tools used in this study were: written survey, semi-structured interviews, and focus group interviews. Due to space limitations, only data from the written survey are considered in this paper.

Participants

This research was conducted with Year 12 senior students in two Solomon Island high schools. One of the reasons for selecting Year 12 for the study was that Year 12 is the best representative of a secondary level as this is the last level in the secondary school. The researcher could explore the general tendency of secondary students' beliefs towards learning mathematics by engaging them in the study before they ventured into tertiary level. The research was conducted in one urban and one rural school. A total of 107 students participated in the study. Of 107 students, 55 students (21 girls and 34 boys) were from the urban high school and 52 students (25 girls and 27 boys) were from the rural high school. Most of the students were 17 to 19 years old.

Data collection procedure

To investigate students' beliefs towards learning mathematics, a written survey was administered to all students in the study. It was structured with a variety of questions on a four-point Likert Scale; strongly disagree (SD), disagree (D), agree (A) and strongly agree (SD). This written survey consisted of two parts. In part A, there were 21 closed belief statements which are discussed below.

Results and discussion

During the analysis process, effort was made to organize all belief statements into some kind of specific categories to actually configure a type of belief that referred to a particular statement. The following four belief categories with the number of statements are outlined in Table 1.

Table 1: Category name and number of statements for each belief category

	Belief category	*Number of statements*
A	Students' beliefs about doing and knowing mathematics	7
B	Students' beliefs about utility of Mathematics	3
C	Student's beliefs about gender differences	1
D	Students' beliefs about their self-efficacy	10

According to Table 1, category A incorporated seven statements (4, 6, 7, 8, 9, 11 & 20) attributing to *students beliefs about doing and knowing mathematics*. In category B, there are three statements (13, 14 & 15) grouped under *students' beliefs about the utility of mathematics.* These are statements that refer to the belief students perceived in mathematics, which could influence their life during their times at school. Only a single statement (16) was categorized under *gender differences* in category C. This particular statement tries to solicit students' view regarding their belief about gender in learning mathematics. In category D, 10 statements are grouped as *students' beliefs about their self-efficacy in learning mathematics*. This category incorporated statements regarding students' beliefs in their confidence, ability, and effort required of doing mathematics.

Students' beliefs about doing and knowing mathematics

The data for this category (see Table 2) revealed students' positive responses towards knowing and doing mathematics. This was indicated by the percentage of agreement in their responses to the statements. The difference between the genders is shown in italics.

For the highest levels of agreement in Table 2, all boys agreed that doing mathematics required working logically in a step-by-step fashion (100%, statement 4), just 98 % of the girls took this view. All boys believed that learning mathematics was a social process, where they could share mathematics ideas with other pupils (100%, statement 20), and about 98% of the girls had that view. Moreover, nearly all boys believed that when working on mathematics problems their answers must be sensible (95%, statement 9), and 93% of the girls agreed. Doing mathematics allows room for original thinking and creativity was supported (statement 6) by 98% boys and 87% of the girls. More boys (92%) than girls (83%) thought that knowing why an answer is correct is as important as getting the correct answer (statement 8).

As shown in the written survey results, for example, 100% of the students believed that learning mathematics required working logically in a step-by-step fashion (statement 4). Students' beliefs in this study align with data from a recent study (Francisco, 2013) where students identified learning mathematics as a matter of knowing the right procedures, and being able to apply rules accurately. The finding implies that students perceived doing mathematics as having more procedural than conceptual understanding (Kloosterman, 2002).

Table 2: Percentages (rounded to whole numbers) of students who agreed with each statement (showing gender differences)

	Statement	Overall (%)				A or SA (%)		
		SD	D	A	SA	Boys n=61	Girls n=46	*Diff*
4	Doing mathematics is usually a matter of working logically in a step-by-step fashion			43	57	100	98	*2*
6	Doing mathematics allows room for original thinking and creativity		4	50	46	98	87	*11*
7	It is okay for learners to come up with their own ways of solving mathematics problems.	6	17	53	24	72	85	*13*
8	Knowing why an answer is correct in mathematics is just as important as getting the right answer.	1	6	57	36	92	83	*9*
9	When working on a mathematical problem, it is important that your answer makes sense to you.	2	3	34	61	95	93	*2*
11	Learning mathematics involves more thinking than remembering	3	14	30	53	77	89	*12*
20	It is important to explain how I solved a problem to other pupils in class	1		47	52	100	98	*2*

Another major finding is that the majority of the students (99%) considered learning mathematics as a social process. They believed that sharing mathematical ideas with their peers or in their groups as part of the learning process. This finding is consistent with Lee and Johnston-Wilder (2013) who found that students like to work on mathematical ideas in groups.

