

Comparative Study on Pre-Service Science Teachers' Self-Efficacy Beliefs of Teaching in Kenya and the United States of America; USA

Catherine M. Aurah^{1,*}, Tom J. McConnell²

¹Department of Science and Mathematics Education, Masinde Muliro University of Science and Technology (MMUST), Kakamega, Kenya

²Ball State University, Department of Biology, University Way, Muncie, IN, USA

*Corresponding author: cataurah@yahoo.com

Received March 27, 2014; Revised April 09, 2014; Accepted April 09, 2014

Abstract This study examined and compared science teacher efficacy beliefs of elementary pre-service teachers in Kenya and U.S.A. by surveying 168 Kenyan and 189 US Pre-service teachers through a cross-sectional survey research design. Data were collected using STEBI-B scale, an inventory developed by Enochs and Riggs (1990), with a reported Cronbach's Alpha coefficients as 0.90 and 0.76 for Personal Science Teacher Efficacy (PSTE) and Science Teacher Outcome Expectancy (STOE), respectively. Data were analysed both descriptively (means and standard deviations) and inferentially using a 2 x 2 factorial MANOVA. The dependent variables were PSTE and STOE scores. The independent variables were participant gender and country of origin. Results indicate a significant interaction between gender and country. There was a significant main effect for country but not for gender. With a significant MANOVA, follow-up univariate ANOVA tests indicated a statistically significant difference in the PSTE with USA scoring higher on average and a significant difference in the STOE score with Kenya scoring higher. Implications for teacher education programs are discussed.

Keywords: *self-efficacy, science education, teacher education*

Cite This Article: Catherine M. Aurah, and Tom J. McConnell, "Comparative Study on Pre-Service Science Teachers' Self-Efficacy Beliefs of Teaching in Kenya and the United States of America; USA." *American Journal of Educational Research*, vol. 2, no. 4 (2014): 233-239. doi: 10.12691/education-2-4-9.

1. Introduction

Since the introduction of the concept of self-efficacy to the literature, there has been a growing interest to discover the impact of self-efficacy beliefs in science education. Bandura describes self-efficacy as "People's judgments of their capabilities to organize and execute courses of action required to attain designated types of performances" (Bandura, 1986, p. 391). According to Bandura, 1997, "teacher efficacy," which is sometimes called "teaching efficacy", refers to teachers' beliefs about their ability to influence student outcomes. Efficacy beliefs determine to what extent people will try to cope with the situation as well as how much time they will spend on the action. Naturally, people tend to choose tasks about which they have high self-efficacy beliefs (Bandura, 1994). This means that people's self-efficacy beliefs help us to predict their motivation and choice. Teacher efficacy is also often divided into outcome expectancies and efficacy expectancies.

Extensive research has been conducted in this area and a long history of evidence exists suggesting a positive correlation between efficacy beliefs and teacher behavior, both for general and science teaching efficacy beliefs. Research, for example, has demonstrated that teachers

with low general teaching efficacy beliefs expect students to fail and place the responsibility for learning entirely on the student rather than the teacher (Ashton, 1984; Ashton & Webb, 1986). In addition, teachers with high general teaching efficacy beliefs have been shown to (a) spend less time engaged in discussion unrelated to the objectives of a lesson (Gibson & Dembo, 1984); (b) be more open to new ideas and more willing to try new instructional techniques (Allinder, 1994; Guskey, 1988; Scribner, 1999; Tschannen-Moran & McMaster, 2009); (c) employ a larger amount of planning and organization for their lessons (Allinder, 1994); (d) have greater enthusiasm for teaching (Allinder, 1994); and (e) are more committed to teaching as a profession (Caprara, Barbaranelli, Steca, & Malone, 2006; Coldarci, 1992; Klassen & Chiu, 2010). In the last twenty five years, teachers' efficacy beliefs, their relation with teachers' instruction and students' learning have been analyzed in many studies (Allinder, 1994; Tschannen-Moran, Hoy, & Hoy, 1998; Wheatley, 2005; Cakiroglu, Cakiroglu & Boone, 2005; Gencer & Cakiroglu, 2007; Tschannen-Moran & Woolfolk Hoy, 2007). Results show that a positive correlation exists between the level of science teaching efficacy beliefs and effective science teaching practices, and that the increase of pre-service teachers' science teaching self-efficacy has been promoted as a primary goal of science teacher education (Brand & Wilkins, 2007). More research indicates that students

