A COMPARATIVE STUDY OF TEACHERS' SELF-EFFICACY FOR TEACHING STEM SUBJECTS AND ATTITUDES TOWARD STEM EDUCATION ACCORDING TO GENDER AT WATTANA WITTAYA ACADEMY, BANGKOK, THAILAND

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Abstract: The purpose of conducting this research was to determine the level of teachers' self-efficacy when teaching STEM subjects and their attitudes towards STEM education at Wattana Wittaya Academy in Bangkok, Thailand. A second purpose was to determine whether there was a significant difference in teachers' self-efficacy for teaching STEM subjects and attitudes toward STEM education according to gender. As a source of data collection, the researcher used Teachers' Self-Efficacy for Teaching STEM Subjects and Attitudes Toward STEM Education (T-STEM Questionnaire). The respondents were 67 teachers completed the questionnaire. The data obtained were analyzed by descriptive statistics, means and standard deviations and independent samples *t*-test. The findings of this study were as follows: Teachers had a high level of self-efficacy for teaching STEM subjects. Teachers had positive attitudes toward STEM education. There was no statistical difference between teachers' STEM teaching self-efficacy for teaching STEM subjects and attitudes toward STEM education according to gender at Wattana Wittaya Academy, Bangkok, Thailand. Recommendations for practice and future research are provided.

Key Words: Self-efficacy, STEM Subjects, Attitudes, Teachers, Gender, Wattana Wittya Academy, Thailand.

Introduction: STEM is an abbreviation of four educational disciplines: science, technology, engineering, and mathematics. STEM education is generally focused on creating interdisciplinary learning. Teachers' self-efficacy for teaching STEM subjects and attitudes towards STEM education play an important role in determining students' interest in STEM subjects and in providing equal opportunities to access and benefit from quality STEM education (Bandura, 1997). Female STEM teachers have a positive impact on girls' performances in STEM education and careers. In contrast, girls' learning experience in STEM education is compromised when teachers hold

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stereotypical attitudes about gender-based STEM capacity or treat boys and girls unequally in the classroom (UNESCO, 2017).

Research Objectives

There were four objectives for this study as follows:

1) What is the level of teachers' self-efficacy for teaching STEM subjects including STEM teaching self-efficacy and beliefs, STEM teaching outcome expectancy, STEM instruction according to gender at Wattana Wittaya Academy, Bangkok, Thailand?
2) What is the level of teachers' attitudes toward STEM education including student technology use, 21st century learning attitudes, teacher leadership attitudes according to gender at Wattana Wittaya Academy, Bangkok, Thailand?
3) Is there a significant difference between teachers' self-efficacy for teaching STEM subjects according to gender at Wattana Wittaya Academy, Bangkok, Thailand?
4) Is there a significant difference between teachers' attitudes towards STEM education according to gender at Wattana Wittaya Academy, Bangkok, Thailand?

Literature Review

STEM Education

As our world continues to shift its dependency from hard labor to technology, it is important for teacher and students to be aware of the number of available positions in STEM careers **(**UNESCO, 2010). If an interdisciplinary educational program like STEM education is implemented in a school in order to improve STEM knowledge and skills, then it should be put into practice in such a way that it is accessible and beneficial to every student. Most of these educational professionals believe that interdisciplinary education increases the student's inquisitiveness and interest in education (Brusinc, 1991).

STEM education has been recently introduced in Thailand. In March 2016, the Minister of Education took the first step in initiating STEM education in Thailand by appointing board members to research best practices and to develop a STEM curriculum (Ministry of Education Thailand, 2016). Additionally, the British Council Thailand has partnered with the Institute for the Promotion of Teaching Science and Technology and the office of Vocational Education Commission to create a national STEM curriculum (British Council Thailand, 2016). There is a great need for STEM education in Thailand. Thailand's aging infrastructure requires bright young minds to develop cost-effective structures. Thailand is often dependent on other countries for transportation systems, machinery and electronics, limiting its

ability to complete the process of globalization. According to Associate Professor Soranit Silthram, the permanent secretary of the Ministry of Science and Technology, Thailand is experiencing a significant economic shift from low wage jobs to jobs that require creativity and innovation (Akin, 2016).

