Journal of Education and Practice
ISSN 2222-1735 (Paper) ISSN 2222-288X (Online)
Vol.7, No.14, 2016

Pre-service Teachers' Mathematics Self-efficacy and Mathematics Teaching Self-efficacy

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Abstract
Pre-service mathematics teachers' mathematics self-efficacy and mathematics teaching self-efficacy were investigated in this study. The purpose was to determine the confidence levels of their self-efficacy in mathematics and mathematics teaching. Also, the study was aimed at finding whether their mathematics self-efficacy and teaching self-efficacy were related. The participants were 49 pre-service mathematics teachers who were in their final year of training in the University. The mathematics self-efficacy items were adopted from Han, et al (2015) and May (2009), while the mathematics teaching self-efficacy items were those used by Khale (2008) and Gavora (2010). The findings of the study revealed that pre-service mathematics teachers had above average confidence levels in both MSE and MTSE. The study also revealed that the pre-service mathematics teachers' MSE and MTSE were significantly related.
Keywords: Mathematics self-efficacy, Teaching self-efficacy, Pre-service teachers

1. Introduction

People have little or no incentive to act if they do not believe that they possess abilities to bring about desired results (Usher & Pajares, 2009). The belief or perception that an individual has about his/her abilities to carry out certain tasks motivates them. Self-efficacy means the belief in one's potentialities. Gavora (2010) defined self-efficacy as one's conviction about their capabilities to carry out certain tasks in a suitable and effective manner. Han, Liou-Mark, Yu and Zeng (2015) defined self-efficacy as one's belief or perception about one's capability to perform at a certain level on a task. Self-efficacy is the individual's conviction or confidence that they can successfully accomplish given tasks at designated level (Schunk, 1991). Although, Usher and Pajares (2009) posited that one's beliefs about his ability are not identical to beliefs about the likely outcomes that one's action will produce, nonetheless the outcomes one expects are largely dependent on one's judgments of what he can accomplish.

Having high level of self-efficacy about one's ability is important as it motivates one to succeed in life. Researchers in education have been conducting self-efficacy studies over the last four decade (e.g. Bandura, 1977). Educational studies on self-efficacy have their bases from the theory of Bandura. According to Bandura (1997), self-efficacy beliefs influence one's ways of thinking and feelings, which may enable or hinder actions. This means if an individual has high self-efficacy level about his abilities, it would push him to venture into greater exploits, while low self-efficacy level will lead to inactivity and nonperformance.

Bandura (1997) defined mathematics self-efficacy as one's beliefs or perceptions with respect to their abilities in mathematics. Mathematics self-efficacy is one's conviction or confidence in their abilities to solve problems in mathematics. Ferla, Valcke and Cai (2015) posited that mathematics self-efficacy indicates individual's self perceived confidence to successfully accomplish a particular mathematics task. Research (e.g. Pajares & Graham, 1999; Zeldin, Britner & Pajares, 2008) has shown that pre-service teachers with high levels of self-efficacy tend to be more motivated to learn than their peers and are more likely to persist when presented with challenges.

1.1 Teacher's mathematics self-efficacy and mathematics teaching self-efficacy

In educational context, teacher self-efficacy is the teacher's personal beliefs in his ability to plan and execute instructional objectives in mathematics successfully. This is the confidence the teacher has in his capability to perform tasks in mathematics. Teacher's mathematics self-efficacy is different from teacher competence. Teacher competence concerns teacher professional knowledge and skills, while teacher self- efficacy is a wider concept. Teacher self-efficacy goes beyond just having professional knowledge and skills; it is also the belief that one has the capability to put his professional knowledge and skills into action. Gavora (2010) pointed out that teacher's high self-efficacy enables him to use his professional knowledge and skills successfully. Which means low mathematics self-efficacy may inhibit the use of professional knowledge and skills, and which may affect students' learning negatively. Gavora stressed that a powerful self-regulatory attribute that enables teachers to use their potentials to enhance students' understanding is teacher self-efficacy. In fact, Gavora (2010) asserted:

> It should be acknowledged that teacher self-efficacy is related to "perseverance;" the stronger the self-efficacy, the greater the perseverance -- and the greater the perseverance, the greater the likelihood that the teaching behaviors will be successful, (p. 18).

This shows how important teacher self-efficacy is, not only to the teacher himself but to the students as well. Having high sense of self-efficacy is an essential motivator to the individual. Han, Liou-Mark, Yu and Zeng (2015) cited Bandura as saying:

> Students with high sense of self-efficacy exhibit strong motivation and approach difficulties as challenges to be mastered; whereas students with low sense of self-efficacy exhibit weak commitment and approach difficulties as threats and with anxiety, (p. 2).