generally learn more from teachers with high self-efficacy than those students would learn from those teachers whose self – efficacy is low (Cakiroglu et al., 2005).

The construct of science teaching efficacy beliefs, introduced by Riggs and Enochs (1990), is different from general teaching efficacy beliefs in that it refers specifically to beliefs about the level of confidence individuals have in their ability to influence student learning related to science. Similar to general teaching efficacy beliefs, this construct is composed of two specific types of beliefs: Personal Science Teaching Efficacy (PSTE) and Science Teaching Outcome Expectancy (STOE). The *PSTE* refers to a teacher's belief in his or her own ability to effectively teach science, while *STOE* reflects the extent of a teacher's belief that, if teachers provide appropriate science instruction, then their students will learn. A number of science education researchers have examined various factors that contribute to personal science teaching self-efficacy (e.g., Balunuz, Jarrett, & Bulunuz, 2001; Cakiroglu & Boone, 2002; Cantrell, Young, & Moore, 2003; Palmer, 2006; Rice & Roychoudhury, 2003). Findings revealed that pre-service teachers' beliefs about science and science teaching and learning were a limiting factor to their development as teachers in elementary pre-service methods courses. Therefore, it is important to determine pre-service teachers' self-efficacy beliefs in teaching due to the fact that they will be teachers in the future (Cakiroglu, et al., 2005). According to Pajares, (1992) and Philipp (2007), beliefs play a critical role in influencing the instructional practices of teachers. Therefore, if we are to improve the way that science is taught at both elementary and secondary school, we must understand which beliefs, and how these beliefs, impact the ways in which teachers implement instructional strategies in their science lessons?

Worthy to note is that it is difficult to make changes in self-efficacy after the establishment of beliefs (Bandura, 1997); therefore, pre-service teachers' self-efficacy beliefs should be examined while undergoing training. The case is of utmost importance in elementary education because elementary teachers are expected to teach all subjects in their classrooms, but it is highly unlikely that they are equally well prepared to teach all of those subjects. More often than not, they are not competent enough to teach science subjects. It has been repeatedly cited that elementary teachers' negative beliefs about science had resulted in a science anxiety, poor attitudes toward science, and in an unwillingness or hesitancy to spend time for teaching science (Brand & Wilkins, 2007). Similarly, many teachers are reported to dislike, fear, and fail to understand science. These findings lead to the conclusion that some elementary teachers' negative attitudes toward science negatively affect their science teaching self-efficacy beliefs, which eventually leads to ineffective science instruction. Furthermore, it is imperative that we underscore the contextual underpinnings of self-efficacy beliefs before we can make any generalizations. Science is a universal discipline. If one were to teach a science topic in the United States, it is exactly the same content he/she would teach in Kenya, except for using local examples to emphasize concepts. An exhaustive search of the literature did not reveal research or data on teachers' self-efficacy beliefs regarding teaching of science in developing countries such as Kenya.