Social Cognitive Theory Defined Self-Efficacy

Albert Bandura's social cognitive theory provides the theoretical framework for analyzing how teachers design an effective STEM education. Self-efficacy is a construct that describes how confident teachers believe they are or how much control teachers have over their own behavior and their ability to reach their goal or a given task (Bandura, 1994). Self-efficacy for teaching STEM subjects includes the following: teachers' STEM teaching self-efficacy and beliefs, teachers' STEM teaching outcome expectancy and STEM instruction.

The ABC Model of Attitudes

Improving student achievement in STEM education not only involves teacher knowledge and self-efficacy, but also a desire to participate in a reform of pedagogy and attitudes of STEM teachers. Teachers' attitudes towards STEM education are the critical factor affecting their use of new teaching strategies. The tri-component conceptualization of attitudes employs the ABC model of attitudes (Ellis, 1957). The ABC model consists of affect, behavior and cognition. Teachers' attitudes towards student technology use in STEM classes allows 21st century learning attitudes to be structured in a highly rigid style of STEM education, providing students with new cross-disciplinary, real-life challenges in order to create an interdisciplinary understanding for the students (Ohio STEM Learning Network, 2016). Teacher leadership attitudes towards purposeful design can enhance the learning experiences of STEM students.

Wattana Wittaya Academy

The STEM project (iSTEM) was introduced in October 2015. The project aims to create a portfolio to showcase student work. Student work is uploaded on the school's website and facebook page @STEMWWA as inspiration for others. However, the school administrator and ten representative teachers participated in the free seminars yearly organized by The Institute for the Promotion of Teaching Science and Technology (IPST) held at their headquarters in Bangkok, Thailand. Moreover, the school has recently created a STEM department and is looking forward to creating a STEM curriculum from early childhood to upper secondary. The school is in partnership with EduPark Co, a company that provides tools such as creative toys and educational games and conduct trainings for teachers to learn ways to incorporate creative toys and games in their lessons.

