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The Capabilities of Science Teachers in Providing Environmental Literacy According to the STSE-Approach for Schools in an Environmentally Impacted Province

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This research aims to: (1) study the capabilities of science teachers in providing environmental literacy according to the STSE-Approach for schools in an environmentally impacted province by taking Wiang Kaen Wittayakhom School (Wiang Kaen, Chiangrai) as a case study; and (2) compare the outcomes of improving science teachers in providing environmental literacy according to the STSE-Approach, as categorised by teaching experience and grades. The research aims to improve the capabilities of science teachers in providing environmental literacy in four dimensions: 1) in-depth knowledge and appreciation in environment, 2) design of learning, 3) the providing of learning activities, and 4) examinating and evaluating learning. The case-study subjects are 8 science and technology teachers of Wiang Kaen Wittayakhom School, Educational Area District 36 (Phayao – Chiangrai), under the Office of the Basic Education Commission. The data was collected by examination and evaluation forms for science teachers. The data was analysed to find mean, standard deviation, and t-test independent. The research indicates that the capabilities of science teachers on providing environmental literacy according to STSE-Approach is at a high level in terms of in-depth knowledge and appreciation of the environment, design of learning, as well as examination and evaluation of learning. The capabilities on providing of learning activities is at a very high level. The data analysis of mean, standard deviation, and t-test independent indicates that science teachers have improved capabilities in providing environmental literacy between the pre and post seminar with a statistical significance of 41.75% to 89.50. Teaching experience and grades do not change the capabilities in providing environmental literacy according to the STSE-Approach.

Key words: *Capabilities of science teacher, Science, technology, society and environment approach, Environmental literacy.*

Background and Significance of the Problem

Currently, there are three main environmental problems at hand which are above the world's capacity to securely handle. They are biological diversity loss, the nitrogen problem, and the climate crisis. If these problems are not immediately handled, the world shall dramatically change for the worse (World Economic Forum (2019:1). Thara (2018:1) suggested in 2018 that the environmental problem in Thailand southeast Asian, and the world is plastic pollution. Although there are several measurements to handle plastic usage, the crisis does not improve. In the middle of 2018, a short-fined pilot whale was found dead in Songkla province with 8 kilograms of plastic in it. In November 2018, a sperm whale was found dead in Indonesia with plastic cups, plastic bags, shoes, and ropes found in it. On air pollution, the World Health Organisation documented that the annual average of dust intensity is up to PM 2.5 and that 9 out of 10 people breathe in air pollution. From 1 January to 21 February 2018, Bangkok faced the worst air pollution crisis for 52 days overall.

In 2018, there was a proposal on Hothouse Earth in the summary of a meeting during the Proceedings of the National Academy of Sciences that the world needs to immediately change from fossil fuel to clean and renewable energy. The failure to do so would set the world into hothouse state which would be permanently critical. The Global Climate Action Summit in San Francisco proposed to reduce greenhouse gas from all economic actions by half before 2030. Aisarangkul Na Ayuttaya (2559: 5) presents the Thai environmental situation by size and the intensity of the problems. The first problem is the unsanitary recycling of electronic garbage that is incorrectly disposed according to academic principles, which leaked chemicals into the environment. The leak would last and directly impact the health of the people. Thailand still does not have a direct legislation dealing with electronic wastes. The second problem is deforestation. The third is the water situation and drought. In the past 2-3 years, several areas in Thailand are facing drought.

During drought seasons in 2015-2016, Thailand faced the worst drought in 15 years. The main reasons are climate change and deforestation. These problems are significant because they impact agriculture, fishery, tourism, industry, and environment.
The fourth problem is coastal erosions, which are increasing worsening. The main reasons are invasive seaside constructions and an incorrect problem-solving approach. The fifth problem is greenhouse gas omission, including environmental situations in Thailand. Climate change is increasing worsening, leading to an agreement on a greenhouse reduction plan in COP21. Decreased rain also causes water deficiency, which brings about coastal erosion. Natural disasters tend to increase. There are cross-border environmental problems, including an

international dust crisis which is unsuccessfully handled in the northern part of Thailand. It is a type of pollution that is challenging for international cooperation. Thailand continuously loses forests yearly. In the last three years, deforestation has increased. Governmental reclamation of forests should continue. The dust problem from forest fires increasingly worsens. The barrier to this is economic agriculture within reserved areas including corns and rubber trees. Consumers should have the right to know which business creates deterioration to the environment and a green label should be developed for products to prevent agriculture in the reserved areas. As for water situations, there are problems of rain deficiency and inefficient water allocation. There should be better water management systems from the beginning to the end of the water line.

