Pre-service secondary school science teachers science teaching efficacy beliefs

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Abstract

The main purpose of the study was to explore pre-service secondary science teachers' self-efficacy beliefs regarding science teaching. The study also compared pre-service secondary science teachers' self-efficacy beliefs with regard to gender and educational level. Data were collected by administering the science teaching self-efficacy beliefs questionnaire to 210 pre-service secondary science teachers. Statistical techniques such as mean scores, t-test and ANOVA were used to analyse the data. Results of the study showed that the pre-service secondary science teachers have very high level of secondary science teaching self-efficacy beliefs. The pre-service secondary science teachers' self-efficacy beliefs and personal science teaching efficacy were gender-related with the males having higher self-efficacy beliefs towards science teaching than the females and the latter having higher personal science teaching efficacy than their male counterparts. It was also observed that the current science education programme of the University of Education Winneba has made little impact on the pre-service secondary science teachers' self-efficacy beliefs towards science teaching.

Keywords pre-service secondary science teachers, self-efficacy beliefs,

Introduction

Much research in recent years has given great attention to the importance of self-efficacy conceppret in understanding teachers' and students' behaviours in the learning process (Savran, & Cakiroglu, 2003). This is evidenced by the plethora of researches conducted in order to measure teacher self-efficacy which affects the behaviours and attitudes of the teachers and the achievement of the students (Gibson & Dembo, 1984; Riggs & Enochs, 1990). A review of literature suggests that the self-efficacy perception of the teachers has been analysed in terms of students' achievement (Tschannen-Moran, & Woolfolk-Hoy, 2001), classroom management and time management strategies (Gibson, & Dembo, 1984). Also, studies reported by Azar (2010) have established that self-efficacy of the teacher positively affects the achievements and attitude of the students. It has also been found to be directly related to the classroom behaviour of the teacher, involving openness to new ideas and the development of positive attitudes towards science teaching (Woolfolk, & Hoy, 1990; Tschannen-Moran, & Woolfolk-Hoy, 2001). They also reported that teachers who are more comfortable with science are more likely to devote more time to teaching it, and are more likely to teach it with creativity.

In fact, highly efficacious science teachers are more likely to use open-ended, inquiry and student-centred teaching strategies while teachers with low source of efficacy are

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more likely to use teacher-centred teaching strategies such as lecture and text-book based teaching or reading from textbooks. It is not therefore surprising that self-efficacy and attitudes of pre-service teachers has been the focus of many studies (Enochs & Riggs, 1990; Morrel, & Carroll, 2003; Palmer, 2001). This points to the importance of teacher's self-efficacy in preparatory science education programmes particularly in Ghana, where there is an immediate need for qualified science teachers capable of innovative science instruction as the Ghana government attempts to ensure that a pool of scientists are trained for business and academic research. It is also hoped that through innovative science instruction Ghanaian citizens may become scientific and technological literates to provide scientific explanations to natural phenomena and to engage in evident based discussions (Ministry of Environment, Science, and Technology, 2007).

Teachers' self-efficacy beliefs help us to predict their motivation and choice and to ascertain their actions in class (Aydin, & Boz, 2010). It is therefore important to determine pre-service teachers' self-efficacy beliefs related to science teaching due to the fact that they will be teachers in the future (Cakiroglu, Cakiroglu, & Boone as cited in Aydin & Boz, 2010). Also, Aydin and Boz (2010) recommend that before planning suitable activities to enhance pre-service teachers' efficacy data should be gathered to determine whether their self-efficacy is high or low. Furthermore, it is difficult to make changes in teachers' self-efficacy beliefs after the establishment of beliefs (Bandura, cited in Bursal, 2012). Therefore, an early detection of low self-efficacy in science teaching is critically important in any education programme (Enoch, & Riggs, 1990). However, neither in-service nor pre-service science teachers' self-efficacy beliefs have ever been investigated in Ghana. This study aims at bridging this gap.

Theoretical framework

The construct of educational beliefs is broad and for research purposes has been refined into more specific sub-constructs (Pajares, 1992). Examples include beliefs about confidence to affect students' performance (teacher efficacy), about the nature of knowledge (epistemological beliefs), about perceptions of self (self-concept) and about confidence to perform specific tasks (self-efficacy). The latter is of particular interest because of the role it is proposed to play in determining behaviour.

According to Bandura (1997), who first described the construct, "perceived self-efficacy refers to beliefs in one's capabilities to organize and execute the courses of action required to produce given attainments" (p. 3), and such beliefs are the most central mechanism of personal agency. As proposed by Bandura, self-efficacy is specific to a particular set of behaviours and comprises two components, efficacy expectations and outcome expectations which respectively relate to belief in personal capacity to affect a behaviour and belief that the behaviour will result in a particular outcome. As a consequence, instruments for the determination of self-efficacy typically include two scales to measure these two components.

The notion of Teaching Efficacy Beliefs has been further developed since Bandura first proposed it in 1977. Gibson and Dembo (1984) confirmed Bandura's two component model consisting of a) a factor that relates to a teacher's sense of teaching efficacy, or belief that a teacher's ability to bring about change is limited by factors external to the teacher (Outcome Expectancy) and b) a factor that relates to a teacher's sense of personal teaching efficacy, or belief that he or she has the skills to bring about student learning (Self-Efficacy). In the present study, the meaning of self efficacy is adapted to reflect the pre-service teachers' belief in being able to teach science and effect learning among their pupils.