Students' beliefs about utility of mathematics

Data in Table 3 presents the percentage of students who agreed or disagreed with each statement, and the percentage of students who agreed in terms of gender.

Overall, majority of boys (95%) and girls (87%) had similar beliefs that mathematics helped them to think better (statement 13). Less than three-quarter of boys (62%) and girls (74%) agreed that their relative success in school depended on their mathematical proficiency. Students believed that learning mathematics in school was important. It helped develop their cognitive thinking and ability.

Almost all boys (97%) and girls (91%) thought mathematics was related to many jobs and careers. Moreover, mathematical knowledge was needed in many work places and to prepare them to cope with the real world challenges. With respect to mathematics and the future, it was interesting to see that the majority of students (96%) highly regarded the important role mathematics played in many jobs and careers. Students' beliefs that mathematics is related to everyday experiences is consistent with earlier findings (Beyers, 2011). The high agreement rate implies that many students were aware of the usefulness of mathematics to solve problems in their everyday lives.

Table 3: Percentages (rounded off to whole number) of students who agreed with each statement (showing gender differences).

	Statement	*Overall (%)*				*A or SA (%)*		
		SD	D	A	SA	Boys n=61	Girls n=46	Diff
11	Mathematics helps me learn to think better.	1	7	35	58	95	87	8
12	Mathematics is needed for many jobs and careers.	2	2	44	52	97	91	6
13	To succeed in school, you need to be good in mathematics.	9	22	51	17	62	74	12

Students' beliefs about gender differences

Table 4: Percentages (rounded to whole number) of students who agreed or disagreed with a statement (showing gender differences).

	Statement	*Overall (%)*				*A or SA (%)*		
		SD	D	A	SA	Boys n=61	Girls n=46	Diff
16	Men are better at maths than women	40	38	11	9	23	20	3

The data in Table 4 shows that less than a quarter of students (n=21, 20%) agreed men are better in mathematics than women. Moreover, a slightly similar number of boys (23%) and girls (20%) agreed with this view. However, 78% had a disagreement about the statement. In addition, 40% of the students strongly disagreed. Among this group of students were 46 boys and 36 girls. Only one girl did not respond to this statement.

Students' beliefs about their self-efficacy

Table 5 presents the percentage of students who agreed or disagreed with each statement about self-efficacy in mathematics learning.

The data in Table 5 revealed that students had a high sense of self-efficacious beliefs toward learning mathematics. The majority of students (90%) agreed that mathematics was interesting and they had the kind of mind needed to do more advanced mathematics (statement 2). In addition, more boys (95%) than girls (78%) were interested in mathematics. While 90% of the students thought they never gave up even though mathematics was hard, 10% did not agree (statement 10). Students' beliefs of having confidence in order to be good at mathematics were rated highly by most students (98%, statement 17). About 92% agreed that they were capable of doing mathematics if they had a kind of mathematical mind (statement 21).

Three-quarter of the students (75%) agreed that they did not find mathematics difficult (statement 5). However, more than a quarter (26%) found mathematics difficult so they avoided it whenever possible. Similarly, more students (64%) believed that they were not poor at doing mathematics compared to those who agreed they were poor (36%) (statement 12).

Table 5: Percentages (rounded to whole number) of students who agreed with the self-efficacy belief statements (showing gender differences).

	Statement	Overall (%)				A or SA (%)		
		SD	D	A	SA	Boys n=61	Girls n=46	*Diff*
1	I am good at mathematics and I enjoy the challenge of it.	4	20	54	22	87	59	*28*
2	Learning mathematics is interesting. I have the kind of mind needed to do advanced mathematics.	1	10	43	47	95	78	*17*
3	I feel okay about making mistakes in mathematics. While I am not especially strong at it, I am not fearful of it either.	6	14	39	41	74	85	*11*
5	Maths is difficult for me so I avoid it whenever possible.	30	45	18	8	23	28	*5*
10	When my work in maths is hard I don't give up.	3	7	29	61	95	83	*12*
12	I am very poor at doing mathematics.	23	41	26	10	31	43	*12*
17	To be good at mathematics you need to have confidence you can do it.	2		24	74	98	93	*5*
18	To be good at mathematics, you need to remember formulas, procedures and rules.	1		18	81	100	98	*2*
19	To be good at mathematics you need to work hard at it.	1	5	19	76	95	96	*1*
21	To be good at mathematics you need to have a kind of "mathematical mind".	2	6	37	55	89	93	*5*

Students displayed high self-efficacy in their choices. For example, most of the students (75%) believed that mathematics was not difficult (Statement 5). Similar conclusions were drawn by Young-Loveridge and Mills (2010). Eighty one percent of the students in their study did not find mathematics difficult.