Gender has been found to be related to teacher self-efficacy beliefs. A number of research studies have devoted to this relationship (Betz & Hackett, 1997; Britner & Pajares, 2001; Britner & Pajares, 2006; Pajares, 1997, Kupermintz, 2002; Lau & Roeser, 2002; Rayburn, 2009; Zeldin, Britner, & Pajares, 2008). Bandura (1986) argued that self-efficacy is related to gender role- playing because it is a key motivational factor that underpinned gender behavior. Research conducted in the field of mathematics and science, reveals that males and females have different experiences and differences in their self-efficacy throughout their education (Simpkins, Davis-Keen, & Eccles, 2006; Wright & Holttum, 2010). Pajares (2005) believes that there is a developmental trend in which females' confidence in their math and science ability becomes significantly lower than males' confidence in their math and science ability as they get older. Additionally, there is a difference between males and females' view regarding their future performance in mathematics and science related careers. Females are believed to perceive their success in mathematics and science courses to be lower than males, and consequently, fewer women choose to major in fields related to mathematics and science once they reach college or even after graduation from college (Betz & Hackett, 1997; Britner & Pajares, 2001; Britner & Pajares, 2006; Pajares, 1997, Kupermintz, 2002; Lau & Roeser, 2002; Rayburn, 2009; Zeldin, Britner, & Pajares, 2008). Thus, teachers' efficacy beliefs are important component for understanding gender differences in experiences related to mathematics and science education.

Much of the research about gender differences in science education has addressed the differences between males and females on issues, such as teachers' leadership positions, classroom behavior, teaching expectations and practices, students participation and achievement gaps (Brickhouse, Lowery, & Schultz, 2000; Brotman & Moore, 2008; Kahle, 2004; Scantebury, & Bakerf, 2007). Little work has specifically considered gender differences in science teachers' self-efficacy, as viewed from pre-service elementary science teachers themselves, especially in Kenya. The present study tried to attend to such a gap that has been untouched by the above reviewed research studies by exploring teachers' self efficacy as it relates to country of origin and their gender.

Therefore this study examined self-efficacy beliefs through a lens based initially in an overarching social cognitive learning theory (Bandura, 1982, 2001), further developed for the examination of teacher behavior by Gibson and Dembo (1984) and of teachers of science by Riggs and Enochs (1990). The aim was to tease out any patterns that may be as a result of context. The findings of this study may reveal possible differences and similarities between students of these two different countries with respect to science teacher efficacy beliefs.

1.1. Purpose of Study

While extensive research has been conducted to examine pre-service teachers' efficacy beliefs in science in United States, there is little work which has been carried out concerning pre-service teachers' efficacy beliefs regarding science teaching in Kenya. Furthermore, no research has been done comparing how Kenyan pre-

service teachers' efficacy beliefs in science teaching might compare to their peers in United States. The purpose of this study was to compare pre-service teachers' self-efficacy beliefs among Kenyan and US pre-service elementary teachers.

1.2. Research Questions

This study was guided by two main questions.

1. How will science teacher self-efficacy beliefs differ between Kenyan and US pre-service elementary teachers?
2. Do self-efficacy beliefs vary with gender?

2. Materials and Methods

2.1. Research Design

This study adopted a cross-sectional survey method. This design was deemed appropriate since the purpose of this study was descriptive, in the form of a survey. There was no hypothesis as such, but the aim was to describe the samples with respect to self-efficacy beliefs.

2.2. Participants

A total of 357 participants were purposively sampled for this study. (USA; $n = 189$ (52.9%) and Kenya; $n = 168$ (47.1%); male = 205 (57.4%); female = 152 (42.6%)). The participants were Pre-service teachers, of an average age of 22 years. In terms of ethnicity, the samples had White/Caucasian, $n = 181$ (50.7%), Black/African American, $n = 171$ (47.9); Asian/Pacific Islander, $n = 1$ (0.3%), Native American Indian, $n = 2$ (0.6%) and Others $n = 2$ (0.6%).

2.3. Instruments

Science Teaching Efficacy Belief Instrument (STEBI-B) developed by Enochs and Riggs (1990) was used to collect data. It is a five-point Likert type instrument whereby 1 = Strongly disagree, 2 = disagree, 3 = Not sure, 4 = Agree and 5 = strongly agree. Personal Science Teaching Efficacy (PSTE) and Science Teaching Outcome Expectancy (STOE) are two sub-scales of the STEBI-B.

