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Effect of a Reform-Based Mathematics Method Courses on Pre-Service Teachers' Mathematics Teaching Efficacy Beliefs

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Abstract

Teaching efficacy beliefs have been the focus of teacher education studies for some decades as one of the most important factors affecting teachers' behaviours, attitudes and effectiveness. The study sought to use quantitative study to investigate the effect of methods of teaching mathematics course on the pre- service teachers' teaching efficacy beliefs in Akatsi College of Education. The questionnaire for the study made use of Mathematics Teaching. The purpose of this quantitative study was to investigate the effect of methods of teaching mathematics course on the elementary pre-service mathematics teachers' mathematics teaching efficacy beliefs in Turkey. Mathematics Teaching Efficacy Belief Instrument was administered to 172 junior elementary mathematics education students as pre-test and post-test prior to and after the methods of teaching mathematics course. The course was carried out through demonstrations, direct instructions and classroom discussions during 14 weeks. The values indicated that the distributions of the pretest and posttest scores, and gain scores for the whole group for PMTE and MTOE were approximately normally distributed. Paired sample t-tests were used to analyze the data and indicated that the methods of teaching mathematics course significantly increased the preservice teachers' mathematics teaching efficacy beliefs. Consequently, it was recommended that further research should involve knowledge of content teaching fractions, so that pre-service teachers' knowledge of content for teaching fraction, rather than allowing them to rate themselves on their beliefs without the actual test.

Keywords: Pre-Service Mathematics Teacher, Mathematics Teaching Efficacy Belief, Methods Of Teaching Mathematics Course

1.0 INTRODUCTION

The conversation about highly qualified teachers is generally focused on knowledge of content (Ball, Hill, & Bass, 2005).; however, an important factor that is often overlooked in the discourse on highly qualified teachers' beliefs about teaching mathematics and students' ability to learn mathematics (Charalambous, Panaoura, & Philippou, 2009). Teachers' self-efficacy beliefs start forming upon entering their teacher education programs and continue to develop throughout their first few years of teaching. They then remain relatively stable for the remainder of their teaching careers. Teachers' self-efficacy beliefs have been shown to influence teachers' teaching behaviors, and students' academic achievement (McCampbell (2014). In addition, changes in classroom roles and approaches to teaching mathematics frequently challenge preservice teachers' beliefs about mathematics (Brian, Jacqueline, Kathleen, & Steve, 2013).

In order to provide quality teacher education, the National Teachers' Standards (NTS) which provide Ghanaian teachers with the range of practical competencies, skills, knowledge and values to deliver high-quality education (MOE, 2017). However, McKinney (2015) observed that the demand of standards does not only puts a new emphasis on the mathematical knowledge for teaching needed by pre-service teachers but also on the teachers' beliefs of their capability to be able to address these new standards. The National Council for Teachers of Mathematics (2014) also asserted that "students' understanding of mathematics, their ability to use it to solve problems, and their confidence in, and disposition toward mathematics are all shaped by the teaching they encounter in school" (p. 16-17). This places an enormous responsibility on teacher preparation programs to ensure that elementary teachers are equipped with research-based best practices that foster high-levels of self-efficacy and self-efficacy in teaching mathematics.

Meanwhile, several researchers have attempted to explain why participation in mathematics methods courses leads to positive gains in pre-service teacher's sense of self-efficacy and beliefs. For example, Turner, Cruz, and Papakonstantinou (2004) argued that such courses not only argument

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teachers' feelings of confidence for teaching mathematics but also expose them to many opportunities for masterly experiences as well as verbal and social persuasion.

Other researchers have also documented the efficacy of mathematics methods courses in changing teacher self-efficacy beliefs and confidence levels. For example, Wilkins and Brand (2004) found that pre-service teachers who participated in mathematics methods course "changed their beliefs in a way that was more consistent with current mathematics education reform and also changed their sense of self-efficacy in a positive way" (p. 231). It is also clear from the responses that practical nature of the mathematics methods courses positively influenced the beliefs of pre-service teachers in their ability to teach mathematics, though their self-rating scores on teaching efficacy showed that majority of the teachers are yet to achieve full confidence to teach mathematics due to lack of actual field experience.