Most students (90%) believed they never give up when encountering difficulty in mathematics (Statement 10). This belief suggests that students who feel self-efficacious are eager to persist longer on difficult tasks and learn more. Beghetto and Baxter (2012) stated that students who feel efficacious about their learning mathematics can see themselves doing well in mathematics lessons despite any difficulty encountered.

Those students who negatively responded to each statement in the written survey need to be facilitated for the development of their positive beliefs towards learning. As noted by Beyers (2011), students' well-formed beliefs with respect to learning mathematics can influence not only their mathematical thinking and performance but also their attitudes and decisions about mathematics in later years.

Limitations of the Study

To address the shortcomings in literature, this study set out to explore high school students' beliefs and attitudes towards their mathematics learning. A number of limitations were encountered in the process of conducting this study, some of these are outlined below.

A small sample size (n=107) was selected for the written survey. It is suggested that the sample size be increased to include students from a range of backgrounds. Additionally, more boys (n=61) than girls (n=46) participated in the written survey.

Due to time constraints, only two schools were chosen for this study. The study focused on Year 12 students hence represented students who had been successful in the Solomon Island context. What about the students who did not get this far? The research could be extended to other schools to address these shortcomings.

The national language in the Solomon Islands is Pijin. Even though the survey questions were written in English and explained to students in Pijin, they may not have been well understood.

Implication of the Study

In spite of the above limitations, the findings provide valuable insights into students' beliefs regarding learning mathematics. The study has an important place in the education system of the Solomon Islands. It has implications for teachers, teacher educators and further research.

Teachers need to be sensitive to the possible effects of negative beliefs and attitudes in mathematics learning. Through continuous reflection on their teaching practices and through ongoing dialogue with their students, teachers can maximise their power to positively influence students' learning and the lessons they teach. Students can be encouraged to make personal reflections on their beliefs and attitudes, anxiety, and performance when learning mathematics. Examples could include using a log book or journaling. From time to time they could review their progress and make improvements where appropriate, and take necessary actions that foster effective and worthwhile learning of mathematics.

The most critical person in any learning environment is the teacher. A number of researchers (Beswick, 2006; White et al, 2006) have highlighted the importance of teachers' own beliefs and attitudes towards mathematics. Teacher educators need to be aware of not only students' mathematical knowledge but also, how the understanding of their own beliefs and attitudes is likely to impact on their pedagogy when teaching the students. Student teachers need opportunities to review, reflect, re-examine their own beliefs and attitudes towards mathematics learning. Teacher educators could use class discussions or statements such as those used in the current study to fuel inquiry into students' perspectives.

The participants in the study were from two schools thus, the findings may or may not generalize to the population of secondary school students as a whole in the Solomon Islands. There is a need for more research with larger, more random samples with different backgrounds to determine how common these beliefs are in the general population.

This study only partially revealed gender differences in mathematics learning because the study only used one statement about gender difference in the written survey. Future research studies could have more statements, and then use interviews to explore this issue in more depth.

Ideally, it would have been good to make links between survey findings and what happened in classrooms. This could have been achieved by doing classroom observations, and by conversing with teachers, enabling the researcher to gain insights into why the students responded in particular ways. Although this was not possible in the present study because of time constraints, such research could throw further light on the issues raised here.

Conclusion

The study found that students have both negative and positive beliefs about learning mathematics. These beliefs can play a vital role in mathematics classrooms. It is important to actually listen to student perspectives to understand what does or does not work for these students in terms of their mathematics learning. There needs to be an awareness of the impact of beliefs in the mathematics classroom. Mathematics teachers may need to review, reflect, re-examine their teaching practices to seek new approaches to improve teaching and learning of mathematics for the development of students' positive mathematical beliefs.

It is hoped that the findings reported in this paper will generate more interest in research with respect to students' beliefs about mathematics and the gender differences that may impact on student learning.

Teachers, teacher educators and researchers need to work together to find better ways to help all students develop positive dispositions.

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