In an attempt to further develop teacher efficacy belief instrument Gibson and Dembo (1984) developed a 30 item Likert type efficacy scale to measure the two dimensions of the teacher efficacy beliefs scale. Factor analysis of responses for 208 elementary school teachers confirmed the existence of two factors that corresponded to Bandura's two component model. The development of the Gibson and Dembo instrument has become a more extensive and reliable measure in the study of teacher efficacy and to explore the importance of teachers' sense of efficacy on their behaviour, attitudes and on students' achievement. Subsequent studies have linked this construct to patterns of classroom behaviour known to yield achievement gains (Gibson, & Dembo, 1985) and have shown it to be positively related to change in individual teacher practice (Smylie, 1988), ratings of lesson presentation, classroom management and questioning (Saklofske, Michayluk, & Randhawa, 1988) and teacher success in implementing innovative programmes (Stein & Wang, 1988).

Science educators have conducted extensive research to investigate the effect of teacher efficacy on science teaching and learning by modifying Gibson and Dembo's instrument grounded on Bandura's (1977) definition of self-efficacy as a situation specific instrument. One of such instrument is Science Teaching Efficacy Beliefs Instrument (STEBI) devised by Riggs and Enochs (1990). The instrument is composed of two scales, the Personal Science Teaching Efficacy Belief subscale (PSTEB) and the Science Teaching Outcome Expectancy subscale (STOE), to measure practising elementary school teachers' sense of science teaching efficacy. A similar instrument was also constructed for pre-service teacher education students and was applied in predicting science teaching behaviours of pre-service teachers and in-service teachers (Azar, 2010). The latter was adapted for this study to measure pre-service secondary science teachers' self-efficacy beliefs towards science teaching.

Related literature

In a study to identify changes in pre-service elementary teachers' sense of efficacy in teaching science, Ginns, Watters, Tulip and Lucas (1995) reported that Science Teaching Efficacy (STE) and Science Teaching Outcome Expectancy (STOE) were not significantly correlated, the former being more dependent on personal traits such as internal locus of control and self concept, whereas the latter was related to levels of aspiration, academic interest and satisfaction. The study concluded that the STOE is more easily influenced by the teacher education programme than the STE, as the latter

is concerned more with global personality traits. It is, however, the concern of teacher educators to improve the students' sense of STE, as this has implications for the teachers' ability to teach science, and the children's ability to learn science (Riggs, & Enochs, 1990). It is also predicted that STE is related to an individual's experience in learning science. For the present study, this means that the teacher education programme may influence the pre-service teachers' STOE beliefs, and the pre-service teachers' experiences of science learning may be related to STE.

Other researchers have conducted extensive research to investigate the relationships between background factors such as gender, years of teaching and grade levels and their self-efficacy beliefs towards science teaching and learning. Saracaloglu and Yenice (2009) conducted a study to find out the levels and reasons of change in levels of self-efficacy of science teachers and elementary teachers. The study investigated any other perceptions of science teachers about their self-efficacy changes according to gender and years of teaching. The sample consisted of 132 teachers (72 females and 60 males) made up of 58 science teachers and 74 elementary teachers. The teachers' years of teaching varied from 1 to 30 years with majority of the teachers with between 20 and 29 years of teaching. The self-efficacy beliefs scale which Hazir and Bikmaz (cited in Saracaloglu, & Yenice, 2009) translated into Turkish was used. The scale had reliability of .85. Gender difference was analysed with t-test which indicated no significant difference by means of gender. They concluded that science self-efficacy was independent of gender. A one-way ANOVA analysis was carried out on the teachers' responses to determine whether teachers' science self-efficacy differed according to years of teaching. It was found out that science self-efficacy was independent of years of teaching.

Pre-service teachers' self-efficacy beliefs at different teacher preparatory programmes were investigated to find out whether these preparatory programmes had an effect on these beliefs. Savran and Cakiroglu (2003) assessed differences between Turkish elementary and secondary pre-service science teachers' (PST) science efficacy beliefs (STEB) and classroom management beliefs. The study sample consisted of 646 PST enrolled in elementary and secondary science teachers' education programme in Turkey. Out of these 412 were ready to teach in secondary schools and 234 were ready to teach in elementary schools. The sample included 361 females and 285 males. They completed adapted form of STEB-B instrument (Enochs & Riggs, 1990) which consisted of 23 items in a five Likert type scale ranging from strongly agrees to strongly disagree. A 2-way ANOVA was performed on scores of each subscales of STEB-B to determine differences between elementary and secondary teachers' personal science teaching efficacy as function of main and interaction effect of gender and educational level. The results indicated significant educational level main effect difference with only the subscales of STEB-B. Both elementary and secondary pre-service teachers had generally more positive self-efficacy beliefs regarding science teaching. The educational level was more of a factor than gender in determining one's self- efficacy beliefs about science teaching. The secondary pre-service teachers were more efficacious than the elementary counterparts on STEB-B subscales. The

researchers recommended that the results are useful in enhancing pre-service teachers' sense of efficacy.

Some relevant studies indicated gender impact on teachers' self-efficacy beliefs. Riggs cited in Bursal (2008) reported that male elementary teachers experience higher self-efficacy for teaching science than female teachers in both in-service and pre-service situations. Also, Brownlow, Jacobi and Rogers (2000) concluded from their study findings that female teachers were much less self-confident in their capabilities with science than their male counterparts. However, other researchers have found out that female Turkish pre-service elementary teachers have slightly higher personal science teacher efficacy beliefs than their male peers, though the difference was reported to be statistically insignificant (Cariroglu, Cakiroglu, & Boone, 2007). Also, gender did not reveal a significant difference in a study conducted by Cariroglu (2008) though the descriptive data revealed that the sense of efficacy-beliefs was higher in the males than in the females. Joseph (2010) also reported similar findings in his study on pre-service science teachers' self-efficacy beliefs towards science teaching. Again, studies reported in literature reviewed by Cakiroglu (2008) indicated no relationship between gender and teacher self-efficacy. Therefore studies on gender differences in science teachers' self-efficacy beliefs towards science teaching are inconclusive and further probe of the issue in different contexts is highly recommended.

