Exploring Student Metacognition and Science, Technology, Society, and Environment issues in a Thai context

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Abstract

Metacognition is a thinking process necessary for promoting scientifically literate persons. The development and enhancement of students' metacognition is strongly emphasized worldwide, including in Thailand. This study aims (1) explored the metacognitive orientation of the classrooms of 1,376 Grades 10-12 students in Northeast Thailand and their perceptions of those environments. The Metacognitive Orientation Learning Environment Scale – Science (MOLES-S) analysis of the data revealed that the participants' classroom learning environments were not adequately metacognitively oriented. The participants' school, grade, gender, and age did not significantly influence differences regarding their perceptions. (2) explored the students' metacognition change of 219 students in Khon Kaen Province with the Questionnaire of Metacognition on Science, Technology, Society, and Environment issues (QM on STSE), and interviews were employed for data collection. The analysis of the interview data suggested that more than 90% of the participants could not describe about how do they think and how they know about how they learn science. Contextual and cultural factors potentially influenced the participants' metacognition. Implications regarding students' metacognition and contextually and culturally-based teaching and learning about metacognition are also discussed.

Keywords: Metacognition, science learning, learning environment, culture, Thailand

Introduction and background:

The movement of educational reform in Thailand was standard and quality has been intensified for the resent few years. The findings from the research on educational reform movement have demonstrated that Thai youngsters at compulsory education levels were having inadequate abilities to analytically thinking had low achievement in Science, Mathematics, and English. National Test assessment as well as evaluation students' scholastic achievement and thinking abilities have been strengthened against the national level of achievement. It was generally found that learners' scholastic achievement, thinking and inquiry skills abilities were at unsatisfactory level although the students themselves, on their self-assessment, indicated the favorable level of achievement. Although the school teachers have attended in-service training courses and programs including further studies for higher degrees in their profession, there are still some lacks in applying appropriate methods and strategies for the development of students' learning achievement and their thinking abilities. Wiratchai (2004) described more than 90 percent of the schools under study were having unsatisfactory level on both average achievement and thinking abilities. Their analytical thinking is at the low level. The student could not relate science knowledge in class to general life. These happenings might have been attributed to the ineffectiveness of science teaching and learning.

On the learning process, the teacher have to understand to thinking is a process not to only content. Accordingly, teaching and learning have to the process also. Which is the use multiple learning theories. The cognitive learning theory explained about learning emphasize to changing thinking process with cognition. The example is the reasoning and focus on the happening in learner. There process enhance cognitive learner with interpretation, organize information, and schema theory (Bruer, 1993, Mayer, 1996; Greeno, Collins, & Resnick, 1996, cited in Eggen & Kauchak, 1997). Schema theory is the knowledge of the people that will be incorporating it into other units name "Schemata". Schemata are knowledge unite have been complied by knowledge about person, material, place, events, process, perspective and others that is a learning basic (Rumelhart, 1984). The intellectual growths occur when the learner could classification of cognition group (Piaget, 1970). The most of educator infer the most important thinking for cognitive learning activity is metacognition (Li & Munby, 1996). It was crucial to provide and facilitate both the teachers and students at school with more academic support for the development the students' learning and thinking abilities so that they could improve quality in their thinking and learning.

The development and enhancement of students' metacognition is strongly emphasized worldwide, including in Thailand. In Thai science classroom, should to let the learner relative thinking and deliberative thinking with metacognition based on the learners' context and culture because Thai students are embedded in Thai culture, tradition, Buddha, and farming. Students interpreted the phenomena that they learn around them with existing knowledge they will attempt construct the knowledge with science student interesting, motivation, be curious, can be seen clearly, and relate science classroom knowledge. Moreover, Thai contextual and cultural is the factors potentially influenced the participants' metacognition because when they learn science they do not discussion and

interaction with other students. Teacher's thinking, parent's thinking, Thai culture and tradition may cover student's head and their thinking to the factors will withdraw into themselves and become silent to protect themselves from criticism with attempt abandon their previous identity and mould themselves. That let Thai students did not participation. Thai science student should to regarding collaborative activity with their group and how this might change ideas. The collaboratively reflective inquiry is a collaboration of the learners reflection that their inquiry and open a chance with discussion, evaluation, and reflection.