Velthuis, Fisser and Pieters (2014) statistically revealed that the impact of mathematics methods courses on pre-service teachers' self-efficacy was significant at the 5% confidence level (t=5.427 with *p*-value <.001), with the estimated regression coefficient for mathematics showing that the self-efficacy of the teachers increased by 7.293 when they participated in the mathematics methodology courses. Velthuis et al. (2014) argued that methods course is more effective than content courses in reinforcing the self-efficacy and teaching efficacy of elementary pre-service teachers as they aspire to instruct teachers on the skills and competencies needed to teach the particular subject, "such as relevant teaching strategies, assessment of students' science [or mathematics] knowledge and application of classroom management techniques" (p. 447). Bleicher (2004) found that professional methods course is more practical in the application of masterly experiences, leading to significant gains in teacher's self-efficacy beliefs.

Similarly, Ozder (2011) reported that mathematics methods course impact positively on elementary pre-service teachers' self-efficacy is welcome based on the available evidence showing that teachers with high self-efficacy beliefs are more capable of using instructional strategies effectively, more capable of ensuring student participation, and more successful in classroom management skills. However, a study by Palmer (2006) found that pre-service teachers can gain confidence directly from success in understanding content and pedagogy, meaning that significant increases in self-efficacy could still be attained through cognitive content masterly as well as cognitive pedagogical masterly

Albayrak and Unal (2011) investigated the effect of methods of teaching mathematics course on the elementary pre-service mathematics teachers' mathematics teaching efficacy beliefs. The researcher administered Mathematics Teaching Efficacy Belief questionnaire to 172 junior elementary mathematics education students as pre-test and post-test prior to and after the methods of teaching mathematics course. Paired sample t-tests were used to analyze the data collected which indicated that the methods of teaching mathematics teaching efficacy beliefs.

Brian, Jacqueline, Kathleen and Steve (2013) studied the influence reform-based Mathematics Method course has on pre-service teachers' beliefs. Twenty-five (25) pre-service-teachers took part in the study. The study used qualitative method. It was found in this qualitative case study that preservice teachers' beliefs about teaching mathematics to students were changed after teachers taught brief sample lessons to their peers and watched video episodes of quality teaching. These findings suggest that preservice teacher beliefs can be positively changed after taking reform-based mathematics methods courses.

1.1 Beliefs and Knowledge

Previous researches are not always consistent on the distinction between knowledge and beliefs. Some researchers explained that there is little difference between knowledge and beliefs (Calderhead, 1996) and the two are hard to separate (Friedrichsen & Dana, 2003). Pajares (1992) claims that "knowledge and beliefs are inextricably intertwined" (p. 325). Grossman, Wilson and Shulman (1993) observed that teachers "treat their beliefs as knowledge" (p. 31). Richardson (1996) sees little difference between the use of knowledge and beliefs in the teacher and teacher education literature. While other researchers continued trying to separate knowledge from beliefs, some researchers suggested four features that can be used to distinguish beliefs from knowledge: existential presumption, alternativity, affective and evaluative and episodic structure (Calderhead, 1996; Nespor, 1987; Pajares, 1992). The first of these features is existential presumption, which is truth that one holds as deeply personal. Existential

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presumptions represent reality to an individual. These beliefs are considered unchangeable. They are beliefs that just exist. The second feature is alternativity. Alternativity refers to an individual creating an alternative environment, though the environment may not exist in reality, but the created environment does represent the ideal environment to that individual. The third feature of beliefs is affective and evaluative loading. Affective and evaluative loading refers to the idea that beliefs are based more on affective bases than knowledge, which tends to have a more objective base (Grossman, Wilson, & Shulman, 1993).

Some researchers continue to try to separate beliefs from knowledge. In an effort to study beliefs by themselves, Raymond (1997) tries to separate knowledge and beliefs in her research. She concludes that knowledge, beliefs and practice contain links that cannot be separated. These researchers have all recognized that knowledge and beliefs are woven together, which agrees with the Comprehensive Framework for Teacher Knowledge model suggested by Ronau and Taylor (2008). Their model suggests that all aspects are connected in some fashion and therefore cannot be taught in isolation. The evaluative aspect of this feature refers to the idea that many beliefs are based on judgments and evaluations of individuals or situations. The fourth feature of beliefs is episodic structure. Episodic structure refers to how beliefs are stored in memory. This feature suggests that beliefs are stored as episodes or situations that occurred in the past and continue to be used as a basis for a particular belief. Another view on differentiating between beliefs and knowledge is put forth by Beswick. Beswick (2007) takes the view that beliefs are "distinguishable from knowledge only in terms of the degree of consensus they attract as a result of the quality and quantity of evidence upon which they are based and their power to make sense of the world" (P. 96).

