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The Impact of the Standard-Based Science Teacher Preparation Program on Pre-service Science Teachers' Attitudes toward Science Teaching

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ABSTRACT

Teachers' attitudes toward science teaching influence science teaching and learning. Promoting positive attitudes toward science teaching in pre-service science teachers appears as an important task for science teacher educators. This study aims (a) to explore 113 pre-service science teachers' attitudes toward science teaching at the beginning of the first semester in a standard-based science teacher preparation program, which had initiated in a university located in the middle region of Thailand, and (b) to track attitude changes of 30 volunteered participants after one semester of participation. The results revealed that, in overall, the participants had positive attitudes toward science teaching both at the beginning and the end of the semester. The participants with different genders significantly had different attitudes toward science teaching both at the beginning and the end of the semester, whereas the class level and study major variables did not significantly yield such differences. After one semester of participation in the standard-based program, the participants did not significantly enhance their attitudes toward science teaching. They, however, expressed additional negative attitudes regarding their inability to teach science adequately. The implications regarding how to promote positive attitudes toward science teaching in the context of science education are drawn from the results.

Key Words: Pre-service Science Teacher; Attitudes; Science Teaching and Learning; Teacher Education.

INTRODUCTION

Learning to teach science is a continuous process, and one of the significant portions takes place in science teacher preparation programs. Based upon constructivist epistemology, individuals are not blank slates; they come into teacher education with something constructed

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from their past experience such as perspectives, knowledge, beliefs, and attitudes. Whatever pre-service science teachers bring with them potentially influences their interpretation and construction of meanings for becoming science teachers. Nevertheless, many science teacher educators consider pre-service science teachers as blank slates and consequently ignore to articulate their existing status.

Numerous studies reiterate a wide range of attitudes held by prospective science teachers at different stages of teacher education (Bitner, 1992; Cox & Carpenter, 1989; Gibson & Van Strat, 2000; Ginns & Foster, 1983; Harty, Samuel, & Andersen, 1991; Lucas & Dooley, 1982; Martin, 1981; Shrigley, 1974; Strawitz & Malone, 1986; Sawanakunanon, 1992; Talsma, 1996; Turkmen, 2007; Westerback, 1982). In the Thai context, Sawanakunanon (1992) found that the primary teachers generally had positive attitudes toward science teaching. The teachers having more high-school science courses had significantly higher attitudes toward science teaching than those having less science courses. However, experiences in science content and science method courses had no effect upon their attitudes toward science teaching.

Harty et al. (1991) found that teachers' attitudes toward science teaching have a potential to influence their teaching, as well as their students' attitudes and achievement. Teachers with negative attitudes are likely pass on those negative attitudes to their students (Westerback, 1982). It is necessary to identify pre-service teachers' negative attitudes and find ways to help them to develop positive attitudes before they become teachers (Bayraktar, 2009). One of the important tasks for science teacher educators is, therefore, to identify their pre-service teachers' attitudes toward science teaching and to utilize them as stepping stones to help the pre-service teachers learn to become effective science teachers.

Becoming a science teacher in Thailand now is more difficult than in the past. Since 2003, a teaching career has been officially accepted as highly-qualified profession according to the section 43 of the Teacher and Educational Personnel Act B.E. 2546 (Secretariat of the Cabinet, 2003). A prospective science teacher must be completely qualified with Knowledge, Professional Experience, and Ethics Standards. Only a qualified person has the right to obtain a Teacher Professional Licence, which legally allows him or her to teach in public schools. The Regulations of Teacher Professional Licence B.E. 2547 (National Teacher Council, 2004) direct the process of delivering and obtaining a teacher licence. These regulations have caused several major changes in teacher education in Thailand. One important regulation is the school experience requirement, that is, a prospective teacher, who desires to obtain a teacher licence, must complete at least one year's (360 hours) experience in school, including at least 210 hours of classroom teaching. This requirement obliges teacher education agencies nationwide to revise their teacher preparation programs by extending student teaching from one semester to two semesters. The extension of student teaching subsequently leads to the extension of teacher education from four to five years. Thus, science teacher preparation programs in Thailand now are a five-year, standard-based program.

The occurrence of standard-based science teacher preparation programs in Thailand is a new and interesting phenomenon. However, the study concerning the impact of such programs upon pre-service science teacher professional development, particularly to attitudes toward science teaching, is still limited.

Attitudes Toward Science Teaching

Attitudes, in general, must have an anchor. Attitudes toward science teaching, as an example, use "science teaching" as the anchor. According to Koballa (1988), attitudes reflect one's favorability of feelings toward a particular object or issue. One's attitudes are learned

from his or her experience. Attitudes are consistent, ready or predisposed to respond, and susceptible to change. For example, some of the pre-service science teachers' negative attitudes toward science originated from their negative experience concerning the text-driven nature of science instruction or a lack of connection between science instruction and their daily lives. On the contrary, rich non-formal or out-of-school experience in science often sustained their interest in, and positive attitude toward, science (Talsma, 1996).

