



Bhutanese Pre-service Teachers' Self-Efficacy Beliefs towards Teaching Secondary Mathematics

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Abstract

Prospective teachers' self-efficacy beliefs determine the success of teaching and learning in their future professional practices. Teachers with high self-efficacy are believed to have more confidence and success in teaching as compared to those teachers with low self-efficacy. Thus, this study aimed at examining the Bhutanese pre-service teachers' self-efficacy beliefs towards teaching secondary mathematics. The study employed a survey design within the positivist methodological framework. The study consisted of 81 pre-service teachers who responded to the secondary mathematics teachers' self-efficacy beliefs questionnaire (SMTSEBQ), an abridged version of several past instruments. This instrument assessed their perceived self-efficacy in terms of process standards of school mathematics. Findings of the study revealed that the Bhutanese pre-service teachers generally perceived their self-efficacy beliefs towards teaching mathematics somewhat positively. Comparison of the pre-service teachers' mean scores on the five SMTSEBQ scales in terms of gender revealed that there was a statistically significant difference for problem-solving and reasoning-proof scales. In regard to programme level, there was a statistically significant difference in their self-efficacy beliefs on the four scales, except for the communication scale. The study is distinctive because it is the first study investigating into the pre-service teachers' self-efficacy beliefs towards teaching secondary mathematics in Bhutanese context.

Key words: Self-efficacy, mathematics self-efficacy, problem solving, reasoning and proof, communication, connection, and representation

Introduction

Pre-service teachers' self-efficacy belief has direct implications on their future professional practices in dealing with the school mathematics curriculum. It is generally believed that the teachers with high self-efficacy are usually more confident and successful in teaching secondary mathematics than those with low self-efficacy. The current study examined Bhutanese pre-service teachers' self-efficacy beliefs towards teaching secondary mathematics in reference to five process standards of school mathematics (i.e., problem solving, reasoning and proof, communication, connections, and representation). These process standards determine the effectiveness of implementing the curriculum in the classrooms. The process standards describe ways that students should acquire and use content knowledge, thus these standards are integrated throughout all of the content standards (National Council of Teachers of Mathematics [NCTM], 2000). Hence, the prospective mathematics teachers should be well-oriented and self-confident with these process standards so that they can teach school mathematics curriculum effectively.

Literature argues that pre-service teachers' mathematics self-efficacy influences their mathematics ability, as well as their impact on classroom practices (Beswick, 2006; Cakiroglue, 2008). This implies that having low mathematics self-efficacy may lead to low self-confidence, thereby hindering the actual teaching performance. It is also argued that those students with higher levels of self-efficacy have been found to be more motivated to learn and more likely to persist when presented with challenging tasks (Bandura, 1997). Similarly, Bhutanese prospective teachers are generally believed to have possessed low self-efficacy beliefs towards teaching secondary mathematics, but there is not much study and evidences on it. However, Tshewang et al. (2017) found out that many beginning teachers have experienced a certain dilemma while applying five process standards in teaching school mathematics curriculum.

As teacher educators, the researchers have the role of fostering student teachers' self-motivation and self-efficacy beliefs towards teaching mathematics. If prospective teachers are not able to develop higher self-efficacy beliefs during their training course, this will definitely impact their ability to teach mathematics as full-fledged teachers. Hence, it was felt necessary to examine pre-service teachers' self-efficacy beliefs towards teaching secondary mathematics, which in turn would significantly influence their future professional practices.

Theoretical Perspectives

The current study aimed at investigating Bhutanese pre-service teachers' self-efficacy beliefs towards teaching secondary mathematics, because they have the role towards building their students' mathematical knowledge, skills, and attitudes towards the subject. The theoretical framework of the study delves into the concepts of self-efficacy, mathematics self-efficacy, sources of self-efficacy, and benefits of enhancing teacher self-efficacy, and process standards of mathematics curriculum.

The term 'self-efficacy' in teaching context generally refers to teachers' confidence in their own teaching abilities in their respective subjects (Giles et al., 2016). Bandura (1986) defines self-efficacy as "people's judgment of their capabilities to organize and execute courses of action required to attain designated types of performances" (p. 391). He also argues that people's feelings, thinking and behaviour in regard to things they do is determined by their self-efficacy (Bandura, 1997). These aspects of self-efficacy beliefs constitute the key factors of personal agency and are instrumental to the goals individuals pursue and the control individuals have over their environment (Bandura, 1997). According to May (2009), mathematics self-efficacy is commonly defined as individuals' beliefs or perceptions regarding their mathematics abilities. Giles et al. (2016) and Enochs et al. (2000) explain mathematics teaching self-efficacy as a teacher's beliefs in his or her ability to teach mathematics effectively.