Humans are a significant mechanism in global change both positively and negatively. Something that can be significantly improved is Thai mandatory education. This is where we improve our knowledge, understanding, reservation, and gain the realisation that the environment is a crucial element of life. Teachers are play the important role of building human capital. Teachers have duties to give knowledge, understanding, reservation, and the realisation of protecting and being responsible for the environment, personally, domestically, and internationally. There are many ways to provide these qualities. One of those ways is to follow the STSE-Approach. The approach provides the educational integration of science, technology, dimensional social issues, and environment. This encourages divergent thinking, small team tasks, problem solving, decision making, constructive criticism, and rational debates. Practice or properly solving problem is a positive relation on creatures and environment and is also negative to creatures and environment. It is beneficial as much as it is harmful (Pedrettie G. 2006: 941–960 ; Benze. 2011; Ermine et al.: 941-960, 2008; Yörük and Other. 2010: 57). The STSE-Approach is in accordance with the objectives of the problems which should help teachers to design the science learning. Furthermore, science can also open up perspectives or environmental problems in the society to learn, understand, and realise the importance of self-solving problems, which is called Environment Literacy. The process according to STSE-Approach has the five following steps:

(1) Identification of social issue stage
(2) Identification of potential solution stage
(3) Need for knowledge stage
(4) Decision-making and reflecting stage
(5) Socialisation stage

Wiang Kaen Wittayakhom School (Wiang Kaen, Chiangrai) is in areas at risk of natural disasters. The data from 2014 onwards shows floods, deforestation, monoculture, landslides, chemical toxicants in agriculture, drought risks, shallow Ngaw river, deterioration of soil, and the expansion of tourism business, which is affecting environment. The area has been

announced at risk of landslide because it is located at the Mekong river, the Thailand-Laos border.

Education is the heart of educating human resources with knowledge, capabilities, realisations, and knowledge of the environment. This is not a simple day-to-day knowledge, but is the core knowledge itself. The practice of solving environmental problems from the inside, having realisations of such practice, being ready to act or take responsibility of the environment by utilising knowledge, capabilities, academic principles to the advantage of oneself, the world, and science is the best tool to promote and demote efficiency at the same time. Therefore, teachers create human resources from STSE-Approach. Thus, the improvement of science teachers to be equipped with Environment Literacy is in accordance with the STSE-Approach for schools in environmentally impacted provinces. This consists of four dimensions: 1) in-depth knowledge and appreciation in environment, 2) design of learning, 3) providing of learning activities, and 4) examination and evaluation of learning. It is a proper guide for building human capital to the benefit of students, teachers, schools, societies, communities, and significant citisens of the world.

Research Questions

How are the capabilities of science teachers in providing environmental literacy according to STSE-Approach for schools in environmentally impacted provinces in post-improvement higher than *pre*-improvement? How are the capabilities of science teachers in providing environmental literacy according to STSE-Approach for schools in environmentally impacted provinces according to teaching experience? And what are the capabilities of science teachers in providing environmental literacy according to STSE-Approach for schools in environmentally impacted province according to grades?

Research Objectives

The objectives of this research are (1) to study the capabilities of science teachers in providing environmental literacy according to the STSE-Approach for schools in environmentally impacted provinces; and (2) to compare the outcomes of science teachers' improvement on providing environmental literacy according to the STSE-Approach when categorised by teaching experience and grades.

Capabilities of Science Teachers and Science Technology Society and Environment Approach: STSE-Approach

Kritiya Ariya and Wareerat Kaewurai (2016:8) encourage teachers to design learning management in the 21st century so that they are: (1) Able to design learning management for