Accordingly, the development of students' metacognition is the processes of reflective of learning that promotes learning understanding, self- regulation, thinking processes, problem solving, and the affected of the use in students' life. So, the teaching and learning science should to focus on students' metacognition on the suitable science content. Which content appropriate is STSE because metacognition is thinking about thinking and how student learn science can enhance all of science content and general. That attempted to STSE issues relevant to the students' everyday life or social situation because student's interesting and challenges in their social and life. Thailand presented in the press, generally relate to environment, alternative energy (e.g., nuclear power plant), diseases, dug and sports technology, materialism, communication, global warming, and others.

The significance of Metacognition:

Metacognition is a process with in-depth thinking of oneself in a situation and made effective from the thinking process of one-self (Flavell, 1979). It is defined as the ability of individuals to reflect, understand, and control their own thinking, learning, and acting. It is a cognitive process to control their-own thinking activity with planning, monitoring, and evaluating. Also, the development of the learner metacognition is a process of reflection on the thinking processes of analysis, synthesis, and problem solving during teaching and learning activities (Brown, 1987). These general issues of metacognition have been analyzed in detail and broken down in very specific components, such as declarative knowledge, procedural knowledge, planning, and monitoring (Sa´nchez-Alonso, S., & Vovides, Y. 2006). Metacognition influence to transformation understanding with talking, writing, language ability, interest, recognition, problem solving, social recognition, monitoring, and several of type self management (Flavell, 1987). Metacognition is also involved with social learning theory, scalability of behavior recognition, personality development, and education (Antonietti, Ignazi & Prego, 2000, Glases, 1982, Davidson, 1994).

Thai culture is influenced by Buddhist doctrine part of which is "Sati". Sati is the controller feeling their own to the middle path. It is control your mind and soul or mental control to forgetful in their do and think with to know by heart the committed and impartial. If the person can control their Sati they can anchored with their implication and practice. Moreover, it is the review of thinking and behavior on your own about the accuracy, appropriateness, restraint a consideration in their mind how do they think and how do they do. What is known is the carelessness, apathetic, and neutrality of mind. If the person can control their Sati they will be thinking is indeed the middle path.

Metacognition is extremely important in learning because it is very important to solve problem in many areas e.g. metacognition is important to reading development. (Hacker 1998, Jacobs & Paris, 1987); metacognition is important to personal mathematics development (Schoenfeld, 1992); and metacognition is important to science knowing

(Georghiades, 2004). So, the teaching of thinking processes and metacognition is important to people's thinking. The thinking of people enhances the headway of a country (Charuenwongsak, 2003). Metacognition consists of three strategies during their learning science are follows: metacognitive knowledge are declarative knowledge, procedural knowledge, and conditional knowledge; metacognitive control are planning, monitoring, and evaluating; and metacognitive awareness are consciousness and realization.

From above data part would came from in science classroom without relative thinking and deliberative thinking towards the learners' context and culture. The learner cannot relate science knowledge to their life. The important thing is the curriculum are not interesting for the learner. The development of students' metacognition is urgently needed to be improved in science education in Thailand.

The STSE situation in Thailand Science Curriculum:

Thailand is a country on Southeast Asia. The country is a democracy system with majesty the king. The country is a long history. There is evidence of ancient civilizations and the state in the territory that a lot. Most residents are Buddhist and the farming. Thailand is divided into 76 provinces, 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 to a great extent. According to the Basic Education Curriculum B.E. 2544, 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) (Ministry of Education, 2001).