One's attitudes appear as a good determinant of his or her action. Generally speaking, attitudes and behavior are correlated. Particularly, attitudes toward science teaching affect whether science is taught, how it is taught, and how much it is taught. Some studies have shown that teachers' attitudes toward science teaching influence their instructional decisions and actions including how much classroom time is devoted to science instruction (Earl & Winkeljohn, 1977; Shrigley, 1974) and how teachers construe the nature of science (NOS) (Lederman, 1992). Teachers' attitudes accordingly have a strong influence on student learning (Cox & Carpenter, 1989).

Several studies have looked at various predictors of pre-service teaches' attitudes toward science teaching. In particular to gender, some studies revealed that pre-service teachers' attitudes toward science teaching did not significantly related to gender (Bitner, 1992; Shrigley, 1974; Turkmen & Bonnstetter, 2000), while another reported that a gender variable influenced teachers' attitudes (Guneyli & Aslan, 2009). Some studies reported that attitudes toward science teaching were related to class level and anxiety about science teaching. Turkmen and Bonnstetter found that there was a significant difference of attitudes toward science teaching held by pre-service teachers in different class levels (freshman, sophomore, junior, and senior). The post-hoc test showed that mean differences of upper class levels were significantly different from those of lower class levels. On the contrary, Ceylan, Ulutas, and Omeroglu (2009) reported that there was no significant difference in pre-service teachers' attitudes toward teaching according to class levels. Similarly, Guneyli and Aslan (2009) found that class levels did not have a significant influence on student teachers' attitudes toward teaching profession. Teachers' attitudes are related to anxiety as Westerback (1982) found that pre-service teachers with positive attitudes toward science teaching had low anxiety about science teaching. In addition, a negative self-perception of ability to teach is a component of negative attitudes toward science teaching among many elementary teachers and leads to a high degree of science anxiety (Cox & Carpenter, 1989).

Change of Attitudes Toward Science Teaching

Although one's attitudes toward a particular object or issue are relatively enduring or stable overtime, they can be changed. Changing attitudes is not random and something must happen to cause the change (Koballa, 1988). There was a variety of efforts in various educational settings reported by extant studies to promote positive attitudes in pre-service teachers. Some of such efforts were effective, while others were not. The subsequent section illustrates the characteristics and effects of such efforts.

Content-based courses could not lead to significant changes in pre-service teachers' attitudes toward science teaching (Lucas & Dooley, 1982). Westerback (1982) added that initial success in science courses could contribute a significant positive change in attitudes toward science teaching in pre-service elementary teachers, whereas math anxiety could suppress their attitudinal changes. In addition, Riley (1975) asserted that the science process skills training or inquiry did not help increase pre-service elementary teachers' attitudes toward science teaching and understanding of science.

Several subsequent studies (Hall, 1992; McDevitt, Heikkinen, Alcorn, Ambrosio, & Gardner, 1993; Minger & Simpson, 2006; Stefanich & Kelsey, 1989; Talsma, 1996), however, argued that hands-on activities embedded in teacher education courses can promote pre-service teachers' positive attitudes toward science teaching. As Talsma (1996) pointed out, throughout their K-12 education most pre-service elementary teachers have covered a lot of science content and have had little opportunity to do science. The presentation of science as concepts and definitions reinforce pre-service teachers' negative attitudes toward science, while hands-on experience was the most memorable for them. The frequently use of hands-on investigations in teacher education is, therefore, needed. Stefanich and Kelsey (1989) reported that coursework in science, which is specifically designed to give pre-service elementary teachers background in science content through small classes with frequent utilization of hands-on investigation, had a significant effect on attitudes toward science and science teaching. Supportably, the well-designed program consisting of nine courses emphasizing problem-solving and investigative hands-on activities could enhance pre-service science teachers' attitudes toward science teaching (McDevitt et al., 1993). Hall (1992) and Minger and Simpson (2006) additionally found that the activity-based science course yielded significantly improvement in their pre-service teachers' attitudes toward science teaching at the end of the semester.

Methods courses in teacher education can promote positive attitudes towards science teaching in pre-service teachers. Bayraktar (2009) found that the methods course made a significant improvement in pre-service primary teachers' attitudes toward science teaching. Martin (1981) and Turkmen (2007) also reported that although the methods course did not substantially change pre-service elementary teachers' attitudes toward science, it substantially and positively changed their attitudes towards science teaching. The slightly different finding found in Strawitz and Malone's (1986) study was that the field experience component of the methods course could significantly change both attitudes toward science and science teaching in their student teachers.

Promoting understanding of NOS and embedding constructivist pedagogy and cooperative learning in teacher education courses potentially leads to more positive attitudes toward science teaching in pre-service teachers. Harty et al. (1991) argued that although developing positive attitudes toward science and science teaching might not result in a better understanding of NOS, a better understanding of NOS might influence more positive attitudes toward science and science teaching. Gibson and Van Strat (2001) found that constructivist instructional methods had a positive impact on their pre-service teachers' understanding of physical science concepts, attitudes toward science teaching and learning, and critical thinking skills. In addition, Earl and Winkeljohn (1977) stated that working in cooperative format of instruction may enhance the pre-service elementary teachers' attitudes toward science teaching.