"If students are underachieving in science, it is most likely due to ineffective science teaching", "The teacher is generally responsible for the achievement of students in science" and "The inadequacy of a student's science background can be overcome by good teaching" are example items from STOE subscale while "I know the steps necessary to teach science concepts effectively" and "I understand science concepts well enough to be effective in teaching science" are items from PSTE subscale.

PSTE has 13 items while STOE has 10 items. The scales include some negative items, so they were reversed during analysis. After reversing the negative items, high score in PSTE indicates high self-efficacy in science teaching. Similarly, high score in STOE means high outcome expectancy for science teaching. Scores in PSTE range between 13 and 65 whereas the scores for STOE range from 10 to 50. Enochs and Riggs (1990) informed of the Cronbach's Alpha coefficients as .90 and .76 for PSTE and STOE, respectively.

2.4. Data Collection Procedures

Data in USA were collected between the months of March through April, 2012 using an online survey via IQSIT. The participants were invited via an e-mail. In Kenya, data were collected through administering of the surveys to pre-service teachers in their intact classes during the spring semester, 2012. In both samples, participants filled informed consent forms prior to the study.

2.5. Data Analysis

Descriptive analysis was conducted to examine the measures of central tendency (mean) and dispersion (standard deviation). Means and standard deviations for the dependent measures (PSTE and STOE) and gender are reported. A 2X2 Factorial MANOVA was conducted to examine the difference in participants' gender and country of origin on the participants' science efficacy beliefs. The general purpose of multivariate analysis of variance (MANOVA) is to determine whether multiple levels of independent variables on their own or in combination with one another have an effect on the dependent variables. In this study, there were two dependent variables (PSTE and STOE) as well as two independent variables each at two levels; gender (male vs. female) and country (Kenya vs. USA). MANOVA assumptions were tested for Multivariate Normality, homogeneity of variance-covariance matrix, and equality of error variance of dependent variable(s) across groups.

3. Results

3.1. Statistical Assumptions

The Shapiro-Wilks test was used to test univariate normality for each dependent variable (PSTE and STOE), which in turn gave insight to the multivariate normality assumption. Shapiro-Wilks test was used in this study because the dataset was less than 2000. In this study the assumption was met for STOE ($w = 0.993$, $p = 0.090$) meaning that the STOE data were Normally distributed. PSTE data were non-normal ($w = 0.981$, $p < 0.001$). However, MANOVA is robust to violations of multivariate normality if groups are of nearly equal size (N of the largest group is no more than 1.5 times the N of the smallest group). In this study, N for Kenya = 168 and N for USA = 189. The result of the Box's M test showed that homogeneity of variance covariance matrix assumption was met for the analysis, $F(9, .907) = 0.518$, $p > .05$. Levene's test assesses whether the null hypothesis that indicates error variance of the dependent variable is equal across groups. Levene's test results are presented in Table 1.

Table 1. Results for Test of Homogeneity of Variances

	F	df1	df2	Sig.
Personal Science Teaching Efficacy	1.901	3	353	.129
Science Teaching Outcome Expectancy	.845	3	353	.470

As can be seen, the assumption was observed to have been met for both dependent variables ($p > 0.05$).

3.2. Descriptive Statistics

The results of the descriptive analyses demonstrated a range of 27 to 53 on the PSTE score (possible range of 13 - 65) and a range of 20 – 49 on the STOE score (possible range of 10 - 50) and no evidence of ceiling or floor effects ($M = 36.91$, $SD = 4.352$ for PSTE and $M = 35.56$, $SD = 4.480$ for STOE).