Bandura (1997) identified four main sources of self-efficacy: mastery experiences, vicarious experiences, social persuasion, and physiological states. *Mastery experiences* relate to students' repeated successes in previous mathematics courses which provide them basis to believe that they will succeed in future mathematics studies as well. *Vicarious experiences* refer to students' involvement in observing social models similar to themselves succeeding with particular tasks. Students will feel more confident in mathematics if they see other students they perceive as similar to themselves succeeding in mathematics. *Social persuasion* refers to encouragement, both positive and negative, from peers, teachers, and parents. *Physiological state* refers to the student's physical state such as fatigue, pain, or nausea.

According to Zimmermann et al. (2011), the benefits of enhancing self-efficacy beliefs of prospective mathematics teachers are abound in the literature, the high mathematics teaching self-efficacy has been associated with the positive impacts on student performance. The teacher with high self-efficacy beliefs has been found to possess more beneficial characteristics than those with lower self-efficacy (Giles et al., 2016). Research also found that self-efficacy beliefs affect educational performance through their effects on motivation, achievement, and self-regulation (e.g., Giles et al., 2016). Several achievement studies have also demonstrated that self-efficacy beliefs are positively correlated with academic achievement (e.g., Jinks & Morgan, 1999; Pajares & Schunk, 2000; Zimmerman et al., 1992).

Teacher efficacy is found to relate to a variety of desirable student outcomes, such as achievement and motivation, making teacher efficacy an important factor in high-quality mathematics instruction (Newton et al., 2012). Teachers who dislike mathematics are found to avoid planning or teaching the subject (Trice & Ogden, 1986), while teachers with high teaching mathematics efficacy engage students in inquiry and student centered teaching, which are linked to higher achievement (Swars et al., 2007). Implementation of effective instructional practices in mathematics has been linked to teacher efficacy (Enon, 1995), and highly efficacious teachers are more effective mathematics teachers than teachers with a lower sense of efficacy (Swars, 2005).

Further, Chang (2015) found that fifth-grade mathematics teachers' efficacy significantly influenced both their students' mathematics self-efficacy and mathematical achievement, which was consistent with findings of previous studies linking teacher's mathematical self-efficacy to students' attitudes and abilities (Ashton & Webb, 1986; Rosenholtz, 1989).

The current Bhutanese school mathematics curriculum is guided by standards set by the National Council of Teachers of Mathematics based in United State of America (Curriculum and Professional Support Division, 2005). For teaching and learning of mathematics, the NCTM (2000) explains the five process standards as given below:

Problem solving is the first process standard of school mathematics curriculum. Solving problems is not only a goal of learning mathematics but also a major means of doing so. Students require frequent opportunities to formulate, grapple with, and solve complex problems that involve a significant amount of effort. Mathematical *reasoning and proof* offer powerful ways of developing and expressing insights about a wide range of phenomena. Mathematical *communication* is a way of sharing ideas and clarifying understanding. Through communication, the ideas become objects of reflection, refinement, discussion, and amendment. *Connection* is defined as student's ability to connect mathematical ideas to their everyday life situations and apply them accordingly. Finally, *representation* refers to student's ability to represent mathematical ideas in a variety of ways: pictures, concrete materials, tables, graphs, number and letter symbols and spread sheet displays.

Many past studies in other countries focused on elementary pre-service teachers' self-efficacy beliefs, while there have been a few studies regarding the preparation of secondary teachers in teaching mathematics Ginsburg et al., (2008). To the best of researchers' knowledge, no such study inquiring about prospective teachers' self-efficacy in teaching secondary mathematics has been conducted in Bhutanese contexts. The study of self-efficacy beliefs of the pre-service teachers on process standards of mathematics curriculum can determine their beliefs and confidence in teaching mathematics.

Objectives and Significance

The focus of the current study was on examining pre-service secondary teachers' self-efficacy beliefs towards teaching mathematics in terms of problem solving, reasoning and proof, communication, connections and representation. Its main objectives were to investigate:

1. Pre-service teachers' self-efficacy beliefs towards teaching secondary mathematics; and
2. Gender and programme level difference in their self-efficacy beliefs towards teaching secondary mathematics.