In teacher education, a communicator appears as one important factor influencing attitudinal change. Martin (1981) mentioned that three principal communicators, who potentially lead to attitudinal change in prospective teaches, were a science methods instructor, a graduate assistant, and a supervisor or an unit evaluator. Pre-service elementary teachers' attitudes tended to shift toward the perceived science teaching attitude level of the most credible communicator. Credibility of a communicator was, therefore, another factor influencing change in attitudes.

A gender variable may involve in attitudinal change. Turkmen (2007) found that at the beginning of the method course the female pre-service elementary teachers significantly had less positive attitudes toward science teaching than males. However, at the end of the course female did improve positive attitudes and there was no significant differences between male

and female attitudes toward science teaching. Comparing between the lecture-based and inquiry-based approaches, Ginns and Foster (1983) found that the inquiry-based approach was more effective to promote positive changes in attitudes toward science and science teaching among female pre-service elementary teachers. Male pre-service teachers, on the contrary, obtained higher positive gain scores for those attitudes under the lecture-based approach. However, some factors may not involve in the positive shift of student teachers' attitudes toward science teaching. Strawitz and Malone (1986) found that there were no significant differences in changes in attitudes toward science and science teaching between student teachers who differed in age, grade point average, and openmindedness. Student teachers assigned to different schools did not differ significantly on changes in concerns and attitudes toward science teaching, but they differed significantly in changes in attitudes toward science.

Standard-Based Science Teacher Preparation Program in Thailand

Thailand is an independent country, which lies in the heart of Southeast Asia. The country is bordered to the north by Laos and Burma, to the east by Laos and Cambodia, to the south by the Gulf of Thailand and Malaysia, and to the west by the Andaman Sea and Burma. Thailand is divided into 76 provinces, which are gathered into six regions, and has population approximately 65 millions. The capital and largest city of Thailand is Bangkok. Thailand has never been colonized, and therefore its educational system does not draw from European models to a great extent. According to the Basic Education Curriculum B.E. 2544 (Ministry of Education, 2001), basic education in Thailand includes 12 years of study that are divided into four major levels: Level 1 (Grades 1-3), Level 2 (Grades 4-6), Level 3 (Grades 7-9), and Level 4 (Grades 10-12).

Teacher education in Thailand has been officially established since 1892 when the first elementary teacher training school was founded. After that, a number of teacher training schools have been expanding to meet an urgent demand for teachers. This dramatic expansion was precipitated by the extension of compulsory education, population growth, and the increasing number of schools. However, this effort was concentrated on the quantity rather than the quality of teachers. At the present, there is a wide concern for the quality of teachers and teacher education. A teaching career is not seen as a professional career. It seems that anyone can be teacher if he or she can remember contents and deliver them to students.

In 2003, the Thai government proclaimed the Teacher and Educational Personnel Act B.E. 2546 (Secretariat of the Cabinet, 2003). "Teaching" is officially stated in the section 43 of the Act as "highly-qualified profession." To be teacher in basic education means to be fully qualified in accordance with the Knowledge, Professional Experience, and Ethics Standards consisting of Language and Technology, Curriculum Development, Teaching, Psychology, Measurement and Evaluation, Classroom Management, Educational Research, Educational Technology and Innovation, and Teacher Conduct Standards. Only a qualified person has a right to hold a Teacher Professional Licence, which legally allows him or her to be teacher in public schools. The process of delivering, holding, and maintaining the teacher licence was subsequently proclaimed in 2004 by the Regulations of Teacher Professional Licence B.E. 2547 (National Teacher Council, 2004).

The Act and Regulations mentioned earlier are bringing about many significant changes in teacher education in Thailand. Teacher preparation agencies nationwide must revise their programs in order to ensure that all prospective teachers are completely qualified according to the Standards and Requirements. In particular to the school experience requirement, each prospective teacher must complete at least one year (360 hours) of experience in school that partially includes at least 210 hours of experience in classroom teaching. To serve the school

experience requirement, science teacher preparation programs extend student teaching from one semester to two semesters. The extension of student teaching subsequently leads to the extension of teacher education from four years to five years. Now, science teacher preparation programs in Thailand are a five-year, standard-based program. In general, such standard-based programs require prospective teachers to take courses in science, education, and teaching methods, as well as to gain experience in classroom observation and participation, student teaching, and classroom action research.

The occurrence of a standard-based science teacher preparation program in Thailand is an interesting phenomenon and the study of its impacts pre-service science teachers who attend the program is also important. This study, therefore, aims to explore pre-service science teachers' attitudes toward science teaching at the beginning of the standard-based program, and to study the impact of such program on their attitudinal change after one semester of participation. The research questions guiding this study are: a) What are pre-service science teachers' attitudes toward science teaching at the beginning and the end of one semester participating in the standard-based science teacher preparation program?; b) Does the standard-based program impact on the participants' attitudes toward science teaching after one semester of participation?; and c) Do the gender, class level, and study major variables relate to the participants' attitudes toward science teaching after one semester of participation?