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1.3 Problem Statement

Ghana implemented a teacher education reform in 2004 which saw the introduction of content and methodology (PCK) courses which are taught and examined separately in order to equip pre-service teachers with mathematical knowledge for teaching. However, following decades of change in initial teacher education, there is concern in Ghana about institutions are preparing future generation of teachers to face the challenge of the 21st century. This concern emanated from that fact that many teachers lack adequate skill when they come out of training (Agbenyega & Deku, 2011). As part of Ghana's quest for Transforming Teacher Education and Learning (T-TEL) a four year Government of Ghana programme supported by the UK Department for International Development(DFID) conducted a longitudinal study from 2015 to 2017 and found that the current curriculum in teacher is weighted heavily towards subjectcontent knowledge to the detriment of curriculum space for developing understanding of pedagogy and practical classroom teaching skills, a situation referred to as 'academic drift'(MOE, 2017).

In line with equipping pre-service with the prerequisite PCK, the National Teachers Standards recommended the development of MKT through blending content and pedagogical activities. However other researchers argued strongly that presenting content and instructional practices in a blended format affect the development of MKT more than addressing the concepts individually (Auslander, Smith, Smith, Hart, & Carothers, 2016; Hoover, Mosvold, Ball, Lai, 2016; Son & Lee, 2016). Hoy recommended that the concept of teacher efficacy beliefs with other dimensions of effective teaching practices should be investigated and findings used for enhancing teacher education programs. Therefore, this study seeks to

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find out whether method courses in mathematics have effect on teacher efficacy pre-service teachers in Akatsi College of Education.

1.4 Purpose of the Study

The findings of the study will settle the debate on whether teaching mathematics methodology courses significantly increase the pre-service teachers' mathematics teaching efficacy.

1.5 Research Question

- 1. What is extent do pre-service mathematics teachers' make gain in their beliefs following their participation mathematics method course?
- 2. What extent do Mathematics Method Courses have effect on pre-service teachers' mathematics teachers' efficacy beliefs?

1.6 Definition of Terms

Mathematics Teaching Outcome Expectancy: Teacher's belief on effective teaching and its connection to student learning (Swars & Dooley, 2010).

Personal Mathematics Teacher Efficacy: Personal mathematics teacher efficacy is a teacher's belief in his or her ability to be an effective teacher of mathematics (Swars & Dooley, 2010).

Mathematics Teaching Methods Course: The Methods of Mathematics Teaching course is a last year course in the mathematics teacher education program. The general goal of the course was to make pre-service teachers understand mathematics concepts and the ideas behind the standard algorithms, rules and formulas and get insight about how to teach a particular mathematical topic (Seviş, 2008).

1.7 Theoretical Framework

This research study is informed by Vygotsky's (1987) sociocultural theory which purports that collective and individual processes are directly related (Cobb & Yackel, 1996). In this case, if an instructor guide learning and enculturation, students are taught the skills and concepts they need to function and become productive citizens in society (Vygotsky, 1987). Thus, learning is understood as a process of "enculturation into a community of practice" (Cobb, 1994, p. 13). Community of practice is a set of ideas developed to strengthen preservice teachers' mathematics identity.

Meanwhile, mathematics identity is one's belief about "(a) ability to do mathematics, (b) the significance of mathematical knowledge, (c) the opportunities and barriers to enter mathematics fields, and (d) the motivation and persistence needed to obtain mathematics knowledge" (Martin, 2000, p. 19). Many of the preservice teachers we have taught had negative experiences with many of their own mathematics teachers and/or the content. The basis for this study is that most of these preservice teachers did not fully understand the mathematics and were fearful of teaching it. Since both 'identity and awareness mediate action and pedagogy' (Gonzalez, 2009, p. 23), attending to identity, there will be attention on preservice teachers' beliefs about teaching and learning mathematics and their roles as teachers of mathematics (Gonzalez, 2009).