learners in the 21st century, (2) provide learning activities for students. B. Fauth et al. (2019:3) discovered that a teacher's ability in learning management relates to knowledge in the cognitive aspects: knowledge and beliefs. Specific knowledge is traditionally regarded as a key factor for teachers' vocational success. There is a widely acknowledged distinction between content knowledge, which refers to a comprehensive understanding of the topics taught, and pedagogical content knowledge, which refers to the ways of making this content knowledge accessible to students. Taweesak Jindanulak (2016: 159) referred professional science teachers to teachers who have good content knowledge in science subjects, including chemistry, biology, physics, and general science, and are able to create learning environments based on STEM education that combines science, mathematics, technology and engineering. Through this learning concept, learners participate in activities that develop their knowledge, understanding and skills in science, and apply their knowledge in creating a piece of work or a method by using the engineering design process. According to the American Association for the Advancement of Science (AAAs), science teachers also need to understand the nature of science. This includes three components: 1) scientific worldview 2) scientific inquiry, and 3) scientific enterprise. Moreover, professional science teachers should have pedagogical knowledge that will enable them to teach, and transfer knowledge to students. They should employ technological pedagogical content knowledge, or TPCK, combining the 3 areas of knowledge 1) content knowledge, 2) pedagogical knowledge, and 3) technology knowledge, for the effective practice of learning and teaching in a technology enhanced learning environment.

STSE-Approach requirements are processes that bring understanding between science, society, technology and the environment together. The main goal is helping students learn the importance of science development in daily life and promoting activities in the lives of people in society (Pedretti and Forbes 2000: 39-41). STSE-Approach is needed for social development. it depends on both the individual and the knowledge that can be made through each individual. The development of science and technology has a positive and negative effect on society and the environment. This method of study must be emphasised to the students, which will help the students to practice research, tests and observations. Education based on this concept will use experiences both inside and outside of schools related to science, technology, motivation. This results from the interest of the students and improves the attitude towards science (Yörük et al. 2009: 69). The STSE-Approach according to the aim of NSTA (The National Science Teacher Association 1990) is expertise in learning management, teaching science, solving problems related to real science and technology. This is in place of teaching with skills and knowledge processes, which encourages students to analyse, apply concepts and processes to the learning management model that is related to STSE-Approach. Adhering to the learning principles of creating knowledge by themselves, students will have ideas understanding what will be an important base for learning about the topic, resulting in students creating connections, concepts, and self-knowledge. Chokchai Yuenyong (2009:3)

mentioned that the learning management steps are as follows: (1) Identification of social issue stage; Identification of social problems caused by science and technology; (2) Identification of potential solution stage in which students check their potential answers to their social issues; (3) Need for knowledge stage, in which students will study science knowledge related to that problem; (4) Decision–making stage, in which students will use the knowledge they have learned to review solutions to problems.; (5) Sharing: Present knowledge and ideas gained through searching for answers; (6) Extending: Bring knowledge, ideas, and conclusions from the problem to study and find additional answers by yourself; (7) Acting: Apply the knowledge gained to practice. From the analytical study, the guidelines for teacher training are based on the STSE-Approach. The 5 steps are as follows: (1) Identification of social issue stage; (2) Identification of potential solution stage; (3) Need for knowledge stage; (4) Decision – making stage and reflection; (5) Socialisation stage.

Research Methodology

The case-study subjects are 8 science and technology teachers of Wiang Kaen Wittayakhom School (Wiang Kaen, Chiangrai), which is a school in a province with environmental problems, Educational Area District 36 (Phayao – Chiangrai) under the Office of the Basic Education Commission. The equipment for research consists of the equipment for research *i.e.* the curriculum on improving the capabilities of science teachers in providing environmental literacy according to the STSE-Approach for schools in environmentally impacted provinces. This consists of three activities. The plan is as follows:

Process of Seminar	Activities
***Pre*-seminar** Examination and evaluation before seminars	*Pre*-seminar evaluation with 2 evaluation forms: 1. Examination form to examine capabilities of science teachers in providing environmental literacy according to STSE-Approach 2. Evaluation form to evaluate capabilities of science teachers in providing environmental literacy according to STSE-Approach
During seminar consists of 3 activities	**First Activity:** What is STSE-Approach? 1. Role play on S, T, S, E, to draw in attention 2. Building understanding on STSE-Approach 3. Summarising by Mapping STSE-Approach **Second Activity:** STSE-Approach and Environmental Literacy 1. Lecture on Environmental Literacy, its concept and relationship with STSE-Approach 2. The risky environmentally situation in the presence with the 'Together on STSE-Approach for providing learning' 3. Conclusion with 'Relationship graph between STSE-Approach and Environmental literacy **Third Activity:** STSE-Approach from classroom action to society 1. How to teach on the environment: lecture and video presentation on environmental crisis 2. The audience devices a learning plan on Environmental Literacy according to STSE-Approach 3. Demonstration of teaching on Environmental Literacy according to STSE-Approach
***Post*-seminar** Evaluation and examination of the seminar	*Post*- seminar evaluation with 2 evaluation forms: 1. Examination form to examine capabilities of science teachers in providing environmental literacy according to STSE-Approach **2.** Evaluation form to evaluate capabilities of science teachers in providing environmental literacy according to STSE-Approach