METHODOLOGY

This study is divided into two phases as follows.

I) First Phase of The Study

The first phase of the study was conducted at the beginning of the first semester of 2008 academic year at one university located in the middle region of Thailand, which had initiated the standard-based science teacher preparation program in 2008. The program requires pre-service science teachers to take at least 164 credits in three groups: General Education, 30 credits; Specific Area (Teacher Profession 51 credits, Specific Courses 77 credits), 128 credits; and Free Elective, 6 credits. At the first phase, the participants must attend the courses illustrated as Figure 1 (Appendices). The purposes of this phase are: (a) to explore pre-service science teachers' attitudes toward science teaching; and (b) to reveal the possible relationships between attitudes toward science teaching and the participants' class level, gender, and study major.

a) Participant

From purposive sampling, there were 113 pre-service science teachers (19 male, 94 female) who participated in this phase. The age of the participants ranged from 18 to 24 years old. Specifically, about one-third of them (34.5%) were 19 years old. The number of the participants in First, Second, Third, Fourth, Fifth years were 28 (24.8%), 17 (15%), 24 (21.2%), 20 (17.7%), and 24 (21.2%), respectively. Nearly a half of the participants (45.1%) have studied Biology, whereas others have studied Chemistry (26.5%), Physics (15%), and General Science (13.3%).

b) Data Collection

The participants were asked to complete the Attitudes toward Science Teaching Questionnaire (ASTQ). The ASTQ is an adapted version of the Revised Science Attitude Scale (Thompson & Shrigley, 1986). The Revised Science Attitude Scale is consisted of 22 items, which are five-level Likert-type attitude scale ranged from strongly agree to strongly disagree. Fifteen items (Items 1, 3-4, 8-14, and 16-20) were adopted and two items (Item 5 and 7) were revised, respectively, from the Revised Science Attitude Scale, and two new

items (Items 18 and 19) were created and added in. The ASTQ is finally consisted of 19 items. The back-translation (Brislin, 1970) was employed to improve the reliability and validity of research. Up to this method, the quality of a translation is verified by an independent translator translating back into the original language. Original and back translated documents can then be compared. The ASTQ was, then, translated into Thai and submitted to two experts (one science educator and one English teacher) to back-translate into English. The original and back translated ASTQ were then compared and any disagreement occurred during back-translation was resolved through the meeting. Figure 2 in the appendices shows the finalized ASTQ.

The ASTQ was tried out with 30 pre-service science teachers who were not the participants of this study. The reliability of the ASTQ determined by Cronbach's Alpha is 0.86 and the corrected item-total correlation ranged from 0.18 to 0.73. The minimum and maximum corrected item-total correlations were Item 3 and Item 5, respectively. The corrected item-total correlation for the two new items (Items 18 and 19) were 0.73 and 0.35, respectively.

c) Data Analysis

In data analysis, the strong agree, agree, neutral, disagree, and strongly disagree responses of the positive statements in the ASTQ (Items 4, 5, 6, 8, 10, 11, 13, 15, 16 and 18), were scored 5, 4, 3, 2, and 1, respectively. The scoring was reversed for the negative statements. Consequently, the possible range of score of the ASTQ is 19 to 95. Means and standard deviations (SD) for each item were calculated. The mean higher than 3.0 was interpreted as positive attitude, while the mean lower than 3.0 was interpreted as negative attitude. In addition, the one-way analyses of variance (ANOVA) was employed to reveal the possible relationships between attitudes toward science teaching and the participants' class level, gender, and study major.

II) Second phase of the study

The second phase was conducted at the end of the first semester of 2008 academic year. The main purpose of this phase are: (a) to track changes in attitudes toward science teaching of volunteered pre-service science teachers after one semester's participation in the standard-based program; and (b) to reveal the possible relationships between changes in attitudes toward science teaching and the participants' class level, gender, and study major.

a) Participant

There were 30 pre-service science teachers (6 male, 24 female) who volunteered to participate in this phase. The participants were six, six, five, seven, and six pre-service teachers in the first, second, third, fourth, and fifth year of study, respectively.

b) Data Collection

The participants were asked to complete the ASTQ again at the end of the first semester.

c) Data analysis

The data were analyzed by using the same scoring and statistical analysis process as mentioned in the first phase. There was a small number of participants in this phase (n = 30) and the tested variables were unsure whether they were normally distributed because the data did not constitute a random sample from a larger population (Hill & Lewicki, 2007). Therefore, the non-parametric statistical analysis (i.e. Wilcoxon Signed Ranks test, Mann-Whitney test, and Kruskal-Wallis Test) was employed to reveal whether the participants significantly changed their attitudes toward science teaching after one semester's participation in the standard-based program and such attitudinal changes significantly related to their class level, gender, and study major.