Conceptual Framework

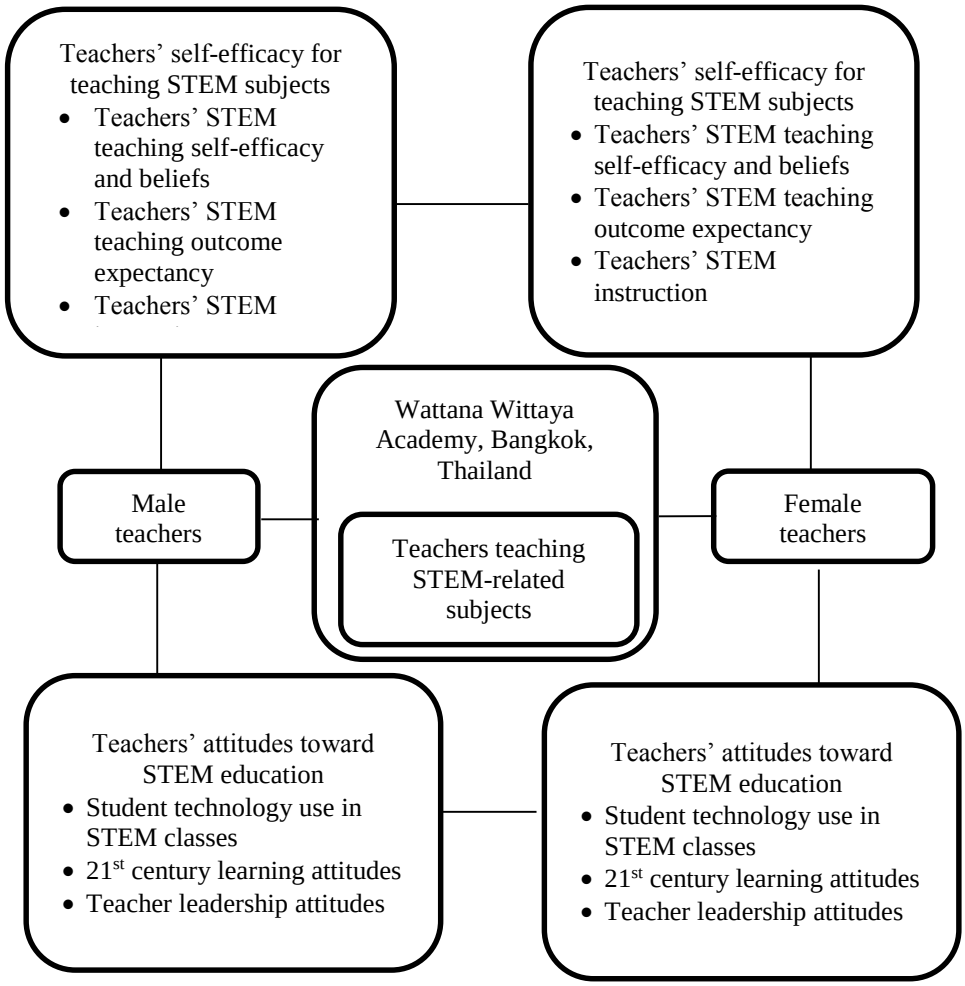

Figure 1. ***Conceptual framework.***

Method

Research Instrument

The questionnaire was designed to determine the impact of STEM programs developed by principal investigator Warwick Arden the following co-investigators Weibe, Ragan and Picart at The Friday Institute for Educational Innovation at the College of Education at North Carolina State University (2012) on teacher efficacy and attitudes. This study is a part of the Maximizing the Impact of STEM Outreach through Data-Driven Decision-Making (MISO) project and received funding from the Golden Leaf Foundation.

The questionnaire consists of two parts. Part one asks teachers to identify their gender. Part two asks teachers to respond to statements about their STEM teaching self-efficacy and attitudes. These subscales utilize a five-point Likert scale. For four of the variables including teachers' STEM teaching self-efficacy and beliefs, teachers' STEM teaching outcome expectancy, 21st century learning attitudes and teacher leadership attitudes, teachers responded to the statements using a five-point Likert scale from one *(strongly disagree)* to five *(strongly agree)*. For the other two variables, student technology uses in STEM classes and teachers' STEM instruction, teachers responded to the statements using a five-point scale from one *(never*) to five *(every time).*

Validity and Reliability

The validity and reliability of all items of the instrument can be found from the questionnaire's original findings. The first two variables under teachers' self-efficacy for teaching STEM subjects, teachers' STEM teaching self-efficacy and beliefs and teachers' STEM teaching outcome expectancy, were adapted from a science teaching efficacy belief questionnaire (Riggs, & Enochs, 1990). The last variable under teachers' STEM teaching self-efficacy, teachers' STEM instruction, was built on the item used in the statewide assessment of North Carolina's Race to the Top grant (Corn, 2013).

The remaining three variables, the attitude toward STEM education variables, were developed from the Student Technology Needs Assessment (2005). The 21st century learning attitudes construct was adapted from the Friday Institute's Student Learning Conditions Survey (2010). Finally, each item in the teacher leadership attitudes construct was taken from the North Carolina Department of Public Instruction's Professional Standards for Educators (2012). The original pilot teacher surveys analyzed showed the Cronbach's alpha of greater than .8 for all variables, meaning that the measurement of variables is considered good.

Population

The total population of this research is 67 teacher teaching mathematics, science and information communication technology teachers of Grade 1 to 6 as well as mathematics, biology, chemistry, physics and information communication technology teachers of grades seven to twelve at Wattana Wittaya Academy, Bangkok, Thailand, during the 2019-2020 academic year.

Collection of Data

The permission from the principal of Wattana Wittaya Academy, Bangkok, Thailand was requested and granted on 3 June 2019. After permission was

granted, the researcher distributed the T-STEM questionnaires. All 67 questionnaires were distributed to teachers teaching STEM-related subject.

Findings

The findings of this study are detailed below.

Research Findings of Research Objective 1

The first research objective was to determine the level of teachers' self-efficacy for teaching STEM subjects according to gender at Wattana Wittaya Academy, Bangkok, Thailand. To address Research Objective 1, data were collected from 34 items from part two of the Teachers' Self-Efficacy for Teaching STEM Subjects and Attitudes Toward STEM Education questionnaire (T-STEM), which includes the following three variables: teachers' STEM teaching self-efficacy and beliefs, teachers' STEM teaching outcome expectancy and teachers' STEM instruction.