Table 2. Descriptive Statistics

Country	Gender	N	Personal Science Teaching Efficacy		Science Teaching Outcome Expectancy	
			M	SD	M	SD
Kenya	Female	92	34.76	4.101	37.46	4.199
	Male	76	37.53	4.881	38.89	4.304
	Total	168	36.01	4.666	38.11	4.295
US	Female	60	38.57	3.839	34.07	4.464
	Male	129	37.29	3.870	32.93	3.918
	Total	189	37.70	3.896	33.29	4.122

Table 3. Results of 2 x 2 Factorial MANOVA Test

Source	Multivariate			Univariate					
	F ^a	p-value	η ²	PSTE			STOE		
				F ^a	p-value	η ²	F ^a	p-value	η ²
Country	64.870	0.000	0.269	15.320	0.000	0.042	103.967	0.000	0.228
GEND	1.323	0.268	0.007	45.520	2.633	0.007	0.107	0.744	0.000
Country * GEND	12.421	0.000	0.066	19.540	0.000	0.052	7.884	0.005	0.022

Results indicate a significant interaction between gender (male and female) and country (Kenya and U.S.A (Wilks' Lambda = .934, $F = 12.421$, $p < 0.001$, $\eta^2 = 0.066$). Approximately 6% of the variance in science teacher efficacy beliefs is explained by the interactive effects of gender and country. This is a medium effect. There was a significant main effect for country (Wilks' Lambda=.731, $F=64.870$, $p<.001$, $\eta^2=.269$), but not a significant main effect for gender (Wilks' Lambda=.993, $F=1.323$, $p=.268$, $\eta^2=.007$). Approximately 27% of the variance in science teacher efficacy beliefs is explained by the country of origin, a large effect according to Cohen's (1988) guidelines, indicative of the importance of cultural context in self-efficacy. To further examine the differences between the countries, univariate follow-up procedures were conducted to determine differences in the individual dependent variables. Results are reported in Table 3.

The results indicated that there was a statistically significant difference in the PSTE ($F=15.320$, $p<.001$, eta squared, $\eta^2 = 0.042$) with USA scoring higher on average. This means that these pre-service elementary teachers in the USA had significantly more positive beliefs in their own ability to influence student learning in science than their peers in Kenya. Although the difference was statistically significant, the effect size was found to be small ($\eta^2 = .042$)

There was also significant difference in the STOE ($F=103.967$, $p < 0.001$, $\eta^2 = 0.228$), with Kenya scoring higher than USA. This means that these pre-service elementary teachers in Kenya had significantly more belief that student learning in science can be influenced by their effective teaching than their peers in USA. This difference was both statistically significant and substantive owed to the large effect size ($\eta^2 = 0.228$). Furthermore, univariate follow-up with regards to significant interaction between gender and country revealed significant difference for both PSTE ($F=19.540$,

The means and standard deviations by gender and country are reported in Table 2.

Further exploration of means by country and by gender revealed that Kenyan participants had higher scores on STOE ($M = 38.11$ compared to $M = 33.29$ for US)) while US participants scored higher on PSTE ($M = 37.70$ compared to $M = 36.01$ for Kenya). For gender, females tended to show higher scores on STOE ($M = 36.12$ compared to $M = 35.14$ for males) while males were better on PSTE ($M = 37.38$ compared to $M = 36.27$ for females) (Table 2).

3.3. Primary Results

When there are two levels of an independent variable, all multivariate test statistics are equal to each other; therefore, Wilks' Lambda was chosen in order to test the significance. Results are reported in Table 3.

$p < .001$, $\eta^2 = 0.052$) and STOE ($F=7.884$, $p = 0.005$, $\eta^2 = 0.022$).

To determine the specific conditions that dictate whether country is significantly related to dependent variables, and to gain an understanding of the overall pattern of the interaction, simple slopes were graphically plotted. Visual inspection of the slopes for both PSTE and STOE reveals the slopes are not parallel, an indication of a significant interaction. The simple slopes revealed that female students in USA show higher personal science teacher efficacy scores than their counterparts in Kenya (Figure 1). However, male students in Kenya outperform female students as indicated by a wider "spread" while in US, the female students outshine the male students on PSTE. Female teachers in US may possess more personal efficacy possibly because they can more easily adjust to each student than male teachers can.