RESULTS

I) Results of the First Phase of the Study

Table 1 showed that the range of means of the participants' attitudes toward science teaching was 2.81 to 4.40. The overall mean and standard deviation of attitudinal scores were 3.73 and 0.98, respectively.

Table 1. *Pre-service science teachers' attitudes toward science teaching.*

	Statement	Mean	SD
1.	I will feel uncomfortable teaching science.	3.83	0.83
2.	I fear that I will be unable to teach science adequately.	3.05	1.00
3.	Teaching science takes too much time.	3.77	0.95
4.	I feel comfortable with the science content that will be taught in the future.	3.42	0.91
5.	I will enjoy teaching science.	3.85	0.79
6.	I would be interested in working in an experimental science curriculum	4.29	0.68
7.	I dread teaching sciences.	3.67	0.91
8.	I am not afraid to demonstrate science phenomena in the classroom.	3.74	0.91
9.	I am not looking forward to teaching science in my elementary classroom.	3.50	1.01
10.	I will enjoy helping students construct science equipment.	3.87	0.79
11.	I am willing to spend time setting up equipment for a lab.	4.04	0.73
12.	I am afraid that students will ask me questions that I cannot answer.	2.81	1.04
13.	I enjoy manipulating science equipment.	4.18	0.75
14.	In the classroom, I fear science experiments won't turn out as expected.	2.90	0.95
15.	Science would be one of my preferred subjects to teach if given a choice.	4.40	0.62
16.	I hope to be able to excite my students about science.	4.23	.668
17.	Teaching science takes too much effort.	3.49	0.79
18.	I feel that I can teach science effectively.	3.64	0.72
19.	I will not enjoy teaching science by doing an experiment.	4.12	0.79
	Total	**3.73**	**0.98**

The overall finding indicated that the participants had positive attitudes toward science teaching. However, there were two items that the participants expressed negative attitudes toward science teaching, that is, Item 12 "I am afraid that students will ask me questions that I cannot answer" and Item 14 "In the classroom, I fear science experiments won't turn out as expected".

Gender of the participants is significantly related to their attitudes toward science teaching, that is, male participants significantly had more positive attitudes toward science teaching than female ($t = 2.228$, $p < .05$). On the contrary, the one-way ANOVA revealed that the participants with different study majors and class levels did not significantly have different attitudes toward science teaching. The three-way ANOVA, as Table 2, also revealed that only the gender variable significantly affected the participants' attitudes toward science teaching and there were no interaction among gender, class level, and study major variables.

Table 2. *Interaction of attitudes toward science teaching, gender, study major, and class level.*

Source	SS	df	MS	F	p
Gender (A)	1.058	1	1.058	5.616	0.020*
Class level (B)	0.851	4	0.213	1.129	0.349
Study major (C)	1.087	3	0.362	1.922	0.132
A x B	1.079	4	0.270	1.431	0.231
A x C	1.118	3	0.373	1.978	0.124
B x C	.600	9	0.067	0.354	0.953
A x B x C	.804	4	0.201	1.067	0.378
Error	15.825	84	0.188		
Total	1593.971	113			

* $p < .05$

II) Results of the second phase of the study

The results in the second phase came from 30 volunteered participants. Overall, at the beginning of the semester these participants' range of means of attitudes toward science teaching scores was 2.87 to 4.43. The overall mean and standard deviation were 3.79 and 0.94, respectively. At the end of the semester these volunteers' range of means of attitudes toward science teaching scores was 2.67 to 4.43. The overall mean and standard deviation were 3.71 and 0.95, respectively (see Table 3).

Table 3. *Pre-service science teachers' attitudes toward science teaching at beginning and end of semester.*

	Statement	Beginning		End	
		Mean	SD	Mean	SD
1.	I will feel uncomfortable teaching science.	4.00	0.74	3.80	0.89
2.	I fear that I will be unable to teach science adequately.	3.23	0.97	2.97	1.10
3.	Teaching science takes too much time.	3.97	1.27	3.77	0.77
4.	I feel comfortable with the science content that will be taught in the future.	3.43	0.90	3.60	0.93
5.	I will enjoy teaching science.	3.93	0.69	4.07	0.74
6.	I would be interested in working in an experimental science curriculum	4.43	0.50	4.23	0.73
7.	I dread teaching sciences.	3.87	0.82	3.57	0.77
8.	I am not afraid to demonstrate science phenomena in the classroom.	3.73	0.98	3.63	0.93
9.	I am not looking forward to teaching science in my elementary classroom.	3.33	1.27	3.33	0.84
10.	I will enjoy helping students construct science equipment.	3.77	0.77	3.87	0.68
11.	I am willing to spend time setting up equipment for a lab.	4.20	0.61	4.17	0.38
12.	I am afraid that students will ask me questions that I cannot answer.	2.97	1.07	2.67	1.24
13.	I enjoy manipulating science equipment.	4.10	0.66	4.17	0.75
14.	In the classroom, I fear science experiments won't turn out as expected.	2.87	0.97	2.73	1.01
15.	Science would be one of my preferred subjects to teach if given a choice.	4.40	0.67	4.43	0.57
16.	I hope to be able to excite my students about science.	4.20	0.55	4.17	0.79
17.	Teaching science takes too much effort.	3.63	0.67	3.57	0.86
18.	I feel that I can teach science effectively.	3.70	0.70	3.60	0.72
19.	I will not enjoy teaching science by doing an experiment.	4.23	0.73	4.10	0.71
	Total	**3.79**	**0.94**	**3.71**	**0.95**