To date, there is no study conducted in Bhutanese contexts, examining pre-service teachers' self-efficacy beliefs towards teaching secondary mathematics. Hence, the study has established the baseline data for assessing the secondary mathematics teachers' self-efficacy beliefs in Bhutanese schools. It is significant in providing insights to teachers, teacher educators, and educational leaders about how teacher self-efficacy beliefs affect secondary mathematics classroom learning atmosphere and student learning outcomes. More importantly, it will be useful in improving strategies and programmes at the pre-service level, which will enhance student teachers' self-efficacy in teaching mathematics.

Research Methods

The study was an investigation of Bhutanese pre-service teachers' perceptions of their self-efficacy beliefs in teaching secondary mathematics. The positivist ontological, epistemological and methodological framework guided the study (Cohen et al., 2000), employing a survey design with the questionnaire as the research tool. The study was situated at one of the teacher education colleges of the Royal University of Bhutan. The population of the study involved 81 student teachers, who were enrolled for the Bachelor of Education (Secondary) programme. It included both male and female student teachers from the three different programme levels, i.e., year 2, year 3, and year 4 B.Ed secondary pre-service teachers at the college.

The pre-service secondary mathematics teachers' self-efficacy beliefs questionnaire (SMTSBQ) was developed, based on the pre-service Science Teaching Efficacy Belief Instrument (STEBI) developed by Enochs and Riggs (1990) and adapted by Ravikumar (1992). In addition, the ideas for developing the instrument were drawn from the Mathematics Self-Efficacy and Anxiety Questionnaire [MSEAQ] (May, 2009), Student and Teacher Questionnaire on Beliefs about Learning and Intelligence (Bonne, 2012), and Teacher Self-efficacy Scale (Bandura, 1986, 1997). However, as and when required the original items of those questionnaires were adapted and modified in order to suit the context of the study. The SMTSBQ questionnaire was administered only once because the study was constrained by the limited timeframe. The instrument was pilot tested before it was finalized for its actual administration.

The survey data gathered through administering the SMTSEBQ questionnaire was analysed and interpreted using both the descriptive and inferential statistics, supported by SPSS Software. Hence, in order to examine the participants' self-efficacy beliefs towards teaching secondary mathematics, the mean and standard deviation for each SMTSEBQ scale were calculated, and these statistics were compared in terms of gender and programme level, and finally drew the conclusion (Koul & Fisher, 2003). The significance of difference in their self-efficacy beliefs in terms of gender and programme level was compared computing the F-test statistic and the partial eta squared statistic for each scale of the SMTSBQ questionnaire.

It is argued that any researcher has ethical obligations to anticipate during data collection, analysis and reporting, and to explain about the study to those studied

(Erickson, 1998). According to Anderson (1998), “the responsibility of ethical research ultimately lies with the individual researcher” (p.17). Hence, the participants’ individual time, rights, privacy, and confidentiality in the process of study were respected (Cohen et al., 2000). The study was conducted only after obtaining written approvals from the College Research Ethics Committee and classroom tutors, and the *informed consent* of all participants were sought prior to data collection.

Data Analysis and Results

The analyses were carried out on the data collected from 81 secondary pre-service teacher participants. The data were processed by being coded to statistical software, SPSS. In analysing the data, the mean and standard deviation, and one-way variance analysis (ANOVA F-test) were computed. In addition, the partial eta² statistic test was conducted to identify magnitude of difference in participants’ views in terms of gender and programme level.

Overall self-efficacy beliefs towards teaching secondary mathematics

In order to gain an overall understanding of pre-service teachers’ self-efficacy beliefs towards teaching secondary mathematics in Bhutanese context, the descriptive statistics (mean and standard deviation) for each SMTSEBQ scale were calculated. For each scale there were five items which were responded on the basis of five-point Likert scale ratings of 1 to 5 (which correspond to ‘Strongly Disagree’, ‘Disagree,’ ‘Not Sure,’ ‘Agree’ and ‘Strongly Agree.’ Table 3 presents the average inter-item mean and standard deviation for the pre-service teachers’ perspectives on each SMTSEBQ scale.