The curriculum on the improvement of science teachers capabilities in providing environmental literacy according to STSE-Approach for schools in environmentally impacted provinces is checked by three experts for content validity, language, to find the index of Item Objective Congruence. IOC is to evaluate the suitability and conformity of the activities with the conformity index at 0.60 – 1.00. Overall, the conformity index is at .076.

Equipment for data collection consists of: Examination form to examine capabilities of science teachers in providing environmental literacy according to STSE-Approach for schools in environmentally impacted provinces is a set of three questions or scenarios, rating scale, content validity by experts, and index of Item Objective Congruence: IOC. It is evaluated for suitability and conformity in the activities with the conformity index at 0.60 – 1.00. Overall, the conformity index is at 0.77. The Reliability is rated at 0.83 by Alpha coefficient. Equipment for data collection consists of: Evaluation form to evaluate capabilities of science teachers on providing environmental literacy according to STSE-Approach for school in environmentally impacted province. It consists of four dimensions: 1) in-depth knowledge and appreciation in environment, 2) design of learning, 3) providing of learning activities, and 4) examination and evaluation of learning. It is rated by five levels. It is actually the environmental situation which requires answers or presentation according to Rubric Score. The quality of the equipment is checked by three experts for content validity, language, to find the index of Item Objective Congruence: IOC. The evaluation of the suitability and conformity of the activities with the conformity index is at 0.60 – 1.00. Overall, there is a conformity index of 0.83. Reliability is rated at 0.88 by Alpha coefficient.

Data Analysis includes the following: Analysis of the capabilities of science teachers on providing environmental literacy according to STSE-Approach by calculating mean and standard deviation. This resulted in the following: 4.51 – 5.00 indicate top capabilities. 3.51 – 4.50 indicate average capabilities. 1.51 – 2.50 indicate less capabilities. 1.00 – 1.50 indicate least capabilities. Comparing *pre* and *post* capabilities of science teachers in providing environmental literacy according to STSE-Approach for schools in environmentally impacted provinces. Comparing capabilities of science teachers in providing environmental literacy according to the STSE-Approach for schools in environmentally impacted provinces, categorised by teaching experience and grades, for t-test Independent.

Research Results

The results of the research on capabilities of science teachers in providing environmental literacy according to STSE-Approach for schools in environmentally impacted provinces indicate that science teachers of Wiang Kaen Wittayakhom School (Chiangrai province) have a high level of capability. The best of those capabilities is providing learning activities as indicated by Table 1.

Table 1: Shows capabilities of science teachers in providing environmental literacy according to the STSE-Approach for schools in environmentally impacted province—a case study of Wiang Kaen Wittayakhom School (Chiangrai province)—by three questions or scenarios.

Capabilities of Science Teachers	$\bar{x}$	**S.D.**	**Level**
1. In-depth knowledge and appreciation in environment	4.38	0.23	High
2. Design of learning	4.44	0.32	High
3. Providing of learning activities	4.78	0.25	Very high
4. Examination and evaluation of learning	4.34	0.30	High
Total	4.48	0.04	High

Table 1 indicates that the mean of capabilities of science teachers in providing environmental literacy according to the STSE-Approach for schools in environmentally impacted provinces—case study of Wiang Kaen Wittayakhom School (Chiangrai province)—by three questions or scenarios, is at high level. The best of those capabilities is providing learning activities, which is at very high level. Other dimensions are at high levels.

The comparison results of capabilities of science teachers in providing environmental literacy according to the STSE-Approach for schools in environmentally impacted provinces—a case study of Wiang Kaen Wittayakhom School (Chiangrai province)— in both *pre* and *post* seminars, analysing data by mean, standard deviation, and Paired Samples T-Test.

Table 2: Shows capabilities of science teachers in providing environmental literacy according to the STSE-Approach for schools in environmentally impacted provinces—a case study of Wiang Kaen Wittayakhom School (Chiangrai province)— in both *pre* and *post* seminars.