Table 1 *Means, Standard Deviations, And Interpretations of Teachers' Self-Efficacy for Teaching STEM Subjects According to Gender at Wattana Wittaya Academy, Bangkok, Thailand*

Variables	Gender	*M*	*SD*	Interpretation
STEM teaching self-efficacy and beliefs	Male	3.44	.80	Moderate
	Female	3.67	.44	High
STEM teaching outcome expectancy	Male	3.65	.59	High
	Female	3.66	.49	High
STEM instruction	Male	2.98	1.03	Neutral
	Female	3.28	.76	Neutral
Overall	Male	3.36	.72	Moderate
	Female	3.54	.45	High

The results in Table 1 show that the overall means of teachers' STEM teaching self-efficacy at Wattana Wittaya Academy, Bangkok, Thailand, was $M = 3.36$ for males, which was interpreted as moderate, and $M = 3.54$ for females, which was interpreted as high.

Research Findings of Research Objective 2

The second research objective was to determine the level of teachers' attitudes toward STEM education according to gender at Wattana Wittaya Academy, Bangkok, Thailand. To address Research Objective 2, data were collected from 25 items from part two of Teachers' Self-Efficacy for Teaching STEM Subjects and Attitudes Toward STEM Education questionnaire (T-STEM), which includes the following three variables: student technology use in STEM classes, 21st century learning attitudes and teacher leadership attitudes.

Table 2 *Means, Standard Deviations, And Interpretations of Teachers' Attitudes Toward STEM Education According to Gender at Wattana Wittaya Academy, Bangkok, Thailand*

Variable	Gender	*M*	*SD*	Interpretation
Student technology use in STEM classes	Male	2.83	1.17	Neutral
	Female	3.21	.91	Neutral
21st century learning attitudes	Male	4.28	.65	High
	Female	4.20	.49	High
Teacher leadership attitudes	Male	4.12	.64	High
	Female	4.24	.55	High
Overall	Male	3.74	.63	Positive
	Female	3.88	.44	Positive

The results in Table 2 show that the overall means of teachers' attitudes toward STEM education at Wattana Wittaya Academy, Bangkok, Thailand, was M = 3.74 for males, which was interpreted as positive, and M = 3.88 for females, which was interpreted as positive.

Research Findings of Research Objective 3

An independent samples *t*-test used to determine whether there is a significant difference between teachers' STEM teaching self-efficacy according to gender at Wattana Wittaya Academy, Bangkok, Thailand.

Table 3 *Result of the Independent Samples t-Test Comparing Teachers' Self-Efficacy for Teaching STEM Subjects According to Gender at Wattana Wittaya Academy, Bangkok, Thailand*

Variable	Gender	*N*	*M*	*SD*	*df*	*t*	*p*
Self-efficacy for teaching STEM subjects	Male	17	3.36	.72	65	-1.21	.23
	Female	50	3.54	.45			

The sample means are displayed in Table 3, which shows that male teachers' attitudes toward STEM education which is quite similar to female teachers' attitudes toward STEM education. (for male teachers', M = 3.36, SD = .72; for female teachers', M = 3.54, SD = .45). Results were analyzed using an independent-sample *t*-test. This analysis failed to reveal significant different between the two groups, t (65) = -1.21; p = .23.

Research Findings of Research Objective 4

An independent samples *t*-test used to determine whether there is a significant difference between teachers' attitudes toward STEM education according to gender at Wattana Wittaya Academy, Bangkok, Thailand.

Table 4 *Result of the Independent Samples t-Test Comparing Teachers' Attitudes Toward STEM Education According to Gender at Wattana Wittaya Academy, Bangkok, Thailand*

Variable	Gender	*N*	*M*	*SD*	*df*	*t*	*p*
Attitudes toward STEM education	Male	17	3.74	.63	65	-1.21	.33
	Female	50	3.88	.44			

The sample means are displayed in Table 4, which shows that male teachers' attitudes toward STEM education which is quite similar to female teachers' attitudes toward STEM education. (for male teachers', $M = 3.74$, $SD = .63$; for female teachers', $M = 3.88$, $SD = .44$). Results were analyzed using an independent-sample *t*-test. This analysis failed to reveal significant different between the two groups, $t\ (65) = -1.21$; $p = .33$.