In sum teacher efficacy has been related to teachers' classroom behaviour, their openness to new ideas and their attitudes towards science teaching. In addition, teacher efficacy appears to influence students' achievement, attitude towards science teaching and learning. Contextual factors such as gender, grade level or science teacher preparatory programme may play a role in shaping pre-service teachers' sense of efficacy.

Riggs and Enoch (1990) suggest that teacher educators must be aware of their students' beliefs and plan for experiences which will have positive impact on teacher self-efficacy and outcome expectancy. Therefore, it is important to investigate pre-service secondary science teachers' self-efficacy beliefs. This will serve as a key in understanding how to increase pre-service science teachers' sense of efficacy in science teacher education programmes. However, except few studies (Azar, 2010; Joseph, 2010; Savran, & Cakiroglu, 2003), most studies are on pre-service elementary school teachers. But the investigation of pre-service secondary science teachers' self efficacy has a critical importance for secondary science education as the level of self efficacy is very important for both the student and the teacher. This is especially so in Ghana where there is a strong advocacy for innovations in science teaching at the secondary school level.

Again, for nearly three decades researchers have investigated teacher self-efficacy beliefs and made significant progress in understanding its nature, how it is related to other variables such as students' achievement and how it can be measured. Yet, little or no work seems to have been done on this construct in Ghana. Therefore, this study

was an attempt to bridge the gap and also contribute to the literature by exploring pre-service secondary science teachers' self-efficacy beliefs regarding science teaching. In addition, the study also compared pre-service secondary science teachers' self-efficacy beliefs with regard to gender and educational level. An analysis of such beliefs among pre-service science teachers in Ghana may provide important information and direction for training science teachers capable of innovative science instruction in our secondary schools. Based on these needs, the following research questions were formulated to guide the study:

1. What is the level of pre-service secondary science teachers' self- efficacy beliefs regarding science teaching?
2. Are there any significant relationships between gender and pre-service secondary science teachers' self-efficacy beliefs?
3. Do pre-service secondary school science teachers' self-efficacy beliefs vary according to educational level?

Methodology

Cross-sectional study with survey method of data collection was employed in the study since the participants were drawn from different levels of the science education programme. In cross-sectional studies, measures of variables are taken at the same time or in practice over a relatively short period of time (Robson, 2002). In this study measurement of variables was at the same time.

Sample

The sample consisted of a total of 210 pre-service secondary science teachers enrolled in various science education programmes in the Department of Science Education, University of Education, Winneba during the second semester of the 2010/2011 academic year. Convenient sampling technique was used to obtain the sample for the study due to the fact that the researcher is in the Science Education Department. The sample was distributed among level 100 (57), 200 (43) and 300 (110). The ages of the participants ranged between 21 and 30 years with a mean age of 22 years. The distribution of the pre-service teachers among the major programme was as follows: Biology Education: 131; Chemistry Education: 67 and Integrated Science Education: 12. Each participant in addition to the major programme was to take a minor subject such as Biology, Chemistry and Physics. The students were expected to take courses in their preferred minor subject up to the end of level 200.

The pre-service secondary science teachers are educated through a four year undergraduate programme made up of three years of taught courses in science content and methodology. The method courses for teaching science include management of science classroom and curriculum materials, nature of science, psychological basis for science teaching, and science curriculum and curriculum material studies and assessment in science. The programme also includes 14 weeks pre-internship seminar which prepares students for the internship programme for the first ten months of the

fourth year of the programme. As part of the preparation for the latter, the students are guided through various activities for pedagogical knowledge such as developing teaching philosophies and skills for reflective practice. They also do peer- teaching. The students are then attached to partner schools to do ten months internship after which they come back to campus for post internship seminars. These involve presentations by students on their teaching philosophies, reflective practice and portfolios for university supervisors to ascertain the progress they made during the internship period.

Students in this study participated by knowing that participation was anonymous and that it would not affect their course grades. They were informed that the aim was a research attempt to examine students' self-efficacy science teaching beliefs the findings of which may improve the content of the programme and the pedagogical approaches or skills of science educators.

Instrument

The Science Teaching Efficacy Beliefs Instrument (STEBI-B) for pre-service teachers was used to collect data for this study. The STEBI-B is an instrument based on Bandura's definition of self-efficacy as a situation-specific construct. The instrument was developed by Enoch and Riggs (1990) and it is widely used to measure pre-service and in-service teachers' efficacy beliefs regarding teaching science. The STEBI-B consists of 23 items in a five-point Likert type scale ranging from one (strongly disagree) to five (strongly agree) and has two subscales: personal science teaching efficacy (PSTE) and science teaching outcome expectancy (STOE). The PSTE has 13 items while the STOE has 10 items. The Personal science teaching efficacy beliefs refer to the extent that teachers believe that they have the capacity to positively affect students' achievement. The science teaching outcome expectancy reflects science teacher's beliefs that student learning can be influenced by effective teaching. The participants responded to each of the 23 items by selecting one of the following responses: strongly agree (5), agree (4), undecided (3), disagree (1) or strongly disagree (1). Negatively worded items were scored in reverse with strongly disagree (1), disagree (2) undecided (3), agree (4) and strongly agree (5). Accordingly, negative questionnaire items 3, 6, 8, 10, 13, 17, 19, 21, and 23 were scored inversely to produce consistent values between positively and negatively worded items. That is, it would produce high scores for those high and low scores for those low in efficacy and outcome expectancy beliefs. The minimum score of the scale is 23 and the maximum score is 115. The total score of individual participants provides a composite index of high self-efficacy beliefs towards science teaching. That is, an individual's high score in PSTE subscale relative to other respondents indicates a strong personal belief in one's own efficacy as a science teacher and a high score on STOE subscale indicates high expectation of the outcomes of science teaching.