Table 3: Overall scale-wise self-efficacy beliefs of participants

	N	Mean	Std. Deviation
Problem solving	81	3.96	0.50
Reasoning & proof	81	3.84	0.48
Communication	81	4.40	0.46
Connections	81	3.84	0.46
Representation	81	3.96	0.48
Valid N (List-wise)	81		

For the given sample, the communication scale had the highest mean (M = 4.40; SD = 0.46) and the reasoning-proof and connections scales the lowest mean (M = 3.84 each; SD = 0.48 & 0.46). The means for all other scales ranged in between these values. The results suggest that across the items under all the scales, the majority of participants responded with ‘Agree’ or with ‘Neutral’. In other words, the means obtained for each SMTSEBQ scale was very close to 4, indicating that the participants perceived their self-efficacy beliefs towards teaching secondary mathematics somewhat favourably in terms of these scales. The standard deviations for all the five scales were less than 0.50, which suggests that there was not large diversity in pre-service teachers’ self-efficacy beliefs.

The study generally revealed that pre-service teachers have neither very high nor very low self-efficacy beliefs towards teaching mathematics in Bhutan.

Gender differences in pre-service teachers' self-efficacy beliefs

To examine participants' self-efficacy beliefs towards teaching secondary mathematics for each SMTSEBQ scale in terms of gender, the means, standard deviations, and F-test statistic were computed. Table 4 presents the means, standard deviations and F-test values for the five SMTSEBQ scales, and the partial η^2 statistic from ANOVA as a measure of the estimated effect size of male-female difference.

Table 4: Comparison of participants' self-efficacy in terms of gender

<i>Scales</i>	<i>N</i>	<i>Male</i> (<i>n=42</i>)		<i>Female</i> (<i>n=37</i>)		<i>Difference</i>		
		<i>Mean</i>	<i>SD</i>	<i>Mean</i>	<i>SD</i>	<i>F</i>	<i>p</i>	η^2
Problem solving	81	4.10	0.51	3.79	0.44	8.11	0.01*	0.10
Reasoning & proof	81	3.94	0.49	3.71	0.46	4.30	0.04*	0.05
Communication	81	4.46	0.44	4.35	0.49	1.09	0.30	0.01
Connection	81	3.89	0.42	3.78	0.50	1.25	0.27	0.02
Representation	81	4.00	0.43	3.90	0.54	0.83	0.37	0.00
Valid N (list-wise)	81							

* $p < 0.05$ is significant

The results indicate that the male participants perceived their self-efficacy beliefs towards teaching mathematics more favourably than their female counterparts.

This is explained by the male sample means for all the five scales were slightly higher than the female sample means. Male-female mean differences were larger for the scales of problem-solving, and reasoning-proof, and F-test indicates statistically significant differences between male and female's self-efficacy beliefs. When the η^2 statistic from ANOVA was calculated to provide an estimate of the magnitude of the difference between male and female pre-service teachers' perspectives, gender appears to have had a little influence on their views.

Programme level difference in pre-service teachers' self-efficacy beliefs

Pre-service teachers' self-efficacy on the SMTSEBQ scales was also compared in terms of programme level. Table 5 shows the average inter-item means and standard deviations, and F-test statistic values for the five scales. It also shows the effect size (partial η^2) for each of the five SMTSEBQ scales. The programme level difference in pre-service teachers' self-efficacy beliefs on the five SMTSEBQ scales indicated that means were higher for 4th year than 3rd year and for 3rd year than 2nd year. In other words, the 4th

year student teachers had the higher self-efficacy beliefs than those of 3rd year and 2nd year student teachers. One-way analysis of variance (ANOVA) for the differences in student teachers' SEBs in terms of programme level revealed statistically significant differences for *problem-solving, reasoning and proof, and connection and representation*.

Table 5: Comparison of participants' self-efficacy beliefs in terms of programme level

<i>Scales</i>	<i>N</i>	<i>2nd year (n=28)</i>		<i>3rd year (n=24)</i>		<i>4th year (n=29)</i>		<i>Difference</i>		
		<i>Mean</i>	<i>SD</i>	<i>Mean</i>	<i>SD</i>	<i>Mean</i>	<i>SD</i>	<i>F</i>	<i>p</i>	<i>η²</i>
Problem solving	81	3.64	0.48	4.08	0.44	4.17	0.41	11.56	.00*	0.23
Reasoning & proof	81	3.66	0.52	3.81	0.48	4.04	0.37	4.98	.01*	0.11
Communication	81	4.31	0.55	4.51	0.40	4.41	0.41	1.18	.31	0.03
Connection	81	3.65	0.54	3.84	0.44	4.03	0.29	5.30	.01*	0.12
Representation	81	3.65	0.53	4.14	0.36	4.10	0.36	10.72	.00*	0.22
Valid N (list wise)	81									

* $p < 0.05$ is significant

According to Peer and Fraser (2015), the partial η^2 statistic from ANOVA indicates an effect size in terms of the proportion of variance in a dependent variable explained by an independent variable. The effect sizes reported in Table 5 suggest that the programme level generally had little influence on student teachers' SEBs towards teaching mathematics, which gives us clues about what aspects require improvement.