The participants holistically had positive attitudes toward science teaching both at the beginning and the end of the semester. When considering item-by-item, at the beginning of the semester the participants had negative attitudes toward science teaching only in two items, that is, Item 12 "I am afraid that students will ask me questions that I cannot answer" and Item 14 "In the classroom, I fear science experiments won't turn out as expected". However, at the end of the semester, surprisingly, they had negative attitudes toward science teaching in three items: two of them (Items 12 and 14) were the same as at the beginning of the semester, and the new one was Item 2 "I fear that I will be unable to teach science adequately". In addition, the non-parametric statistical analysis (i.e. the Wilcoxon Signed Ranks test) for both individual item and the overall revealed that the participants did not significantly change their attitudes toward science teaching as a result of one semester's participation in the standard-based program.

The Mann-Whitney test revealed that male had more positive attitudes toward science teaching than female both at the beginning ($z = 1.976$, $p < .05$) and the end of the semester ($z = 2.130$, $p < .05$). However, male and female did not show the significant difference in their attitudinal change after one semester's participation in the standard-based program. The Kruskal-Wallis Test showed that the participants with different study majors and class levels were not significantly different in attitudes toward science teaching both at the beginning and the end of the semester. Also, both variables did not yield the significant changes in the participants' attitudes toward science teaching after one semester's participation in the standard-based program.

DISCUSSION

I) Discussion of the first phase of the study

This study revealed that the pre-service science teachers in the standard-based teacher preparation program holistically had positive attitudes toward science teaching. This finding is similar to Turkmen and Bonnstetter (2000) and Guneyli and Aslan (2009) who found that pre-service teachers had overall positive attitudes toward science and science teaching. In addition, Bayraktar (2009) also found that 124 pre-service primary teachers' attitudes toward science teaching were mostly positive at the beginning of a science methods course. However, the participants of this study showed negative attitudes toward science teaching in two items, that is, Item 12 "I am afraid that students will ask me questions that I cannot answer" and Item 14 "In the classroom, I fear science experiments won't turn out as expected". These findings contradict Minger and Simpson (2006) who reported that the pre-service elementary teachers did not concern about those two items. According to Bayraktar (2009), there was a moderate positive relationship between attitudes toward science teaching and science teaching self-efficacy beliefs ($r = 0.646$, $p = 0.000$). The participants' negative attitudes toward science teaching in items 12 and 14 may be arisen from their low self-efficacy beliefs with respect to answering student questions and managing science experiments. Items 12 and 14, as mentioned earlier, may also imply that the participants concern about their content knowledge and experimental skills, respectively.

Only the gender variable significantly affected the participants' attitudes toward science teaching and there were no interaction among gender, class level, and study major variables. The significant impact of the gender variable on teachers' attitude toward teaching found in this study is similar to Guneyli and Aslan (2009), but the pattern of difference is not the same. In Guneyli and Aslan's study, female student teachers' attitudes toward teaching profession were higher than male student teachers, while in this study female had higher positive

attitudes toward science teaching than female. The impact of gender on teachers' attitude toward teaching found in this study the findings found by Shrigley (1974), Turkmen and Bonnstetter (2000) and Bitner (1992) that there was no significant gender difference in the pre-service teachers' attitudes toward science teaching. With respect to class level, the finding of this study is similar to Ceylan et al. (2009), who found that sophomore and senior students did not significantly have different attitudes toward teaching. However, this finding contrasts Turkmen and Bonnstetter (2000), who found that there was a significant difference between attitudes toward science and science teaching for science education student teachers with different class levels because of the number of science courses they had taken. The difference of employed research instrument and characteristics of participants may explain the difference of findings.

II) Discussion of the second phase of the study

Overall, the participants had positive attitudes toward science teaching both at the beginning and the end of the semester. This finding is similar to Sawanakunanon' study (1992), which showed that primary teachers generally had positive attitudes toward science teaching. When considering item-by-item, surprisingly, they had negative attitudes toward science teaching in three items: two of them (Items 12 and 14) were the same as at the beginning of the semester, and the new one was Item 2 "I fear that I will be unable to teach science adequately". This finding may imply that after one semester participation in the standard-based program the participants tend to fear about their inability to teach science adequately. It seems that the science courses, education courses, methods course, classroom experience, and student teaching experience the participants attended and derived in the first semester in the standard-based program are not effective for promoting their positive attitudes toward science teaching with respect to content knowledge, laboratory skills, and also ability to teach science. However, another possible reason is that the participants started the standard-based program with high attitude scores, so there is no room for their improvement.