Discussion

Teachers' Self-Efficacy for Teaching STEM Subjects at Wattana Wittaya Academy, Bangkok, Thailand

The research findings revealed that teachers' self-efficacy and beliefs in regard to teaching STEM subjects were positive. Almost all of the participating teachers *strongly agreed* with all the statements regarding their STEM-teaching confidence and understanding of STEM concepts. However, when responding to Statement 5, which says, "I wonder if I have the necessary skills to teach STEM classes," a high number of teachers choose *agree* or *strongly agree*. According to Appropriate STEM Education Design for Kindergarten in Thailand (Na Ayuthaya, Dejakaisaya & Santanakul, 2015) teachers of young children are not confident when teaching STEM because these teachers did not study an integrated STEM course. To effectively teach STEM, STEM teachers need to have science, technology, engineering and mathematics content knowledge and necessary teaching skills.

The research findings revealed that teachers believe that effective instruction can help students overcome difficulties. In this section of the questionnaire, no teacher chose *strongly disagree* in response to any of the statements regarding STEM outcome expectancy. However, in the STEM instruction section of the questionnaire, the researcher was surprised to find that a significant number of participating teachers indicated that their students are

not using scientific skills and tools during STEM instruction. There may be many reasons for this. Teachers might lack training; teachers might have only a poor curriculum to guide them; teachers may not have enough time for projects and activities.

In a study, Srikoom, Hanuscin and Faikhamta (2018) found that teachers are motivated to improve their teaching and are confident in their ability to deliver STEM instruction but find that the time necessary for teaching STEM is not allowed by the curriculum. One solution to the problem of lack of time is to implement a flipped classroom. According to Kelly (2015) who studied the use of a flipped or inverted classroom in three STEM classes, teachers stated having extra class time for the students to work over projects and tasks, and the teacher is open for direct student collaboration and assistance. Teachers is able to create a deeper understanding of the subjects and concepts in the students.

Two STEM instruction activities are especially important: engaging in content-driven dialogue and quantitative reasoning. The ability to reason quantitatively allows students to interpret graphs, whereas allowing students to engage in content-driven dialogue give students the opportunity to process their learning and teachers the opportunity to correct and expand student understanding. These activities are not suitable for large classes, as they require a significant amount of time and opportunity for all student to speak.

Teachers' Attitudes Toward STEM Education at Wattana Wittaya Academy, Bangkok, Thailand

The research findings revealed that the students of the participating teachers use technology about half the time in their STEM classes. The researcher was concerned by the high number of teachers who responded *never* in response to statements about students working on technology-enhanced projects that approach real-world application of technology and about students using technology to help solve problems. One reason the students of the participating teachers may not be using technology to its full extent could be the school's lack of technology. It could also be that teachers lack training necessary to equip them to facilitate their students' technology use or that teachers do not value the use of technology. According to Chomphuchart (2017) are concern about whether or not technology benefits or gets in the way of student learning.

The research found a high level of agreement towards the statements regarding the 21st century learning attitudes. These learning attitudes involve discipline as well as students taking responsibility for themselves and others, but these are not the only ways in which students can develop in STEM classroom.

According to Bybee (2013), "In STEM education, students may develop cognitive skills while engaged in the study of specific STEM-related social or global situation" including "adaptability, complex communication, nonroutine problem solving, self-management, and systems thinking" (p.38). STEM teachers need to be intentional about ensuring their students are given the opportunity to develop these skills in their classrooms.

The research found a high level of agreement towards the statements regarding the teacher leadership attitudes. The participating teachers believe it is important that they take responsibility for all students learning and empower students. As Lauermann (2013) states, Teachers' personal sense of responsibility potentially influences their instructional practices, psychological well-being and ultimately their students' learning and performance.