The instrument is a valid and reliable tool for studying pre-service teacher's science teaching efficacy beliefs. The items in the PTSE subscale and STOE subscale had

high reliability 0.89 and 0.76 respectively. Studies which used the instrument also reported high reliability values (Morrel, & Carroll, 2003; Tekkaya, Cakiroglu, & Ozkan, 2004; Joseph, 2010).

The questionnaire was randomly administered. The participants were guaranteed confidentiality and the instrument was filled anonymously with no identifying information. No time limit was given during completion of the questionnaire. It was collected when a participant indicated that she/he had completed it.

Data Analysis

The STEBI-B data were analysed using Statistical Package for the Social Science (SPSS) version 16 for Windows to conduct factor analysis following the same procedure used by Enochs and Riggs (1990). The principal components model of factor analysis was employed and varimax rotation was used to compare factor loadings. Next, reliability tests on the pre-service secondary science teachers' scores to individual items and to the subscales were conducted as suggested in previous studies (e.g. Enochs & Riggs, 1990; Riggs & Enoch cited in Cetinkaya & Erbes, 2011), to determine the Cronbach alpha and item-total correlations for the scale and the PTSE and STOE subscales.

Descriptive statistics function of the software was used to determine mean scores and standard deviations on pre-service secondary science teachers' scores on STEBI-B and the subscales by gender and educational level. The means, standard deviations, frequencies and percentages were used to understand the data. Mean ratings of 1.0 to 1.75 represent low, 1.76 to 2.25 moderate, 2.26 to 3.25 high and 3.26 to 4.00 very high. These criteria were used by Shamsid-Deen and Smith (2006) in a similar study.

The inferential statistics function of SPSS was used to examine association of the background variables with the STEBI-B scale scores and subscales (PTSE and STOE) scores. For this analysis, the data set was split into the various categories composing each background variable and either an independent t-test (for variable with two groups e.g., gender) or ANOVA (for variables with more than two groups) conducted to detect any significant differences between group means. The t-test statistic was used to determine if there was significant difference between male and female pre-service secondary science teachers with regard to their self-efficacy science teaching beliefs for general and specific educational level. One- way ANOVA was used to explore the different educational levels or grade levels on pre-service secondary science teachers' personal science teaching efficacy and science teaching outcome efficacy scores. Dunnet C post hoc test was employed to determine differences between educational levels. The a priori alpha level for the analytical test of difference was established at the level of .05. Effective sizes were also calculated for each analysis to determine the magnitude of the effect of the variables (educational levels) on the pre-service secondary science teachers' personal science teaching efficacy and science teaching outcome efficacy.

Results

Factor analysis

Factor analysis was conducted on the data collected following the same procedure used by Enochs and Riggs (1990). Since the STEBI-B was adopted for this study, it was prudent to determine the structure validity of the scale. The 23 items of the attitude scale were analyzed using principal component analysis (PCA) model of Statistical Package for the Social Science (SPSS) version 16. Prior to performing PCA, the suitability of data for factor analysis was assessed. Inspection of the correlation matrix revealed the presence of many coefficients of 0.3 and above. Kaiser-Meyer-Oklin coefficient was found as 0.784 exceeding the recommend value of 0.6, which indicated that the sample was adequate to use factor analysis. In addition to this the Barlett's Test of Sphericity revealed a significant chi-square value ($\chi 2 = 974.963$, df= 209, p= .000) supporting the factorability of the correlation matrix. An inspection of the scree plot revealed a clear break after the second component. Using Catell's (1966) scree test, it was decided to retain two components for further investigation. To aid in the interpretation of these two components, varimax rotation was performed. The two accounted for 33.07 % of the total variance, with Factor 1 contributing 20.43% and Factor 2 contributing 12.65 and with eigenvalues of 4.29 and 2.66 for factors 1 and 2 respectively. The two factors were moderately correlated (r = .46, p = .000) signifying that they are related but independent. The Cronbach alpha reliabilities of the subscales, PSTE and STOE, were .92 and .68 respectively. Two items (7 & 18) were dropped from the instrument because of their failure to load on to either of the two factors. Finally, the Ghanaian version of the STEBI-B consists of 21 items and PSTE subscale includes 12 items and STOE subscale includes 9 items. The results of the analysis are presented in Table 1. The values of alpha coefficients for the items of the scale ranged from .73 to .78 indicating an acceptable reliability (Patton, 2002) with overall Cronbach's alpha for the whole scale as 0.76, which indicates high reliability of the questionnaire.