Experimental group	***n***	$\bar{x}$	***S.D***	***t***	***p***
Pre-seminar	8	41.75	4.62	24.11*	.000
Post-seminar	8	89.50	3.16		
$p^* \leq .05$					

Table 2 indicates that the mean of capabilities of science teachers in providing environmental literacy according to the STSE-Approach for schools in environmentally impacted provinces—a case study of Wiang Kaen Wittayakhom School (Chiangrai province)— in *post* seminar is 89.50 which is higher than *pre* seminar at 41.75. The analysis of the difference between *pre* and *post* seminar by T-Test results is $t = 24.11$ and $p \leq .05$. The result indicates higher capabilities of science teachers because of the seminar being in accordance with the STSE-Approach, which results in a significant increase of .05.

Table 3: Shows capabilities of science teachers in providing environmental literacy according to the STSE-Approach for schools in environmentally impacted provinces—a case study of Wiang Kaen Wittayakhom School (Chiangrai province)— in *pre*, during, and *post* seminar.

Capabilities of Science Teachers	***Pre* seminar %**	**During seminar %**	***Post* seminar %**	**Overall %**	**Level**
1. In-depth knowledge and appreciation in environment consists of 4 elements; 1.1. Science learning providing for environmental literacy 1.2. Environmental understanding is divided into 3 levels; 1.2.1. Facts gathering by observation and prediction of natural phenomenon 1.2.2. Higher understanding of nature: being able to explain natural phenomenon, being able to comment and suggest forms or rules regarding nature and apply those in explaining and predict natural phenomenon 1.2.3. The highest understanding of natural phenomenon: being able to arrange relationship among rules and form of thoughts or theories into mind system 1.3. Having scientific mind: being interested in environment and being confident in environmental literacy 1.4. Thinking process in finding reasons to learn	41.25	87.5	90	72.92	High
2. Design of learning 2.1. Creating structure and learning units on science subjects (physics, chemistry, biology, and computer) according to STSE-Approach 2.2. Creating science learning plan according to STSE-Approach	43.75	92.71	86.67	74.38	High

3. Providing of learning activities 3.1. Demonstration of teaching according to the learning plan 3.2. Performing the teaching on students	40.00	95.83	93.75	76.53	High
Capabilities of Science Teachers	***Pre* seminar %**	**During seminar %**	***Post* seminar %**	**Overall %**	**Level**
4. Examination and evaluation of learning 4.1. Design and creating equipment for examination and evaluation according to STSE-Approach	41.88	89.69	86.88	72.81	High
Total	41.75	92.00	89.5	74.42	High
	Low	**Very high**	**Very high**	**High**	**High**

The result of comparing capabilities of science teachers in providing environmental literacy according to the STSE-Approach for schools in environmentally impacted provinces—a case study of Wiang Kaen Wittayakhom School (Chiangrai province)—categorised by teaching experience and grades. This analysis is a comparison between capabilities of science teachers in providing environmental literacy according to the STSE-Approach for schools in environmentally impacted provinces—a case study of Wiang Kaen Wittayakhom School (Chiangrai province)—categorised by teaching experience and grades. The result indicates that Teachers with more than 5 years and less than 5 years have the capabilities of science teachers in providing environmental literacy according to the STSE-Approach overall and in each dimension at the same level. Details are in Table 4.

Table 4: Shows comparison of the capabilities of science teachers in providing environmental literacy, categorised by teaching experience of more than 5 years and less than 5 years, according to the STSE-Approach for school in environmentally impacted provinces.

Capabilities of Science Teachers	**More than 5 years**		**Less than 5 years**			
	$\bar{x}$	***S.D.***	$\bar{x}$	***S.D.***	***t***	***sig***
1. In-depth knowledge and appreciation in environment	5.00	0.00	4.33	0.58	1.73	0.23
2. Design of learning	4.80	0.45	5.00	0.00	0.23	0.84
3. Providing of learning activities	5.00	0.00	5.00	0.00	0.00	1.00
4. Examination and evaluation of learning	4.60	0.55	4.67	0.58	0.23	0.84
Total	**4.85**	**0.29**	**4.75**	**0.33**	**0.08**	**0.94**

Science teachers of grade 1-3 and 4-6 in environmentally impacted provinces—a case study of Wiang Kaen Wittayakhom School (Chiangrai province), Educational Area District 36—are not differentiated regarding their abilities to provide environmental literacy according to the STSE-Approach overall and in each dimension. Details are in Table 5.