The finding revealed that there was no significant change in attitudes toward science teaching as a result of one semester's participation in the standard-based program. The tentative explanation is that the newly Thai standard-based program did not bring much change to the earlier version except increasing pre-service teachers' classroom experiences from one semester to two semesters. Thus, teaching and learning environment in the program tends to be the same. In addition, this study confirms the resistance to change of attitudes toward science teaching held by pre-service teachers. As Wiggins, Follo, and Eberly (2007) found that pre-service teachers' attitudes remained relatively stable over time. It also suggests more effort in fostering desirable attitudes among these pre-service science teachers. Although the standard-based science teacher preparation program had initiated in the university, particularly is the context of this study, many science courses taught at the Faculty of Science continue to be fact-laden, non-inquiry oriented with cookbook laboratories. The emphasis on rote learning and cookbook experiments in such courses may result in the participants' concerns about a lack of content knowledge and experimental skills. In addition, Gibson and Van Strat (2000) found that fact-laden with cookbook lab science courses could impact negatively on the pre-service teachers' interest in teaching science. Furthermore, these pre-service teachers tend to view science as a body of knowledge which they are expected to transmit to their children, whereas the goal of science instruction is to encourage children to ask their own questions and find ways to answer. The strong emphasis of rote learning in Thai education may be arisen from Thai culture in particular to seniority as Burnard (2006) argued. Seniority, which is sometimes referred to as 'big person/little person', strongly influences the

teaching-learning process in Thai education. A teacher is generally held in very high regard (a big person) that leaves little room for students (a little person) to argue and debate. The teacher is, therefore, the repository of knowledge and his or her task is to convey that knowledge to students. The student's task is to note down and remember knowledge transmitted from the teacher. Similarly, Cox and Carpenter (1989) who reported that the courses in teacher education, which deal almost exclusively with the cognitive domain, could not effectively reduce pre-service teachers' science anxiety and negative attitudes toward science teaching. However, the finding of this study may contradict some extant studies which reported that courses in teacher education could impact on pre-service teachers' attitudes toward science teaching (Lucas & Dooley, 1982; Martin, 1981; Turkmen, 2007). Such difference may be originated from the different focus of the study, that is, this study aims to explore the effect of the whole courses, not a particular course (e.g. a science course or a methods course), in the new science teacher preparation program after being implemented for one semester.

In sum, among three variables (i.e. gender, study major, and class level) there was only the gender variable that potentially yielded the statistical significantly difference in the pre-service science teachers' attitudes toward science teaching both at the beginning and the end of the semester. Also, those three variables did not yield significant changes in the pre-service science teachers' attitudes toward science teaching after one semester of participation in the standard-based program. The impact of gender variable on the pre-service teachers' attitudes toward science teaching both at the beginning and the end of the semester found in this study may contradict Turkmen (2007) who found that at the beginning of the method course the female pre-service elementary teachers significantly had less positive attitudes toward science teaching than male. But, at the end of the course female did improve positive attitudes and there was no significant differences between male and female attitudes toward science teaching. Cautiously, this study involves the impact of the whole courses, including a methods course, conducted in the first semester of the standard-based program on the participants' attitudes toward science teaching.

CONCLUSION and IMPLICATIONS

This study reveals that the standard-based science teacher preparation program seems to be ineffective to promote significant improvement of attitudes toward science teaching in pre-service science teachers. This study supported the claim that attitudes toward science teaching are resistant to change. Only one semester may not be enough to promote positive attitudes toward science teaching in pre-service teachers. This study implies that attitudes toward science teaching are gradually accumulated throughout a longitudinal process in teacher education. The development of positive attitudes toward science teaching is, therefore, a difficult task requiring extended period instead of a certain period of time. Keeping positive attitudes toward science teaching over teacher preparation programs is also another difficult task. Science teacher preparation programs, especially a newly created one as the standard-based program, should pay more attention to these two difficult tasks.

Involved stakeholders in the science teacher education may use the instrument employed in this study (the ASTQ) in combination with other qualitative methods to explore what attitude toward science teaching held by pre-service science teachers and to track how and why they have changed their attitudes in teacher education. In addition, science teacher educators should pay attention to particular aspects of science teaching that pre-service teachers have negative attitudes and help them remedy such negative attitudes before perform classroom teaching. In the context of this study, to help the pre-service science teachers

increase their ability to answer student questions, to manage dilemmas in experiments, and to teach science adequately is my urgent task as teacher educator.

We, as a science teacher educator, cannot wait pre-service science teachers to improve their attitudes toward science teaching as an indirect product of doing scientific inquiry in the university as Riley (1975) emphasized: Science process skills or inquiry training did not help increase pre-service teachers' attitudes toward science teaching. We should appropriately combine several effective aspects as reported by extant studies in courses in science teacher education such as initial success in science courses (Westerback, 1982), activity-based science courses (Hall, 1992; Minger & Simpson, 2006), hands-on activities (Stefanich & Kelsey, 1989; Talsma, 1996), inquiry (Ginns & Foster, 1983), problem-solving (McDevitt et al., 1993), constructivist pedagogy (Gibson & Van Strat, 2000), cooperative learning (Earl & Winkeljohn, 1977), NOS (Harty et al., 1991), a credible communicator (Martin, 1981), extended period of field immersion (Wiggins, Follo, & Eberly, 2007), and viewpoints towards students (Ceylan et al., 2009).