Teacher' Self-Efficacy for Teaching STEM Subjects According to Gender at Wattana Wittaya Academy, Bangkok, Thailand

The research found no significant difference between male and female teachers' self-efficacy in the following three variables: STEM teaching self-efficacy and beliefs, STEM teaching outcome expectancy and STEM instruction. Similar study by Martin, Yin, and Mayall (2006) showed that female teachers have a lower level of self-efficacy in regards to classroom management than male teachers. Butucha (2013) also found a significant gender difference in self-efficacy in regards to classroom management where male teacher scored higher than female teachers. According to Lesha (2017), a study exploring the differences between male and female teachers found that male teachers are more competent in classroom management self-efficacy and student engagement than female teachers, as male teachers are usually stricter.

As cited in Truscott (2006), female students prefer female teachers to male teachers in STEM classes. The author states that female students would benefit from female teacher-student STEM mentorship programs.

Teacher' Attitudes Towards STEM Education According to Gender at Wattana Wittaya Academy, Bangkok, Thailand

The research found no significant difference in teachers' attitudes in the following three variables: student technology use in STEM classes, 21st century learning attitudes and teacher leadership attitudes. In a study, Srikoom, Hanuscin & Faikhamta (2018) found that male teachers have a more positive attitude towards student use of technology in the classroom than female teachers. In addition, Alrasheedi (2009) found that ICT training has a greater impact on male teachers than on female teachers.

There is lower rate of female faculty hired in STEM fields, but the retention rate remains the same for both males and females (Kaminski & Geisler, 2012). Moreover, female teachers are taking a lead in early childhood (Kelleher, 2011). Truscott (2006) mentions that female teachers are more reliable than male teachers in terms of social persuasion as a source of self-efficacy.

Recommendations

Based on the findings, this study recommends the following.

For Administrators. Administration should invest in their STEM teachers by providing many engaging, relevant professional development opportunities. Administrators must create policies and practices that encourage teachers to engage in professional learning. Administrators must identify the needs of their STEM teachers and then evaluate specialized professional learning programs to find the best fit for their teachers. Schools should purchase the relevant resources to facilitate their teachers continued development in STEM knowledge. Administrators should create a network of local businesses and community partners to facilitate outside-the-classroom STEM experiences for the students. This could include internships, workshops geared to the students' age level and level of STEM knowledge and mentorships. Before students are permitted to visit STEM companies, administrators must ensure that the students will be safe. Administrators should ensure that the students are exposed to balanced number of male and female STEM field employees.

For Future Researchers who are interested in studying teachers' STEM teaching self-efficacy and attitudes. The scope of this study was limited to Wattana Wittaya Academy; therefore, the future researcher can broaden the sample size of teachers who are teaching STEM subjects in other schools and universities in order to obtain more data. As well as a well-balanced of genders in sample size. Future researcher can design and implement research that examines a variety of approaches taken in STEM classes, including what program models and instructional strategies work for particular age groups and under what conditions.

For STEM Teachers. Teachers should understand the impact of gender stereotyping in STEM and how female teachers especially can have an impact on girls' participation in STEM, both in school and in a career. STEM teachers should form a collaborative teaching culture with their STEM colleagues. Teachers should plan with and discuss curriculum, teaching materials and teaching strategies. STEM should share science laboratories and equipment. These teachers need to develop a common language to describe their common work.

REFERENCES

Akin. (2016, November 30). Teaching youth to love innovation and science. *Bangkok Post.* Retrieved from https://www.bangkokpost.com/tech/local-news/1147909/teaching-youth-to-love-innovation-and-science.

Alrasheedi, H. (2009). Information and communication technology (ICT): Effects of Gender and training among Kuwait teachers. *Ohio University, Curriculum and Instruction Instructional Technology (Education).*

Arden, W., Wiebe, E., Ragan, S., & Picart, J. (2012). *Maximizing the Impact of STEM Outreach through Data-Driven Decision Making.* Retrieved from http://miso.ncsu.edu/wp-content/uploads/2013/06/T-STEM_FridayInstitute_DevAndPsychometricProperties_FINAL.pdf

Bandura, A. (1994). Self-efficacy. In V. S. Ramachaudran (Ed.), *Encyclopedia of Human behavior*, *4*, 71-81. New York: Academic Press. Retrieved from http://www.uky.edu/~eushe2/Bandura/ BanEncy.html

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

British Council. (2016). *STEM education*. Retrieved from https://www.britishcouncil.or.th/en/programmes/education/our-work-support-higher-education-and-research-sector/NewtonFund/stem-education

Brusinc, S. (1991). *Determining effects on fifth grade students' achievement and curiosity when a technology education activity is integrated with a unit in science* (Unpublished doctoral dissertation). Virginia Polytechnic Institute and State University, Blacksburg

Butucha, K. (2013). Gender and school type difference in self-efficacy in teaching. *Sky Journal of Educational Research*, (1).