Table 5 Shows a comparison of science teachers of grade 1-3 and 4-6 according to the STSE-Approach for schools in environmentally impacted provinces, specifically Wiang Kaen Wittayakhom School, from situational practice or problems regarding actual environment disasters in Wiang Kaen, Chiangrai.

Capabilities of Science Teachers	**Grade 1-3**		**Grade 4-6**			
	$\bar{x}$	***S.D.***	$\bar{x}$	***S.D.***	***t***	***sig***
1. In-depth knowledge and appreciation in environment	3.95	0.06	4.15	0.18	1.42	0.29
2. Design of learning	4.19	0.24	4.09	0.27	0.31	0.79
3. Providing of learning activities	4.13	0.18	4.23	0.26	0.49	0.67
4. Examination and evaluation of learning	4.02	0.02	4.00	0.24	0.00	1.00
Total	4.12	0.04	4.12	0.04	0.63	0.54

Discussion and Conclusion

The result of researching the capabilities of science teachers in providing environmental literacy according to the STSE-Approach for schools in environmentally impacted provinces indicates that science teachers have high capabilities. The highest dimension of those capabilities is providing of learning activities. The rest, which includes in-depth knowledge and appreciation in environment, design of learning, and examination and evaluation of learning, are at high level. Arranging content and activities is from easy to difficult. Focus on

continuous practice and having proper assembly techniques and period clear content. There is technology media for training (Amonsee, 2011:559), as well as the content reflection with natural science. Integrating the nature of science with science learning makes trainees more knowledgeable about the nature of science (Sawitree *et al.*,2017: 1083). Moreover, the learning activities according to STSE-Approach emphasises learning science by experience, scientific and technological problems in reality instead of theorical and process teaching. This would promote analytic skill and the ability to apply the concept and process (Rungtiwa and Phongsuk, 2013: 289-290) Yager and Akcay (2008:2). Provide activities to practice thinking, and actual work regarding problems or situations, which are caused by promoting or applying science to find solutions, truth, rules, theories, or scientific principles for problems in society and the environment. This includes being able to apply knowledge, theories, and effects from the development of scientific learning, educational philosophy, technology, society, and environment with scientific processes. This can be achieved by using technology to find solutions like creating new science and technology for promoting or solving environmental problems for oneself or society. Practicing inside and outside of school increases the interest of students by improving their attitude to science (Yörük *et al.* (2009: 69). This also leads the teachers to gain knowledge. Understanding is the target of providing learning according to the STSE-Approach. This is because they practice it themselves when choosing problems regarding how to solve the problem of society and environment themselves from situations or events involving the environment from their own community, Rungtiwa (2017: 60).

The result of improvement in the capabilities of science teachers in providing environmental literacy according to the STSE-Approach for schools in environmentally impacted provinces evaluates the teachers in five levels and two categories: *i.e. pre* and *post* seminars and performance of the science teachers. It indicates that at *pre*-seminar evaluation, the science teachers held a mean of 41.75 which increased to 89.50 after the *post*-seminar evaluation. The analysis by t-test indicates that there is a significant difference in confidence at .05 (t= 24.11, p-value = .00). Science teachers hold the capabilities of science teachers in providing environmental literacy according to the STSE-Approach in *post*-seminar more than *pre*-seminar. Also, the examination and evaluation points in *pre*, during, and *post* seminars, were from the practice of teachers and problem solving according to the imposed situation. It is found that overall development is at a high level at 74.42. For the evaluation of all three stages, it is found that during and *post* seminar, the results are at very high level of 92.00% and 89.50%, respectively. In each dimension, the providing of learning activities, which consists of (1) demonstration of teaching according to the learning plan and (2) performing the teaching on students, is better than other dimensions, at 76.53% which is in high level, and is better than other dimensions. The important factors consist of: Analysis and learning of the target according to the STSE-Approach. This approach of providing learning, examination, and evaluation, fundamental information research of teachers, information regarding national environmental information, and the problem and situation of communal environments affected