Similarly, teachers with high sense of self-efficacy show such strong motivation. This is so, as high mathematics self-efficacy affects positively teachers' attitudes and behaviors towards mathematics (Han, et al, 2015).

Mathematics teaching self-efficacy is the belief or perception of an individual in their abilities to teach mathematics successfully. Gavora (2010) opined that individual differences in teacher effectiveness may be as the result of teaching self-efficacy. Gavora further pointed out that high sense of teaching self-efficacy is related to positive teaching behavior. Research has indicated that high self-efficacious teachers are more likely to use effective methods in their teaching. Students learn more from teachers who have high self-efficacy. Teachers with high mathematics teaching self-efficacy are always ready to accept new ideas, exhibit willingness to embrace innovations (Henson, 2001), are less likely to experience stress, believe in the freedom of students to a greater extent (Brouwers & Tomic, 2003) and pay more attention to low ability students (Ross & Bruce, 2007). Teachers with high teaching self-efficacy display greater interest and commitment for teaching and are more likely to remain in the teaching profession (Tschannen-Moram & Hoy, 2001).

Mathematics teaching self-efficacy is about how teachers influence students positively to foster success in mathematics and reduce anxiety and negative beliefs about mathematics (Kahle, 2008). Researchers have shown the need for teacher self-efficacy and teaching self-efficacy and how they affect the types of learning environment in a classroom (Kahle, 2008). Understanding the beliefs or perceptions of teachers about their abilities is essential to improving their professional training (Pajares, 1992). Bandura (1993) said, "Teachers' beliefs in their personal efficacy to motivate and promote learning affect the types of learning environment they create and the level of academic progress their students achieve" (p. 117). Research has shown teacher teaching self-efficacy affects teacher's choice of instructional method and classroom environment, which in turn affect both student learning and student self-efficacy (e.g. Siegle & McCoach, 2007; Kahle, 2008). It means students' learning of mathematics can be affected either positively or negatively, depending on whether the teacher has high or low sense of mathematics teaching self-efficacy.

Unlu and Ertekin (2013) conducted a study on the relationship between mathematics teaching self-efficacy and mathematics self-efficacy of 144 pre-service elementary mathematics teachers. The study indicated high performance on both scales by the participants; and also there was significant positive relationship between mathematics teaching self-efficacy and mathematics self-efficacy of the pre-service elementary mathematics teachers. Similarly, Khale (2008) conducted a study on how elementary school teachers' mathematics self-efficacy and mathematics teaching self-efficacy relate to conceptually and procedurally oriented teaching practices. One of the objectives of the study was to examine relationship between mathematics self-efficacy and mathematics teaching self-efficacy. The participants were 75 elementary school teachers. The findings of the study showed that mathematics self-efficacy and mathematics teaching self-efficacy were strongly related.

Esterly (2003) examined pre-service and novice elementary mathematics teachers' teaching efficacy and mathematics epistemological beliefs. Sixty pre-service elementary teachers took part in the study, and the results revealed that mathematics self-efficacy predicted mathematics teaching efficacy.

A study by Siegle and McCoach (2007) on increasing student mathematics self-efficacy through teacher training indicated significant relationship between mathematics self-efficacy and mathematics achievement. Also, Liu and Koirala (2009) studied the effect of mathematics self-efficacy on mathematics achievement of high school students. The study aimed at investigating whether mathematics self-efficacy could predict mathematics achievement, and the findings showed positive relationship between mathematics self-efficacy and mathematics achievement of high school students.

1.2 Statement of the problem

It has been shown from the review of the literature that high sense of mathematics self-efficacy and mathematics teaching self-efficacy are essential constructs, and they positively influence teachers' attitudes and behaviors to teaching. Teachers with high sense of mathematics self-efficacy and mathematics teaching self-efficacy are said to be efficient and effective in teaching. It has also been pointed out that understanding the beliefs of teachers about their capabilities helps to improve their professional training. The problem for this study was to investigate the relationship between mathematics self-efficacy and mathematics teaching self-efficacy of pre-service mathematics teachers. To what extent are the mathematics self-efficacy and mathematics teaching self-efficacy of pre-service mathematics teachers related? This is the focus of this study.

1.3 Purpose of the study

The main purpose of this study was to investigate the relationship between mathematics self-efficacy and mathematics teaching self-efficacy of pre-service mathematics teachers. Specifically, the study aimed at:

1. Determining the confidence level of mathematics self-efficacy of pre-service mathematics teachers.
2. Determining the confidence level of mathematics teaching self-efficacy of pre-service mathematics teachers.
3. Determining the relationship between mathematics self-efficacy and mathematics teaching self-efficacy of pre-service mathematics teachers.