The Ministry of Education announced implementation of the Basic Education Curriculum 2001, which served as the core curriculum for national education at the basic level. The curriculum prescribed goals and learning standards. It also provided a framework and orientation for enhancing quality of life of learners, who would attain virtue, wisdom, as well as capacity to maintain Thailand's competitive position in the world community. On the capacity for applying life skills for applying various processes in daily life; self-learning; continuous learning; working; and social harmony through strengthening of happy interpersonal relationships; elimination of problems and conflicts through proper means; ability for self-adjustment to keep pace with social and environmental changes; and capacity for avoiding undesirable behaviour with adverse effects on oneself and others. And goals of education to awareness of the need to preserve all aspects of Thai culture and Thai wisdom, protection and conservation of the environment, and public-mindedness with dedication to public service for peaceful and harmonious co-existence (Ministry of Education, 2001).

On the Learners' quality and Learners' competencies of science curriculum defined in the widely to work constructively with others; express opinions based on reliable references and sound reasoning resulting from scientific and technological development and application, bearing in mind moral obligation to society and the environment; and be ready to acknowledge views of others (Ministry of Education, 2008). The translation of the science curriculum to the classroom has not been obvious, and especially of the teaching and learning of STSE issues. In class, teachers teach on 8 standards that are without STSE issues. On standard 2 lives and the environment there is ecology content in textbook with a bit that point to social, culture, and STSE issues. The STSE issues about generally relate to environment, alternative energy (e.g., nuclear power plant), diseases, dug and sports technology, materialism, communication, global warming, and others.

Thailand was planning construct the nuclear power plant for forty years for the lack of energy and alternative energy but do not succeed because the conflict from society and several opinions. On 1967 was started point to attempt construct nuclear power plant in Thailand until now can not to do that. The important part is the social knowledge for decision making (Electricity Generating Authority of Thailand, 2010). Electricity Generating Authority of Thailand (2010) described the five suitable locations has the highest rate of appropriate with three aspects of engineering, environment, and economy. There are Ubonrachathanee Province, Nakhonsawan Province, Trad Province, Suratthanee Province, and Chumporn Province (ASTV Manager Online, March 14, 2011). When the effect of earthquake, tsunami, nuclear power plant, and the effect of radiation in Japan on March 11, 2011 that have the heavy resistance from social in Thailand. Thai people and several institute peace of the area hard against and criticism about this situation. School, teacher, student and lay people should to understand and thinking the situation with knowledge and more information. The science, technology, society, and environment issues are very important for science learning.

Methodology:

This study is dividing into two main phases.

I) First Phase of the Study

The first phase, which is explore the state of the metacognitive orientation and to reveal the possible relationships the participants' gender, grade, and school in the first semester of the 2010 academic year of the classrooms of 1,376 grades 10-12 students from 10 provinces in Northeast Thailand and their perceptions of those environments.

a) Participant

From purposive sampling, there were 1,376 students from urban school 1,081 (78.6%) and local school 295 (21.4%), grades 10 337(24.5%), 11 927(67.4%), and 12 112(8.1%) students. The participants' gender ranged male 379 (27.9%), and female are 997 (72.5%). And the participants' ages ranged are 15 11(0.8%), 16 587(42.7%), 17 671(48.8%) and 18 107(7.8%) students.

b) Data Collection

The participants were asked to complete the Metacognitive Orientation Learning Environment Scale – Science (MOLES-S). The MOLES-S is the characteristics of metacognitively oriented learning environments elucidated above were reflected in eight dimensions and 35 items: (1) Metacognitive Demands, (2) Teacher Modelling and Explanation, (3) Student-Student Discourse, (4) Student-Teacher Discourse, (5) Student Voice, (6) Distributed Control, (7) Teacher Encouragement and Support, and (8) Emotional Support. The conceptualisation of such dimensions was an important first step in developing the initial version of a learning environment instrument for evaluating the metacognitive orientation of science classrooms (Thomas, 2002). Up to this method, the quality of a translation is verified by an independent translator translating into the Thai language and submitted to five experts (three science educator, one metacognition educator, and one English educator). And back translated MOLES-S were then compared and any disagreement occurred during back-translation was resolved through the meeting.