Even though this study has its own value, it has the limitation concerning the small sample size employed that limits the generalization of findings to a larger population of pre-service science teachers in Thailand.

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Appendices

Figure 1. *Structure of the standard-based science teacher preparation program*

Physics	Chemistry	Biology	General Science
Year 1, First semester			
Basics of Education	Basics of Education	Basics of Education	Basics of Education
Computer Education	Computer Education	Computer Education	Computer Education
Calculus I	Calculus I	Calculus I	Calculus I
Principles of Biology	Principles of Biology	Principles of Biology	Principles of Biology
Laboratory in Biology	Laboratory in Biology	Laboratory in Biology	Laboratory in Biology
Physical Education	Physical Education	Physical Education	Physical Education
English	English	English	English
Thai Language	General Chemistry I	Health for Life	Thai Language
Year 2, First semester			
Calculus III	School Observation and Participation	Organic Chemistry	Science Process Skills
General Physics II	General Physics I	General Physics II	General Physics II
Concept of Sciences and Philosophy	Concept of Sciences and Philosophy	Laboratory in Organic Chemistry	General Botany
Environment, Technology and Life	Environment, Technology and Life	General Zoology	Environment, Technology and Life
English	English	English	English
	Laboratory in Physics I		
	Principle of Statistics I		
Year 3, First semester			
Classroom Observation and Participation	Classroom Observation and Participation	Classroom Observation and Participation	Classroom Observation and Participation
Methods of Teaching Elementary Science	Methods of Teaching Elementary Science	Methods of Teaching Elementary Science	Methods of Teaching Elementary Science
Science Instructional Media	Science Instructional Media	Principles of Genetics	Calculus II
Practicum I	Inorganic Chemistry I	Laboratory in Genetics	Selective course
Measurement and Evaluation in Science	Measurement and Evaluation in Science	Measurement and Evaluation in Science	Measurement and Evaluation in Science
Mechanics I	Environmental Chemistry	Chordate Comparative Anatomy	Elective course
Elective course	Elective course		
Selective course			
Year 4, First semester			
Teaching Observation and Participation	Teaching Observation and Participation	Teaching Observation and Participation	Teaching Observation and Participation
School Science Project	School Science Project	School Science Project	School Science Project
Principles of Guidance	Principles of Guidance	Principles of Guidance	Principles of Guidance
Selective course	Selective course	Selective course	Selective course
Elective course	Elective course	Elective course	Elective course
	Lab in Biochemistry		
	Biochemistry		
Year 5, First semester			
Student Teaching	Student Teaching	Student Teaching	Student Teaching

Figure 2. *The Attitudes toward Science Teaching Questionnaire (ASTQ)*

Directions: Please respond to each of the following statements.

If you 'Strongly Agree' with the statement, circle number 5.
If you 'Agree' (but not strongly) with the statement, circle number 4.
If you are 'Neutral' (neither agree nor disagree) with the statement, circle number 3.
If you 'Disagree' (but not strongly) with the statement, circle number 2.
If you 'Strongly Disagree' with the statement, circle number 1.

No.	Statement	Response				
1.	I will feel uncomfortable teaching science.	5	4	3	2	1
2.	I fear that I will be unable to teach science adequately.	5	4	3	2	1
3.	Teaching science takes too much time.	5	4	3	2	1
4.	I feel comfortable with the science content that will be taught in the future.	5	4	3	2	1
5.	I will enjoy teaching science.	5	4	3	2	1
6.	I would be interested in working in an experimental science curriculum	5	4	3	2	1
7.	I dread teaching sciences.	5	4	3	2	1
8.	I am not afraid to demonstrate science phenomena in the classroom.	5	4	3	2	1
9.	I am not looking forward to teaching science in my elementary classroom.	5	4	3	2	1
10.	I will enjoy helping students construct science equipment.	5	4	3	2	1
11.	I am willing to spend time setting up equipment for a lab.	5	4	3	2	1
12.	I am afraid that students will ask me questions that I cannot answer.	5	4	3	2	1
13.	I enjoy manipulating science equipment.	5	4	3	2	1
14.	In the classroom, I fear science experiments won't turn out as expected.	5	4	3	2	1
15.	Science would be one of my preferred subjects to teach if given a choice.	5	4	3	2	1
16.	I hope to be able to excite my students about science.	5	4	3	2	1
17.	Teaching science takes too much effort.	5	4	3	2	1
18.	I feel that I can teach science effectively.	5	4	3	2	1
19.	I will not enjoy teaching science by doing an experiment.	5	4	3	2	1