1.4 Research Questions

The following research questions were formulated to guide the study:

1. What is the confidence level of mathematics self-efficacy of pre-service mathematics teachers?
2. What is the confidence level of mathematics teaching self-efficacy of pre-service mathematics teachers?
3. Are mathematics self-efficacy and mathematics teaching self-efficacy of pre-service mathematics teachers related?

1.5 Hypothesis

The following hypothesis was tested at 0.05 level of confidence:

H0: There is no significant relationship between the mean scores of mathematics self-efficacy and mathematics teaching self-efficacy of pre-service mathematics teachers.

2. Methodology

2.1 Research design

The survey method was used in collecting data from the participants. The quantitative methods were employed in addressing the independent variables of mathematics self-efficacy and mathematics teaching self-efficacy.

2.2 Participants

The participants in this study were pre-service teachers undergoing training as prospective secondary school teachers. The participants were in their final year of training, and had participated twice in teaching practice as part of their professional training. The participants were 49 in number.

2.3 Data collection Instrument

Two instruments were used for data collection in this study. The instruments are Mathematics Self-efficacy (MSE), and Mathematics Teaching Self-efficacy (MTSE). The MSE instrument is a 10-item questionnaire. The first five items were adopted from Han, Liou-Mark, Yu and Zeng (2015). They used these items to assess the mathematics self-efficacy of undergraduates. The last five items were the items used by May (2009) to assess college students mathematics self-efficacy. The MSE instrument is based on a 5-point scale with 1 indicating strongly disagree and 5 indicating strongly agree. Sample items are shown in Table 1.

The MTSE instrument is also a 10-item questionnaire. The first seven items are from the study by Kahle (2008); the first five items were adopted while items 6 and7 were slightly modified to suit this study. In fact, these two items were changed from negative to positive statements, so that higher score would indicate higher sense of mathematics teaching self-efficacy. Items 8-10 were adapted from Gavora (2010). The items were slightly modified to address Mathematics teaching self-efficacy. The MTSE questionnaire is based on a 5-point scale. The respondents were to indicate their level of confidence from 'strongly disagree' to 'strongly agree'. Sample items are shown in Table 2.

Table 1. Sample of mathematics self-efficacy items

1.	I am certain, I can understand the ideas taught in the mathematics course	**SD D U A SA**
2.	I expect to do well in the mathematics class	**SD D U A SA**
3.	I am sure I can do an excellent job on the problems and tasks assigned in the mathematics class	**SD D U A SA**

Table 2. Sample of mathematics teaching self-efficacy items

1.	I will continually find better ways to teach mathematics	**SD D U A SA**
2.	I know how to teach mathematics concepts effectively	**SD D U A SA**
3.	I understand mathematics concepts well enough to be effective in teaching secondary mathematics	**SD D U A SA**

2.4 Data collection method

Data were obtained through the administration of the instruments to the participants of this study. The instruments were administered by the researchers themselves. All the 49 participants responded to the items in the two questionnaires and returned same.

2.5 Methods of data analysis

Descriptive and inferential statistical tools were used to analyze the data obtained. Descriptive statistical tools were employed in answering research questions 1 and 2, while research question 3 was answered using co relational statistics.

3.0 Results

Research question one: What is the confidence level of mathematics self-efficacy of pre-service mathematics teachers? To answer this research question, the participants were administered questionnaire on mathematics self-efficacy scale, and their responses were analyzed using descriptive statistics. The results of the analysis are presented in Table 1. When the mean response of the participants on an item is 3 or above, it indicates that majority of the participants have high level of confidence on the item. From the table, it can be seen that mean responses of individual items are all above the value 3.0. And, also the grand mean responses of the participants on all the items on the mathematics self-efficacy questionnaire is 4.04 (see Table 1). This revealed the pre-service mathematics teachers' level of confidence. Therefore, it indicates that pre-service mathematics teachers have high level of confidence in mathematics self-efficacy.