Thus, the results reported clearly reveal that pre-service teachers generally perceived their self-efficacy beliefs towards teaching secondary mathematics somewhat favourably on all the five SMTSEBQ scales. In terms of gender difference, their SEBs was statistically significant on the scales of problem solving and reasoning and proof. In terms of programme level, their SEBs showed a statistically significant difference on problem solving, reasoning and proof, connections, and representation scales. This implies that the 4th year pre-service teachers perceived their SEBs towards teaching secondary mathematics more positively than those of 3rd year and 2nd year pre-service teachers. This can be explained by the fact that the 4th year student teachers are exposed to much more training and experiences (such as school practicum, micro-teaching), knowledge and skills, research and scholarly activities as part of their programmes at the college than the 3rd year and 2nd year students.

Discussions and Conclusion

The purpose of this article is to report on the pre-service teachers' self-efficacy beliefs towards teaching secondary mathematics based on the five SMTSEBQ scales. The results show that the only scale which has the average inter-item mean value of 4.40 is Communication scale and for the other four scales, the mean ranges from 3.84 to 3.96, while the standard deviation for all scales is less than 1. This finding is indicative of the fact that Bhutanese prospective secondary teachers have low self-efficacy belief in most of the process standards, apart from communication standard. This contradicts the findings of many past studies (Dedes, 2008; Doruk & Kaplan, 2012; Temiz, 2012; in Korkmaz & Ünsal, 2016) which revealed that mathematics teachers have high self-efficacy beliefs for teaching. In addition, Ünsal et al. (2016) argue that mathematics teachers stated opinions on having high self-efficacy beliefs concerning the teaching process. This suggests for further improvement of Bhutanese pre-service secondary teachers' self-efficacy beliefs in the process of their professional training at the college.

The results indicate that the male participants perceived their self-efficacy beliefs towards teaching mathematics more favourably than their female counterparts, which is explained by the male sample means for all the five scales which were slightly higher than the female sample means. However, the male-female differences were observed larger for the scales of problem-solving ($F= 8.11, p=.01<.05$), and reasoning-proof ($F= 4.30, p=.04<.05$). Hence, the F-test results indicated statistically significant difference between male and female's self-efficacy belief for these two scales. In line with these findings, there are studies suggesting that self-efficacy differs with regards to gender (Akbulut, 2006; Ünsal et al., 2016).

The findings in regard to programme-level difference in pre-service teachers' self-efficacy beliefs towards teaching secondary mathematics on the five scales of the SMTSEBQ indicated that the 4th year student teachers had higher SEBs than those of 3rd year and 2nd year student teachers. Furthermore, the one-way analysis of variance (ANOVA) test results revealed that there is a statistically significant difference for the scales of *problem-solving* ($F= 4.30, p=.04<.05$), *reasoning and proof* ($F= 4.30, p=.04<.05$), *connections* ($F= 4.30, p=.04<.05$) and *representation* ($F=4.30, p=.04<.05$). This finding suggests that the programme level has educationally significant influence on their SEBs towards teaching secondary mathematics. In other words, professional seniority variable affects pre-service teachers' perspectives on their self-efficacy beliefs concerning the teaching process. Similarly, several past studies argue that mathematics teachers' teaching process self-efficacy beliefs increase as their professional experiences increase (Ünsal et al., 2016; Fives & Buehl, 2010).

Overall, the participants in this study displayed somewhat high self-efficacy towards teaching secondary mathematics. However, this study reinforces the need to enhance Bhutanese prospective teachers' SEBs in terms of using five process standards of teaching mathematics. It may be facilitated by offering various professional development opportunities to pre-service teachers pertaining to school mathematics curriculum. Creating opportunities for them to interact with the curriculum experts would also boost their SEBs towards teaching mathematics, which may contribute to maximising the learning potential for students in mathematics. In addition, teacher educators concerned must be responsible to enhance their student teachers' self-efficacy in teaching mathematics. To this effect, teacher educators can reflect on this

study to understand the gap that exists between the pre-service teachers' SEBs and their future professional practices which ultimately implicates the student learning in mathematics.

Competing interests

"Authors declared no competing interests exist."

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