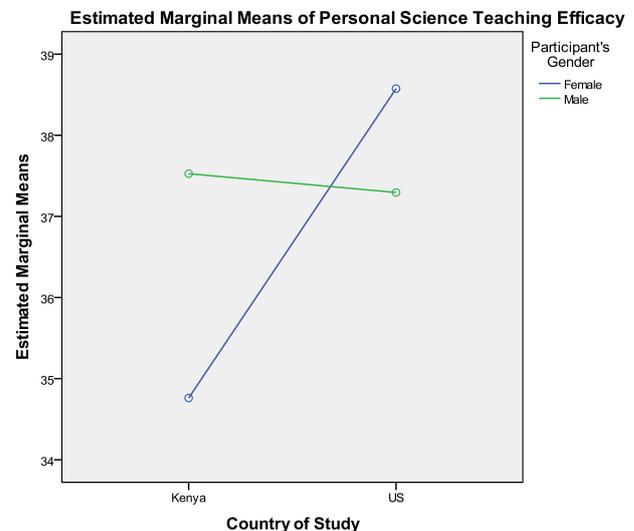


Figure 1. Simple Plot for Interaction Effects between Country and Gender on PST

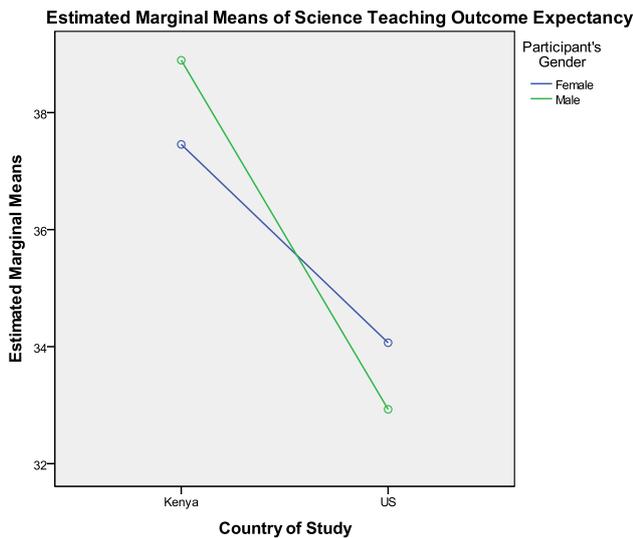


Figure 2. Simple Plot for Interaction Effects between Country and Gender on STOE

The simple slopes for STOE indicate that both male and female students in Kenya show higher science teaching outcome expectancy than their counterparts in USA (Figure 2). Furthermore, in Kenya, male students in Kenya outperform female students while in US female students have higher STOE than their male counterparts. However, in both cases the slopes show minimal spread, meaning that the differences are minimal.

4. Discussion and Conclusions

Research on teacher efficacy beliefs has expanded in order to both broaden and deepen our understanding of the construct of teacher efficacy. Studies evaluating cultural comparisons of teacher efficacy suggest that teachers in different cultures may vary in degree to which they believe themselves to be efficacious in their teaching (Campbell, 1996; Cakiroglu, 2005; Lin, 2002). The present study has been tried to determine the differences in teacher efficacy level between Kenya and US pre-service elementary science teachers. Specifically, the study investigated the relationship between science teacher efficacy in both dimensions and two variables (Gender and country). The cross-cultural comparison illustrated a significant interaction between gender and country whereby female students in USA showed higher personal science teacher efficacy scores than their counterparts in Kenya as seen in the significant interaction. It is said that personal teaching efficacy is closely related to classroom management skills.