Table 3. Means and standard deviations of mathematics self-efficacy of pre-service teachers

S/N	Item	N=49	Mean	SD
1	I am certain, I can understand the ideas taught in the mathematics course		3.90	0.54
2	I expect to do well in the mathematics class		4.24	0.68
3	I am sure I can do an excellent job on the problems and tasks assigned in the mathematics class		4.08	0.63
4	I think I will receive a good grade in the mathematics course		4.02	0.65
5	I know that I will be able to learn the material presented in the mathematics class		4.33	0.74
6	I feel confident when taking a mathematics test		3.77	0.81
7	I feel confident when using mathematics outside school		3.92	0.98
8	I am sure I will be able to do well in future mathematics courses		4.27	0.63
9	I am sure I am the kind of person who is good at mathematics		4.02	0.84
10	I feel confident enough to ask questions in my mathematics class		3.88	1.00
	Grand mean and standard deviation		**4.04**	**0.17**

Research question two: What is the confidence level of mathematics teaching self-efficacy of pre-service mathematics teachers? To answer this research question, data were obtained through administering questionnaire items on mathematics teaching self-efficacy to the pre-service mathematics teachers. The data collected were analyzed and presented in Table 2. The table shows that the mean response of each item on this scale is above the value 3.00. This revealed that majority of the participants have some level of confidence in the individual items. On the overall items, the grand mean response is 4.22 with a standard deviation of 0.22. This again, indicates that the pre-service mathematics teachers have high level of confidence on mathematics teaching self-efficacy.

Table 4. Means and standard deviations of mathematics teaching self-efficacy of pre-service teachers

S/N	Item	N=49	Mean	SD
1	I will continually find better ways to teach mathematics		4.35	0.77
2	I know how to teach mathematics concepts effectively		3.92	0.75
3	I understand mathematics concepts well enough to be effective in teaching secondary mathematics		4.04	0.67
4	I understand mathematics concepts well enough to be effective in teaching secondary mathematics		4.22	0.65
5	When teaching mathematics, I will usually welcome students' questions		4.47	0.64
6	I will find it easy to use manipulative to explain to students why mathematics works		3.83	0.99
7	I believe I have the necessary skills to teach mathematics		4.16	0.65
8	When a student has difficulty understanding a mathematics concept, I believe I can help the student understand it better		4.35	0.55
9	I am confident, I can help students master new concepts in mathematics		4.41	0.56
10	I feel I will be able to improve students' achievement in mathematics through various methods of teaching		4.49	0.61
	Grand mean response and standard deviation		**4.22**	**0.22**

Research question three: Are mathematics self-efficacy and mathematics teaching self-efficacy of pre-service mathematics teachers related? To answer this question, Pearson product- moment correlation coefficient was calculated, and it is as shown in Table 3. This indicates a positive relation between mathematics self-efficacy and mathematics teaching self-efficacy of the pre-service mathematics teachers. To further ascertain whether the relationship is significant, the following hypothesis was tested at 0.05 confidence level.

H0: There is no significant relationship between the mean responses of mathematics self-efficacy and mathematics teaching self-efficacy of pre-service mathematics teachers.

This value r = .521, $p<0.05$, was found to be significant. Therefore, there is significant relationship between the mathematics self-efficacy and mathematics teaching self-efficacy of pre-service mathematics teachers.

Table 5: Pearson product-moment correlations between mathematics self-efficacy and mathematics teaching self-efficacy of pre-service teachers

Variables	1	2
1.Mathematics Self-efficacy	-	.521*
2.Mathematics Teaching Self-efficacy	.521*	-

4.0 Discussion and Conclusion

The findings of the study revealed that pre-service mathematics teachers have high level of mathematics self-efficacy and mathematics teaching self-efficacy. These findings are in agreement with findings of Unlu and Ertekin (2013), Khale (2008) and Esterly (2003). Another important finding of this study is the positive relationship that existed between pre-service mathematics teachers' mathematics self-efficacy and mathematics teaching self-efficacy. In other words, the conviction that the teachers have in their ability to do mathematics correlated positively with the belief in their capability to teach mathematics. This finding is in line with previous studies (e.g. Esterly, 2003; Khale, 2008; Unlu & Ertekin, 2013). In fact, Khale (2008) and Unlu and Ertekin (2013) reported strong relation between the two constructs. Similarly, Esterly (2003) reported that mathematics self-efficacy accounted for mathematics teaching self-efficacy. The results also indicated that the pre-service mathematics teachers' scores in mathematics teaching self-efficacy were generally higher than their scores in mathematics self-efficacy. This can be noticed from the mean scores of the individual items in the teaching self-efficacy scale. Unlu and Ertekin (2013) reported similar findings.

However, the item on the ability to use manipulative to explain to students how mathematics works, received the least mean score relative to others. There is therefore, the need to pay much more attention to the

use of instructional materials in teaching mathematics during teacher training programs. It is also suggested that interview be part of methods for data collection in future research of this kind. This would reveal more of the pre-service teachers' beliefs of their potentials towards mathematics and mathematics teaching efficacy.

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