by the real world's situation. The time period in the seminar is proper in order to allow the teachers to practice and revise their plans when providing learning or their action plan. There were practices before application. The seminar curriculum for science teachers is supervised by experts and had been revised before actual application. Kalungrid (2017: 61) states that the check for suitability and conformity of the main elements of a curriculum in all dimensions including content, actives, seminars, examination, and evaluation is by checking with experts. Its application would result in a high level in development by seminar takers. Learning by actual events and places is a problem for the teachers who try to express themselves in thinking, argument, and discussion on reasonable evidence in accordance with science. It also requires a challenging of attitude when solving a particular issue. The most important issue is the practice required to get into the problem and solve the actual problem. Analysis of students in science knowledge by various equipment suggests the selection of the problem from actual natural events in the community of students, analysis of natural content and the actual problem in society (Rungtiwa, 2018: 34-35). Science teachers reflected on the work by designing learning plans according to the STSE-Approach, and then practiced teaching. This made science teachers realise things, have new ideas, which are integrated regarding nature and Constructivism theory and in alliance with B. Fauth et al. (2019:3). The seminar motivated the teachers to seek and solve things by themselves. They were challenged by questions to motivate critical thoughts, and to face and solve the problem head-on in. This would create a Self-concept which would lead teachers to see the truth and would create learning. This is in accordance with Prachya (2012: 14), who suggests that seminars lead audience into actual and current events through media, mock situations, and outside learning in communities help create questions and the urge to seek knowledge for them. The problem should be local and is related in the real life, as suggested by Laksikak and Angkana (2017: 186). The learning provided according to the STSE-Approach would help the teachers know, understand, and express the need to preserve the environment and natural resources, and participate in taking care of it. Students would care about the problem, which is real in their community, making them have better knowledge and understanding.

The result of comparison of capabilities of science teachers in providing environmental literacy when categorised by teaching experience of more than 5 years and less than 5 years indicates that there is no difference across the dimensions. This is because the science teachers performed the teaching in the same context. They are clearly equipped with the STSE-Approach (Teamjan, 2017:129-130). Most importantly, the curriculum for science teachers is designed and has passed the evaluation process in accordance with the STSE-Approach, which is to use seminars to practice on the real situation or problem of society and environment through many procedures and tactics. This is in accordance with Roth and Kim (2008: 516-517), who suggest that problem solving from simulations would create divergent thinking for mutual decision making on scientific information is a STSE-Approach. Nadia (2012:754) also suggests that the training of teachers would make them realise that teaching should employ the actual problem

in life. This would lead teachers to see the importance and value of the issue. Therefore, curriculum development and activity creation, tactics of efficient understanding in accordance to the STSE-Approach, would give them a differentiated experience and the capabilities to teach in accordance with the STSE-Approach for the students in a similar learning environment.

The result of the comparison on capabilities of science teachers in providing environmental literacy according to the STSE-Approach for schools in environmentally impacted provinces, when categorised by teaching experience and grades shows no difference. This is because the science teachers truly understand the seminar and the content of it. This is probably because they decided that their problem is independent from real life or the community, and would be the core of the lesson content. The Ngaw river erosion in the village and the geology of chemicals or the use of fertilizers by grapefruit farmers are examples, as is the shallowed Ngaw river. These give teachers the opportunity to perform efficiently, independently, and be creative in teaching the curriculum. This is a significant motivation for the teachers to learn, and to desire social impact from their work with their students. This is in accordance with Pedretti G. (2006: 941), who finds that science teachers who are efficient and independent would create opportunities for them to express their self-independence and thus efficiently promote the teaching. In accordance to the STSE-Approach, teachers improved their capabilities in an educational system which helped them open their perspective to ways of teaching more efficiently. Another point is that flipped teaching would help the teachers look back to their previous capabilities and challenge themselves in solving the current problem. Hui-Min Laia (2018: 37) suggests that flipped teaching or looking back to previous problems would guide teachers to look for better solutions by themselves through motivation and practice. This would help the teachers focus on their responsibilities. Another point is that the STSE-Approach targets solving problems (STS Problem-Solving Model). Nutthawit suggested (2005: 163-168) learning through the local environment by practice would help develop the curriculum (Environmental science Self-efficacy, Rosario 2009). This would encourage whomever provides environmental learning by science and technology to participate in the activities, and to debate regarding the kind of environmental learning that should be integrated with scientific content and challenging activities. The practice would help to motivate their responsibilities to science and the environment for more meaningful learning (Tan, 2009: 32). Therefore, the activities in the curriculum are clearly designed to be in accordance with the STSE-Approach, which aims for science teachers to be able to provide learning in all grades without differentiation in capability.

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