2.0 METHODOLOGY

2.1 Methods

The design of this quantitative study was a single- group pre-test-post-test pre-experimental design. In this type of design, one group of subjects is given a pre-test, then the treatment and then the post-test. Pre-test and post-test are the same but given at different time. In most of the Colleges of Education in Ghana, a packet programme is implemented where method of teaching mathematics classes is compulsory to attend. For this reason, there was no opportunity to assign participants into control or experimental groups by random selection, and single group pre-test-post-test pre-design was carried out by researchers. The Mathematics Teacher Efficacy Belief Instrument (MTEBI) was administered to a

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group of pre-service elementary mathematics teachers, attending method of teaching mathematics course, at the first week of the first semester and the last week of the second semester as a post test.

2.2 Participants and ethical issues

In this study the population consisted of the pre-service teachers enrolled in the undergraduate Mathematics program in Akatsi College of Education. Participants included in the study were level 300 pre-service teachers and the group consisted of 78 female and 94 male students who attended a three-credit mathematics method course during the semester for 14-weeks. The pre-service teachers had preceded some content mathematics courses and background studies before the mathematics method course. Participating in the study were purposively selected. Students' consents were sought orally, none of the students refused to participate in the study. They were also informed that it was not obligatory to reveal their identity while answering the questionnaire.

2.3 Instrument

The instrument used in this study was Mathematics Teaching Efficacy Belief Instrument (MTEBI) had been developed by Enochs et al. (2000). The instrument consisted of 21 items. It was found to be valid and had factorial validity through confirmatory factor analysis. MTEBI has two subscales as Personal Mathematics Teaching Efficacy (PMTE) and Mathematics Teaching Outcome Expectancy (MTOE). The Personal Mathematics Teaching Efficacy instrument is a 13-item questionnaire while Mathematics Teaching Outcome Expectancy (MTOE) instrument is an 8- item questionnaire. In the PMTE scale, preservice teachers' beliefs in their capabilities of being effective mathematics teachers and in the MTOE scale, pre-service teachers' belief that teaching enables student learning. The PMTE and MTOE instruments are based on a 4-point scale with 1 indicating strongly disagree and 5 indicating strongly agree.

Respondents were asked to indicate their levels of agreement with the various items under each section on a four-point scale (1 = strongly disagree, 2 = disagree, 3 =agree, 4= strongly agree). The scores were interpreted as follows: one is the lowest possible score which represents a negative perception, while four is the highest possible score which represent a very strong positive perception. On the scale of 1 to 4, 2.5 being the median, when the mean is above 2.5 it implies the perception exists, but when the mean is below 2.5, it implies the perception does not exist

2.4 Data Collection Procedure

The researchers administered the questionnaires to the students having explained the purpose of the study and the sampling techniques. The respondents were given enough time to complete the questionnaire. All retrieved questionnaires were adequately completed and were found usable for the study.

2.4 Data Analysis

The data collected were organized and analyzed using statistical tools such as mean, standard deviation.

3.0 RESULTS AND FINDINGS

What gains do pre-service teachers' make in their Personal Mathematics Teaching Efficacy (PMTE) and Mathematics Teaching Outcome Expectancy (MTOE) after taking a mathematics method course?

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Table 2.1: Mean	PMTE	and	MTOE	scores	on	MTEBI
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Variable	Pre-test	Post-test	Gain (Posttest- Pretest)
PMTE			
Ν	120	120	120
Mean	29.52	30.68	1.16
Standard Deviation	2.13	2.65	0.52
Skewness	0.073	-0.148	-0.221
MTOE			
Ν	120	120	120
Mean	21.650	25.450	3.8
Standard Deviation	1.658	1.729	0.07
Skewness	0.226	0.279	0. 505

Table 21: Protect Posttast and Gain Scores for the Whole Group

As shown in Table 2.1, while pre-service elementary mathematics teachers have a mean score of 29.5167 (SD = 2.13) on the pretest, their mean score in the posttest is 30.68 (SD = 2.65) out of 120 for PMTE. Thus, the average gain scores of pre-service mathematics teachers are found as 1.16 (SD = 0.52). This gain score constitutes 0.97% of 120, the highest possible score in the test. A standard deviation of (SD = 0.52) revealed clearly that they do not differ in their perception about their ability to be effective teacher of mathematics. Table 2.1 revealed a negative coefficient of skewness (Sk = -0.221) which showed that the distribution is skewed to the left with the mean < median < mode indicating a very high belief of being effective teachers of mathematics.