This result may suggest that USA female pre-service teachers are more likely to show high classroom management skills compared to Kenyan females. Since *PSTE* refers to a teacher's belief in his or her own ability to effectively teach science, this study may suggest that female pre-service teachers in US are more self-confident as science teachers than their female counterparts in Kenya. The contrast was true for STOE where both male and female students in Kenya showed higher STOE scores than those of US. Since *STOE* reflects the extent of a teacher's belief that, if teachers provide appropriate science instruction, then their students will learn, it may seem that Kenyan students strongly believe that their

pedagogy will positively influence learning in science more than do US students. The MANOVA test revealed a significant main effect for country; with USA scoring higher on *PSTE* while Kenya scored higher than US. This finding of the current study is consistent with studies on cultural comparisons of teacher efficacy which suggest that teachers in different cultures may vary in degree to which they believe in themselves to be efficacious in their teaching (Cakiroglu, et al., 2005; Lin, et al., 2002). Perhaps, US teachers feel more personal teaching efficacy because they counter less student problems or are more tolerant of such problems.

There was a non-significant main effect of gender. This is inconsistent with a long history of research that has consistently revealed that males outsmart females in their experiences and self-efficacy throughout their education (Simpkins, Davis-Keen, & Eccles, 2006; Wright & Holttum, 2010; Pajares, 2005). For example, Pajares (2005) believes that there is a developmental trend in which females' confidence in their math and science ability becomes significantly lower than males' confidence in their math and science ability as they get older. This finding may encourage science educators, educational leaders and researchers to work towards improving science efficacy beliefs among male pre-service science teachers, especially in the *PSTE*.

In conclusion, the present study aimed to determine science pre-service teacher efficacy beliefs across gender and country of origin. It revealed the need to expand further studies on teacher efficacy to different context in terms of culture as it is being applied more universally. Although gender differences were not detected, it was interesting to see the trajectories of gender when in interaction with country. It was evident that females in US tended to have stronger efficacy beliefs than males while in Kenya the contrast was true. This still points to the importance of investigating this construct contextually. Self-efficacy is context-specific and should thus be studied contextually. According to the literature and findings of this study it is necessary to take into consideration the efficacy beliefs in the teacher training environment or professional development courses to promote and fostering sense of teaching efficacy beliefs among teachers in these two countries.

The findings of this study have implications for science educators. Teacher educators may have to pay special attention on the two components of the science teacher efficacy beliefs; *PSTE* and *STOE* because an individual may show a strong orientation towards one and not the other.

5. Recommendations

Teacher educators must model good pedagogy linked to science content and foster a supportive environment where pre-service teachers can explore and practice their new skills. Since the training of the pre-service teachers has an important effect on their self-efficacy beliefs, the self-efficacy belief of the students who receive training in the faculties of education should be monitored periodically by the educators and activities designed for enhancing their self-efficacy should be intensified in the teacher training programs.

6. Directions for Future Research

In such cross cultural comparisons of science teaching efficacy, future research should consider beliefs about science teaching, for an understanding of pedagogy in science, e.g. whether "active" or "passive" learning is related to teachers' beliefs regarding their effectiveness in science teaching. In addition, parallel longitudinal studies may help one better understand the influence of pre-service teacher education programs to prospective teachers across cultures instead of cross-sectional ones. Furthermore, longitudinal research design is needed to examine self-efficacy of teachers, following teachers from their pre-service years up to their in-service teaching experiences.

Acknowledgements

The authors would like to sincerely thank Prof. Amadalo Musasia, and Mr. Peter Edome, both from Masinde Muliro University of Science and Technology for their support during data collection. More gratitude goes to students of Kaimosi Teachers' Training College, Eregi Teachers' Training College, and Ball State University for accepting to participate in this study.

Statement of Competing Interests

The authors do not have any competing interests.

List of Abbreviations/Acronyms

ANOVA:	Analysis of Variance
MANOVA:	Multivariate Analysis of Variance
PTE:	Personal Teacher Efficacy
STEBI-B:	Science Teacher Efficacy Beliefs-Version B
STOE:	Science Teacher Outcome Expectancy
STE:	Science Teacher Efficacy
TE:	Teacher Efficacy
U.S.A:	United States of America

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