Table 1: Descriptive statistics and factor loadings of STEBI-B scale

Factor	Item	N	Mean	SD	Cronbach Alpha	Factor loading	Correlations
Factor 1							
PSTE	2	210	4.23	.91	.74	.36	.346
	3	210	4.05	1.26	.74	.69	.414
	5	210	3.58	.92	.74	.51	.338
	6	210	3.77	1.21	.74	.63	.419
	8	210	3.97	1.31	.74	.58	.381
	12	210	3.81	.83	.75	.55	.327
	17	210	3.38	1.27	.74	.48	.359
	19	210	3.65	1.24	.73	.62	.491
	20	210	3.63	1.23	.74	.57	.378
	21	210	3.67	1.23	.73	.59	.489
	22	210	4.06	1.00	.74	.72	.373
	23	210	3.56	1.15	.73	.66	.456
Factor 2							
STOE	1	210	3.28	1.37	.76	.45	.310
	4	210	4.06	.94	.74	.51	.320
	9	210	4.01	1.01	.74	.46	.326
	10	210	2.60	1.25	.78	-.51	.324
	11	210	3.87	1.06	.74	.59	.416
	13	210	3.2	1.33	.76	.45	.325
	14	210	3.64	.97	.75	.58	.377
	15	210	3.98	.96	.74	.60	.338
	16	210	3.90	.98	.75	.63	.363

Data acquired from the study were analysed separately according to the research questions and presented in tables. The study administered the STEBI-B to 210 pre-service secondary science teachers, 20.5 % females and 79.5 % males. Details of the participants are provided in Table 2.

Table 2 Background variables for participants (N = 210)

Category	N	f (%)
Gender		
Male	167	79.5
Female	43	20.5
Total	**210**	**100**
Age		
18-21	42	20.0
22-30	102	48.6
31+	66	31.4
Total	**210**	**100**
Educational level		
100	57	27.1
200	43	20.5
300	110	52.4
Total	**210**	**100**

Question 1 *What is the level of pre-service secondary science teachers' self-efficacy beliefs regarding science teaching?*

Table 3 summarises the mean scores and standard deviations of the 21 items of the instrument. The item means ranged from 2.61 to 4.23 and 20 items with mean values above the theoretical mean of the scale (3.0). The total item mean was 3.71(SD = 0.91). All items except item 10 indicate largely positive attitudes toward the use of science teachers' efficacy beliefs in education. This indicates that most of these items had high effect on pre-service secondary science teachers' self-efficacy beliefs towards science teaching. In fact five items (2, 3, 4, 9 and 22) had mean scores above 4.0 while twelve items had mean scores above 3.5. This implies that the pre-service teachers generally have very high level of self-efficacy beliefs towards science teaching.

Table 3 **Descriptive statistics: Means and SD for pre-service secondary science teachers' scores on STEBI-B**

Factor	Item	N	Mean	SD	Factor	Item	N	Mean	SD
Factor 1					**Factor 2**				
PSTE	2	210	4.23	.91	**STOE**				
	3	210	4.05	1.26		1	210	3.28	1.37
	5	210	3.58	.92		4	210	4.06	.94
	6	210	3.77	1.21		9	210	4.01	1.01
	8	210	3.97	1.31		10	210	2.60	1.25
	12	210	3.81	.83		11	210	3.87	1.06
	17	210	3.38	1.27		13	210	3.2	1.33
	19	210	3.65	1.24		14	210	3.64	.97
	20	210	3.63	1.23		15	210	3.98	.96
	21	210	3.67	1.23		16	210	3.90	.98
	22	210	4.06	1.00					
	23	210	3.56	1.15					

Question 1 *Are there any significant relationships between gender and pre-service?*

The PSTE subscale includes 12 items and a minimum score of 12 and a maximum score of 60 of this scale. The item mean scores ranged from 3.38 to 4.23 with an overall mean score of 3.78 (SD = 0.25). These results can be interpreted as that the pre-service secondary science teachers have very high PSTE and that they have necessary skills to teach science effectively. The STOE subscale includes 9 items and minimum score of 9 and a maximum score of 45. The mean scores ranged from 2.61 to 4.06 with overall mean score of 3.62 (SD = 0.49). Except for items 10 (moderate) and 13 (high), it can be interpreted that the pre-service secondary science teachers have very high level of science teaching outcome expectancy which student learning can be influenced by given effective instruction.

Secondary science teachers' self-efficacy beliefs

Research question 2 sought to find out whether pre-service secondary science teachers' self-efficacy beliefs towards science teaching is gender related. The descriptive statistics on the responses of the gender groups on the questionnaire are presented in Table 4. The means score (79.42, SD = 8.05) obtained by the males indicated that they seem to have higher level of self-efficacy beliefs towards science teaching than their female counterparts (M = 77.52, SD = 10.05). However, the females (M = 46.70, SD = 5.32) seem to have a higher personal teaching self-efficacy towards science than their male counterpart (45.01, SD = 7.69) while the males seem to have higher science teaching outcome expectancy than the females as indicated by their respective means of the scores obtained for the subscale (see Table 4). An independent-sample two-tailed t-test was performed to investigate pre-service secondary science teachers' self-efficacy beliefs with regard to gender. The results of the t-test analysis are presented in Table 4. The t-test was significant [t (208) = -1.17, $p < 0.05$] for STEBI-B and significant [t(208) = -1.68, $p < .05$] for PSTE but not for STOE [t(208) = .20, $p > .05$]. It implies that self-efficacy beliefs towards science teaching and personal science teaching efficacy are gender related. Therefore the males have higher self-efficacy beliefs towards science teaching than the females while the females have higher personal science teaching efficacy than their male counterparts.

Table 4 **Mean score, SD and t-test on gender and Pre-Service Secondary Science Teachers' Self-Efficacy Beliefs towards Science Teaching**

Gender	Number of students	Mean score	Standard deviations	df	t	P
	PSTE					
Male	167	45.01	7.69	208	-1.68*	.005
Female	43	46.70	5.32			
Total	**210**					
	STOE					
Male	167	28.57	3.87	208	.20	.956
Female	43	28.44	3.83			
Total	**210**					
	STEBI-B					
Male	43	79.47	8.05	208	-1.17*	.023
Female	167	77.52	10.09			
Total	**210**					

*P< .05

Question 1 *Do pre-service secondary school science teachers' self-efficacy beliefs vary according to educational level?*

The descriptive statistics on the responses of the educational levels on the questionnaire are presented in Table 5. The means scores for PTSE of the educational levels ranged between 44.15 and 46.81 with standard deviations between 6.15 and 7.78. The overall mean score was 45.36 (SD = 7.28). The mean scores for STOE ranged between 28.28 and 29.07 with an overall mean score of 28.55 (SD = 3.85).