For MTOE pre-service elementary mathematics teachers have a mean score of 21.65 (SD = 1.66) on the pretest, their mean score in the posttest is 25.45 (SD = 1.73) out of 120. the average gain scores of pre-service mathematics teachers are found as 3.8 (SD = 0.07). This gain score constitutes 3.2% of 120, the highest possible score in the test. With regard to the minimum score, the pretest (18) went up to 22 in the posttest. The increase in the maximum score from pretest to posttest was also not so large that it. Those values indicated that the distributions of the pretest and posttest scores, and gain scores for the whole group for PMTE and MTOE are approximately normally distributed.

A standard deviation of (SD = 0.07) revealed clearly that they do not differ in their perception about their belief of effective teaching and its connection to student learning. Table 2.1 revealed a positive coefficient of skewness (Sk = 0.505) which showed that the distribution is skewed to the right with the mean > median > mode also indicating that majority of pre-service teachers held similar beliefs of carrying effective teaching and connecting it to student learning.

F	Positiest Score	S(N = 120)						
				95% CI				
	М	SD	SEM	Lower	Upper	t	df	p(.05)
PMTE Pre-test Post-test	-1.167	1.911	0.174	-1.512	-0.821	-6.687	119	0.00
MTOE Pre-test Post-test	-3.800	1.274	0.116	-4.030	-3.570	-32.670	119	0.00

Table 2.2: Paired Sample T-Tests for All Assessed Variables Comparing Pretest and Deathart Conreg (N = 120)

It was seen that there was a difference between the mean scores of the pre-service teachers' prior to and after the Mathematics Method course. In order to determine whether this difference between the pre-test and post-test scores of the pre-service teachers attending Mathematics Method course with

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respect to MTEBI were significant, paired sample t-test were implemented, as the scores were distributed normally. The findings in Table 2.2 revealed that there was a significant difference between the pre-test and post-test scores with respect to Personal Mathematics Teaching Efficacy, PMTE (t (119) = -6.687, p=.00) and Mathematics Teaching Outcome Expectancy, MTOE (t (119) = -32.670, p = .00) subscales from paired sample t-test analysis. This implies that Mathematics Method course had a significant positive effect on the elementary pre-service mathematics teachers' mathematics teaching efficacy.

3.0 DISCUSSION AND CONCLUSION

The quantitative study conducted applied a single group pre-experimental design to explore the effects of Mathematics Method Course on the teaching efficacy of pre-service mathematics teachers. The finding of the study showed that pre-service teachers had high mathematics teaching efficacy beliefs after attending Mathematics Method courses changed the mathematics teaching efficacy of them. The values indicated that the distributions of the pretest and posttest scores, and gain scores for the whole group for PMTE and MTOE are approximately normally distributed. A standard deviation of (SD = 0.07) revealed clearly that they do not differ in their perception about their belief of effective teaching and its connection to student learning. Table 2.1 revealed a positive coefficient of skewness (Sk = 0.505) which showed that the distribution is skewed to the right with the mean > median > mode also indicating that majority of pre-service teachers held similar beliefs of carrying effective teaching and connecting it to student learning.

The findings in Table 3 revealed that there was a significant difference between the pre-test and post-test scores with respect to Personal Mathematics Teaching Efficacy, PMTE (t (119) = -6.687, p= .00) and Mathematics Teaching Outcome Expectancy, MTOE (t (119) = -32.670, p= .00) subscales from paired sample t-test analysis. This finding revealed that Mathematics Method course had a significant positive effect on the elementary pre-service mathematics teachers' mathematics teaching efficacy. However, no analysis was done to determine which aspects of the course caused the changes in efficacy beliefs, and also whether change has really resulted from the Mathematics Method course solely. The findings are consistent with previous studies on effects of methods on efficacy beliefs of pre-service teachers (Albayrak and Unal (2011), Bleicher (2004), Ozder (2011), Palmer (2006), Velthuis et al. (2014)

Recommendations

Based on the findings and conclusions, the following recommendation were made:

- According to Cakiroglu (2008) teaching efficacy are opened to changes in the early phases of learning to change. Therefore, frantic efforts should be made to increase the level pre-service teachers' efficacy.
- The reasons why some pre-service teachers have high self-efficacy whereas others have low should be investigated.
- further research should be conducted to test pre-service teachers' knowledge of content and teaching is assessed to confirm their confidence in content knowledge of teaching, rather than allowing them to rate themselves without the actual test.

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