c) Data Analysis

In data analysis, responses of the MOLES-S were scored 5 = Almost Always, 4 = Often, 3 = Sometimes, 2 = Seldom, 1 = Almost Never, respectively. The mean higher than 3.0 was interpreted as be sufficiently oriented to developing and enhancing students' metacognition, while the mean lower than 3.0 was interpreted as not be sufficiently oriented to developing and enhancing students' metacognition. In addition, the one-way analyses of variance (ANOVA) was employed to reveal the possible relationships between the environment to enhance metacognition and the participants' school, grade, gender, and age.

II) Second phase of the study

The second phase which is explore the state of the students' metacognition on Science, Technology, Society, and Environment issues and to reveal the possible relationships the participants' gender, grade, and school in the second semester of the 2010 academic year of the classrooms of grades 11-12 students from Khon Kaen provinces in Northeast Thailand and current situation before intervention.

a) Participant

From purposive sampling, there were 219 students from urban school 99 (45.21%) and local school 120 (54.79%), grades 11 188(85.84%), and 12 31(14.16%) students. The participants' gender ranged male 49 (22.37%), and female are 170 (77.63%). And the participants' ages ranged are 16 48(21.92%), 17 140(63.93%) and 18 31(14.16%) students. And in-depth interview with 4 teachers and 6 students.

b) Data Collection

The participants must attend the Questionnaire of Metacognition on Science, Technology, Society, and Environment issues (QM on STSE) is the characteristics of questionnaire metacognition elucidated above were reflected of three strategies during their learning science are follows:

1. Metacognitive knowledge are declarative knowledge, procedural knowledge, and conditional knowledge. The cognitive tasks, in-depth interview, open-ended questions, and scoring criteria were developed assessment of metacognition required appropriate contexts for the achievement of metacognitive purposes. The QM on STSE consists of five STSE issues are alternative energy (nuclear power plant), diseases (serious diseases "AIDS"), dug and sports technology, communication, and global warming. The QM on STSE submitted to five experts (three science educator, one metacognition educator, and one English educator). And back QM on STSE were then compared and any disagreement occurred during back-translation was resolved through the meeting;

2. Metacognitive control, in data analysis, the almost always, often, sometimes, seldom, and almost never responses of the QM on STSE were scored 5, 4, 3, 2, and 1, respectively. The mean higher than 3.0 was interpreted as be sufficiently students' metacognition, while the mean lower than 3.0 was interpreted as not be sufficiently students' metacognition. In addition, the one-way analyses of variance (ANOVA) was employed to reveal the possible relationships between the environment to enhance metacognition and the participants' school, grade, gender, and age and;

3. Metacognitive awareness in data analysis, the almost always, often, sometimes, seldom, and almost never responses of the QM on STSE were scored 5, 4, 3, 2, and 1, respectively. The mean higher than 3.0 was interpreted as be sufficiently students' metacognition, while the mean lower than 3.0 was interpreted as not be sufficiently

students' metacognition. In addition, the one-way analysis of variance (ANOVA) was employed to reveal the possible relationships between the environment to enhance metacognition and the participants' school, grade, gender, and age.

c) Data analysis

1. Metacognitive knowledge are declarative knowledge, procedural knowledge, and conditional knowledge. The cognitive tasks, in-depth interview, open-ended questions, and scoring criteria were developed assessment of metacognition required appropriate contexts for the achievement of metacognitive purposes. The overview of scoring criteria is presented in Table 1 adapted from Rompayom (2010).