The standard deviations ranged between 3.65 and 4.20. The level 200 pre-service secondary science teachers seem to have a higher personal teaching self-efficacy towards science followed by the level 100 with level 300 students having the lowest personal teaching self-efficacy towards science. Again, the level 200 pre-service secondary science teachers seem to have a higher science teaching outcome expectancy than their level 100 and 300 counterparts followed by the level 300. A similar trend was noticed with their mean scores for STEBI-B scale except that level 100 seemed to have higher self-efficacy beliefs towards science teaching than level 300 students.

Table 5 **Descriptive statistics of pre-service secondary science teachers' self-efficacy beliefs towards science teaching based on educational level**

Educational level	Number of students	Mean Score	Standard Deviation
PTSE			
Level 100	57	46.61	6.84
Level 200	43	46.81	6.15
Level 300	110	44.14	7.74
Total	210	45.36	7.28
STOE			
Level 100	57	28.28	4.20
Level 200	43	29.07	3.65
Level 300	110	28.48	3.74
Total	210	28.55	3.85
STEBI-B			
Level 100	57	78.65	9.49
Level 200	43	80.07	8.55
Level 300	110	76.70	10.15
Total	210	77.92	9.72

A one-way analysis of variance was conducted to evaluate the relationship between the educational levels and the subscales, PSTE and STOE. The independent variable included three levels, level 100, 200 and 300. The dependent variables were PSTE and STOE. The results of the analysis are presented in Table 6. In terms of the educational level, the analysis showed that there was a significant difference among the mean scores of the educational levels for personal teaching self-efficacy towards science ($F(2, 207) = 3.33$, $p < 0.05$) but not for STOE ($F(2, 207) = .55$, $p > 0.05$). However, post hoc analysis showed no significant mean difference among the mean scores for the educational levels on PTSE subscale (see Table 7). Despite this finding it could be said that the level two hundred pre-service secondary science teachers had the highest personal teaching self-efficacy towards science with level 300 having the lowest level of personal teaching self-efficacy towards science (see Table 5).

Table 6 Result of ANOVA of PSTE/STOE scores according to educational level

Sources of Variance	Sum of Squares	Df	Mean Square	F	p	Effect size
Between Groups	392.751	2	196.375	2.10	.125	
Within Groups	19354.873	207	93.502			
Total	19747.624	209				
PSTE						
Between Groups	345.239	2	172.620	3.33	.038*	
Within Groups	10742.975	207	51.898			
Total	11088.214	209				
STOE						
Between Groups	16.261	2	8.130	.55	.579	
Within Groups	3075.763	207	14.859			
Total	3092.024	209				

*p < 0.05

Table 7 Dunnett C test of PSTE scores according to educational level

Groups/ levels	Mean difference	Standard error	p
100-200	-0.199	1.304	1.303
100-300	2.477	1.168	1.168
200-300	2.677	1.193	1.194

*p > 0.05

Discussion

Self-efficacy beliefs of pre-service secondary science teachers towards science teaching were investigated according to PSTE and STOE sub factors. Furthermore, changes of these subscales scores according to gender and educational level of the participants were analysed. Gender and educational levels showed no significant associations to STOE scores. Therefore the remainder of this section will discuss associations between PSTE scores and the two variables: gender and educational levels.

It seems that the successful implementation of science education programmes in senior high schools in Ghana may depend on science teachers' self-efficacy beliefs, that is, their personal beliefs about their ability to teach science and their ability to produce positive outcomes in science for students. The results from the self-efficacy survey indicated a generally positive efficacy beliefs expressed by most of the pre-service teachers regarding their ability to teach science. Many of the subjects confirmed that they understand science concepts well enough to teach science effectively to students. However, they seem generally not to be optimistic and do not belief that they will indeed be effective science teachers in future.

Descriptive statistics showed that pre-service secondary science teachers' self-efficacy beliefs were high for PSTE and STOE as in Bleicher (2004), Yilmaz and Cavas cited in Bayraktar (2011) and Joseph (2010). In terms of educational level there were different both in PSTE and STOE. The mean scores for the level 200 were the highest for both PSTE and STOE (see Table 5). The lowest mean score belonged to level 300. The findings are in contrast to those reported by Aydin and Boz (2010) and Bayraktar (2011). Aydin and Boz reported in their study that the seniors (fourth years) obtained the highest mean score and attributed this to the teaching experience and the other courses taken at the last year of the programme which could have provided more experience to them. Bayraktar conducted a study to investigate the effectiveness of a primary teacher education programme on pre-service teachers' science teaching efficacy beliefs by grade. The results showed that there was a statistically significant difference between seniors and freshmen pre-service teachers and concluded that the primary teacher education had effect on grade level. The reasons for the inverse in this study may be difficult to find. This is because the level 300 at the time of the study had almost completed the content and method courses including peer teaching/micro teaching as part of the preparation for internship component of the four year programme. One would have expected that the senior would have had enough subject content knowledge and some exposure to teaching strategies. The results seem to suggest that pre-service secondary science teachers' science teaching beliefs did not evolve through their training in secondary science education programme.