Bybee, R. (2013). *The case for STEM education: Challenges and opportunities.* NSTA press.

Chomphuchart, N. (2017). Thai university students' attitudes toward the Use of the Internet in Learning English. *Rangsit Journal of Educational Studies*, (4)(1) doi:10.14456/rjes.2017.2

Corn, J. (2013) Second annual race to the top professional development evaluation report: Part II Local Outcomes Baseline Study. Raleigh, NC: Friday Institute for Educational Innovation, North Carolina State University. Available from https://cerenc.org

Ellis, A. (1957). *Rational emotive behavior therapy.* Washington DC: American Psychological Association.

Kaminski, D., & Geisler, C. (2012). Survival analysis faculty retention in Science and Engineer by gender. Doi:10.1126/science.1214844

Kelleher, F. (2011). Women and the teaching profession: Exploring the feminization debate. *Commonwealth Secretariat and UNESCO*.

Kelly. (2015). STEM Teacher efficacy in inverted classroom. *North Carolina State University.* Retrieved from https://repository.lib.ncsu.edu/bitstream/handle/1840.16/10632/etd.pdf?sequence=2&isAllowed=y

Lauermann, F. V. (2013). *Teacher responsibility: Its meaning, measure and educational implications.* Retrieved from https://deepblue.lib.umich.edu/bitstream/handle/2027.42/99839/fanim_1.pdf?sequence=1

Lesha, J. (2017). Gender differences in primary school teachers' self-Efficacy beliefs. *European Journal of Education Studies*

Martin, N. K., Yin, Z. & Mayall, H. (2006). *Classroom management Training, teaching experience and gender: do these variables impact teachers' attitudes and beliefs toward classroom management style?* Retrieved from http://files.eric.ed. gov/fulltext/ED494050.pdf

Ministry of Education Thailand (2016). Minister of Education signed an order for STEM education. *ASEAN Information Center Government Public Relation Department.* Retrieved from http://thailand.prd.go.th/1700/ewt/asean/ewt_news.php?nid=1099&filename=index

Na Ayuthaya, Dejakaisaya & Santanakul. (2015). Appropriate STEM education design for kindergarten in Thailand. *20th International Academic Conference, Madrid.* Doi: 10.20472/IAC.2015.020.043

North Carolina Department of Public Instruction. (2012). North Carolina professional teaching standards. Releigh, NC. Retrieved from http://www.ncpublicschools.org/doc/effectiness-model/ncees/standards/prof-teach-standards.pdf

Ohio STEM Learning Network (2016). How is STEM different from a traditional approach to education? *about Ohio STEM learning network*. Retrieved from http://www.osln.org/about/faq/

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

Srikoom, W., Hanuscin, D. L., & Faikhamta, C. (2017). Perception of in-service teachers toward teaching STEM in Thailand. Retrieved from Asia-Pacific on science learning and teaching (18)(2)(6).

Student Technology Needs Assessment. (2005). *School technology needs assessment.* Retrieved from https://www.fi.ncsu.edu/wp-content/uploads/2013/05/School-Technology-Needs-Assessment-STNA.pdf

Truscott, T. (2006). Relationships between STEM self-efficacy, same-sex role models and academic behavior. Retrieved from https://pdfs.semanticscholar.org/5b3c/c5af45c3516f07ce91b8b2fd19690efe4644.pdf

UNESCO. (2010). *Current challenges in basic science education*. Retrieved from http://unesdoc.unesco.org/images/0019/001914/191425e.pdf

UNESCO. (2017). *SAGA-STEM and gender advancement: Improved measurement of gender equality in science, technology, engineering and mathematics.* Retrieved from http://unesdoc.unesco.org/images/0024/002443/244375E.pdf