A number of studies recommend that pre-service teachers should undertake more content and method courses (Enochs, & Riggs, 1990; Tigler, cited in Cakiroglu, 2001) to improve pre-service science teachers' self-efficacy beliefs. However, data from this study suggest that more content and methodology courses do not appear to influence the pre-service secondary science teachers' personal self-efficacy beliefs regarding science teaching. The third year (level 300) pre-service teachers had more content and method courses than their first and second year colleagues. Yet the latter had higher mean scores than the third years. Also, Cantrell, Young and Moore cited in Joseph (2010) suggest that teacher training programmes that include science lessons planning, micro-teaching experiences in a supportive environment should have a positive effect on pre-service science teaching efficacy.

Though these experiences were part of the pre-internship seminar for the third years, the results of the study suggest that these experiences did not have a significant influence since the second years indicated more positive self-efficacy beliefs than the third years. This suggests further studies to investigate the possible factors responsible for these differences. The researchers agree with Cakiroglu (2001) that science teacher educators should structure existing courses to include experiences that make students aware of and able to confront their existing beliefs about their ability to teach science. This requires well planned science methods classes which should be based and hands-on and minds-on activities. Indeed, in their Science Teaching Efficacy Belief Instrument Study Enoch and Riggs, cited in Savran and Cakiroglu (2001)

suggest that early detection of low self-efficacy in science teaching can be valuable in providing specific conditions for pre-service secondary science teachers such as science lesson observation, peer teaching and self-evaluation of micro-teaching to enhance science teaching self-efficacy.

Consistent with other studies conducted in many countries (e.g. Brownlow, Jacob, & Rogers, 2000; Enochs, & Riggs, 1990; Riggs, 1991) and inconsistent with few studies in other countries such as Turkey (e.g. Gencer & Cakiroglu, cited in Bursal, 2008) gender effect was found to be a significant factor in Ghana. The Ghanaian female pre-service secondary science teachers were found to have higher personal science teaching self-efficacy than their male counterparts. This seems to support the assertion made by Sridhar and Badiei (2008) that female teachers possess more personal teaching efficacy beliefs possibly because they can more easily adapt to each student than the male teachers can. The differences in the studies may result from contextual differences. However, the results suggest further research is needed to investigate the possible factors that positively impact on the females compared to their male counterparts.

Conclusion and Recommendations

In order to determine pre-service secondary science teachers' self-efficacy beliefs regarding science teaching, whether there is a relationship between science teaching self-efficacy beliefs of pre-service secondary science teachers who are at different grades and whether science teaching self-efficacy beliefs is gender related, STEBI-B was administered to pre-service secondary science teachers. Descriptive statistics showed that pre-service secondary science teachers' self-efficacy beliefs regarding science teaching were generally very high for both PSTE and STOE. In terms of educational level or grade level, there were differences both in PSTE and STOE. The mean scores for second grade level were highest in both PSTE and STOE followed by the second grade level in PSTE and the third in STOE. This suggests that pre-service secondary school science teachers' PSTE and STOE did not evolve through the science education programme, which was followed by the participants of the present study. However, which component of the programme is more influential on the PSTE and STOE couldn't be made explicit. Investigating the specific effects of the different components of the programme such as science content courses, science methods courses and on-campus teaching practice of the pre-internship programme would be useful to reach a more specific conclusion on which components need to be improved. The final year pre-service teachers' mean scores on STEB-B and PTSE are relatively low. This suggests that the content and methodology course have no effect on pre-service secondary science teachers' self-efficacy beliefs regarding science teaching. It is there necessary to take into consideration the efficacy beliefs in the teacher training programme and develop courses to promote and foster sense of teaching efficacy beliefs among pre-service teachers. There is also an urgent need to think about the ways of improving the pre-service science teachers' science teaching efficacy beliefs especially in their personal science teaching efficacy.

Self-efficacy beliefs regarding science teaching was found to be gender-related. There was significant difference between mean scores for the scale and PSTE. The males had higher self-efficacy beliefs than the females while the females had a higher PTSE than their male counterparts.

The aim of studies on self-efficacy is to better inform science teacher educators to enable them to provide an opportunity for pre-service science teachers to develop increased self-efficacy and outcome expectancy beliefs upon this foundation. The goal is to build capacity for pre-service secondary science teachers' self-efficacy beliefs and outcome expectancy beliefs into increased teaching confidence in their future teaching careers. Thus, science teacher educators must be aware of their students' beliefs and structure the existing methods courses or any new courses to allow pre-service teachers to gain science teaching skills which will have positive impact on teacher self-efficacy and outcome expectancy.

References

Aydin, S. & Boz, Y. (2010). Pre-service elementary science teachers' science teaching efficacy beliefs and their sources. *Elementary Education Online, 9(2)*, 694-704, [Online]:http://ilkogretim-online.org.tr

Azar, A. (2010). In-service and pre-service secondary science teachers' self-efficacy beliefs about science teaching, *Educational Research and Reviews, 5(4),* 175-188.

Bayraktar, S. (2011). Turkish pre-service primary school teachers' science teaching efficacy beliefs and attitudes toward science: The effect of a primary teacher education programme. *School Science and Mathematics, 111, 3*, 83-92.

Bandura, A. (1997). *Self-efficacy: The exercise of control*. New York: W.H. Freeman and Company.

Bandura, A. (1977). Self-efficacy: Towards a unifying theory of behavioural change. *Psychological Review, 84(2),* 191-215.

Bleicher, R. E. (2004). Revisiting the STEBI-B measuring self-efficacy in pre-service elementary teachers. *School Science and Mathematics, 104(8),* 389-391.

Brownlow, S., Jacobi, T., and Rogers, M. (2000). Science anxiety as a function of gender and experience. Sex Roles: *A Journal of Research, 42,* 119–31.

Bursal, M. (2012). Changes in American pre-service elementary teachers' efficacy-beliefs and anxieties during a science methods course. *Science Education International, 23(1),* 40-55.

Bursal, M. (2008). Changes in Turkish pre-service elementary teachers' personal science teaching efficacy beliefs and science anxieties during a science method course. *Journal of Turkish Science Education 5 (1),* 99-112.

Cakiroglu, E. (2008). The teaching efficacy beliefs of pre-service teachers in the USA and Turkey. *Journal of Education for Teaching, 34(1),* 33-44. doi: 10.1080/02607470701773457

Cakiroglu, J., Cakiroglu, E., & Boone, W. (2005). Pre-service teacher self-efficacy beliefs regarding science teaching: A comparison of pre-service teachers in Turkey and the USA, *Science Educator, 14(1),* 31-40.

Cantrell, P., Young S. & Moore A. (2003). Factors affecting science teaching efficacy of pre-service elementary teachers. *Journal of Science Teacher Education, 14,* 177-192.

Cattell, R. B. (1966). The scree test for the number of factors. *Multivariate Behavioral Research, 1,* 245-276.

Cetinkaya, B., & Erbes, A. K. (2011). Psychometric properties of the Turkish adaptation of the Mathematics teacher efficacy belief instrument for in-service teachers, *The Spanish Journal of Psychology, 14(2),* 41 Retrieved 11/10/2012 from http://dx.doi.org/10.5209/rev_SJOP.

Enochs, L.G. & Riggs, I.M. (1990). Further development of an elementary science teaching efficacy belief instrument: A pre-service elementary scale. *School Science and Mathematics, 90*, 694-706.

Gibson, S., & Dembo, M. H. (1984). Teacher efficacy: A construct validation. *Journal of Educational Psychology, 76,* 569-582.

Ginns, I. S., Tulip, D. F., Watters, J. J., & Lucas, K. B. (1995). Changes in pre-service elementary teachers' sense of efficacy in teaching science. *School Science and Mathematics, 95,* 394-400.

Joseph, J. (2010). Does intention matter? Assessing the science teaching efficacy beliefs of pre-service teachers are compared to the general student population. *Electronic Journal of Science Education, 14(1),* 1-14.

Ministry of Environment, Science and Technology (MEST) (2007). *National Science and Technology Policy Document*, Ghana, Accra: MEST

Morrell, P. D., & Carroll, J. B. (2003). An extended examination of pre-service elementary teachers' science teaching self-efficacy, *School Science and Mathematics, 103 (5),* 246-251.

Pajares, M. F. (1992). Teacher beliefs and educational research cleaning up a messy construct. *Review of Educational Research, 62*, 307-332.

Palmer, D. H. (2001) Factors contributing to attitude exchange amongst pre-service elementary teachers. *Science Education, 86(1),* 122-38.

Patton, M. Q. (2002). *Qualitative research and evaluation methods* (3rd ed). London: Sage Publications, Inc.

Riggs, I. M. (1991). *Gender differences in elementary science teacher self-efficacy*, Paper presented at the Annual Meeting of the American Educational Research Association.

Riggs, I. M., & Enochs, L. G. (1990). Toward the development of elementary teachers' science teaching efficacy belief instrument. *Science Education, 74(6),* 625-637.

Robson, C. (2002). *Real World Research:* A resource for social scientists and Practitioner Researchers; second edition. Oxford: Blackwell Publishers.

Saklofske, D., Michaluk, B., & Randhawa, B. (1988). Teachers' efficacy and teaching behaviors. *Psychological Report, 63,* 407-414.

Saracaloglu, A. S. & Yenice, N. (2009). Investigating the self-efficacy beliefs of science and elementary teachers with respect to some variables. *Journal of Theory and Practice in Education, 5(2),* 244-260.

Savran, A. & Cakiroglu, J. (2001). Pre-service biology teachers' perceived efficacy beliefs in teaching biology. *Journal of Education 21*, 105-112.

Savran, A., & Cakiroglu, J. (2003). Difference between elementary and secondary pre- service science teachers' perceived efficacy beliefs and their classroom management beliefs. *The Turkish Online Journal of Educational Technology, 2(4).*

Shamsid-Deen, I., & Smith, B. P. (2006). Integrating contextual teaching and learning practices into the family and consumer sciences teachers' curriculum. Journal of Family and Consumer Sciences Education, 24(1), 14-27.

Sridher, Y. N., & Badiei, H. R. (2008). Teacher efficacy beliefs: A comparison of teachers' in Iran and India. *Journal of the Indian Academy of Applied Psychology, 34 (special issue)* 81-89.

Stein, M. K., & Wang, M.C. (1988). Teacher development and school improvement: The process of teacher change. *Teaching and Teacher Education,* 4, 171-187.

Smylie, M. A., (1988). The enhancement function of staff development: organizational and psychological antecedents to individual teacher change. *American Educational Research Journal, 25*, 1-30.

Tekkaya, C., Cakiroglu, J., & Ozkan, O. (2004). Turkish pre-service science teachers' understanding of science and their confidence in teaching it. *Journal of Education for Teaching, 30,* 57-66,

Tschannen-Moran, M., & Woolfolk Hoy, A. (2001). Teacher efficacy: Capturing an elusive construct. *Teaching and Teacher Education, 17*, 783-805.

Wenner, G.J. (1993). Relationship between science knowledge levels and beliefs toward science instruction held by pre-service elementary teachers. *Journal of Science Education and Technology, 2,* 461-468.

Woolfolk, A. E., & Hoy, W. K. (1990). Prospective teacher sense of efficiency and beliefs about control. *Journal of Educational Psychology, 82,* 81-91.