Table 1. The overview of scoring criteria of Metacognitive Knowledge

Score	**Description**		
	Declarative knowledge	**Procedural knowledge**	**Conditional knowledge**
0	Nothing relevant to the task. The student does not describe *what* the task related to.	Students do not describe which strategy they use to solve a problem, and *how* they solve that problem.	Students do not explain *when and why* to use strategies to solve problem.
1	Student writes nonspecific statements that are related to their life, but they are not related to the question.	Students seem to understand of the task purpose, but they make nonspecific statements that are not interrelated or connected between given information and the question.	Student lists general strategies used to solve problem, but they do not explain only *when or why* to use that strategies or nonspecific statement.
2	Student has a clear overview of what the task is related to.	Student has clearly defined which strategy they use. Students explicitly consider the implications between given information and the question.	The student generates clearly when and why to use strategies they use to solve problem. The overview of their strategy connects concretely to the given information and the question.

2. Metacognitive control is the questionnaire on planning, monitoring, and evaluating elucidated above were reflected in 9 items on STSE issues adapted from the SEMLI-S (Thomas, 2008) and Brown, (1978) and;

3. Metacognitive awareness is the questionnaire on consciousness and realization were reflected in 5 items on STSE issues adapted from the SEMLI-S (Thomas, 2008) and MRI (Schraw & Dennison, 1994).

Result:

I) Results of the First Phase of the Study

1) The metacognitive orientation of the classrooms.

Table 2 showed that the range of means of the participants' metacognitive orientation of the classrooms was 2.38 to 3.78. The overall mean and standard deviation of attitudinal scores were 3.59 and 1.01, respectively.

Table 2. The participants' metacognitive orientation of the classrooms on MOLES-S.

	Statement	Mean	SD
	Metacognitive demands M:PD		
1	Students are asked by the teacher to think about how they learn science	3.36	0.88
2	Students are asked by the teacher to explain how they solve science problems	3.55	0.81
3	Students are asked by the teacher to think about their difficulties in learning science	3.39	0.93
4	Students are asked by the teacher to think about how they could become better learners of science	3.50	0.98
5	Students are asked by the teacher to try new ways of learning science	3.72	0.91
	Total	3.50	0.90
	Student - student discourse M:R		
6	Students discuss with each other about how they learn science	3.22	0.97
7	Students discuss with each other about how they think when they learn science	3.26	0.96
8	Students discuss with each other about different ways of learning science	3.20	0.94
9	Students discuss with each other about how well they are learning science	3.30	1.01
10	Students discuss with each other about how they can improve their learning of science	3.07	1.06
	Total	3.21	0.98
	Student - teacher discourse M:R		
11	Students discuss with the teacher about how they learn science	3.10	1.02
12	Students discuss with the teacher about how they think when they learn science	3.13	1.02
13	Students discuss with the teacher about different ways of learning science	3.05	0.99
14	Students discuss with the teacher about how well they are learning science	3.04	1.03
15	Students discuss with the teacher about how they can improve their learning of science	3.14	1.00
	Total	3.09	1.01
	Student Voice M:PD		
16	It is OK for students to tell the teacher when they don't understand science	3.63	0.92
17	It is OK for students to ask the teacher why they have to do a certain activity	3.31	1.01
18	It is OK for students to suggest alternative science learning activities to those proposed by the teacher	2.94*	1.05
19	It is OK for students to speak out about activities that are confusing	3.17	1.03
20	It is OK for students to speak out about anything that prevents them from learning	3.04	1.00
	Total	3.22	1.00
	Distributed Control M:PD		
21	Students help the teacher plan what needs to be learned	2.47*	1.03
22	Students help the teacher decide which activities they do	2.38*	1.02
23	Students help the teacher to decide which activities are best for them	2.52*	1.05
24	Students help the teacher decide how much time they spend on activities	2.52*	1.10
25	Students help the teacher decide when it is time to begin a new topic	2.41*	1.12
	Total	2.46*	1.06

Table2. The participants' metacognitive orientation of the classrooms on MOLES-S.

(continue)

	Statement	Mean	SD
	Encouragement and Support M:R		
26	The teacher encourages students to try to improve how they learn science	3.77	1.01
27	The teacher encourages students to try different ways to learn science	3.64	0.93
28	The teacher supports students who try to improve their science learning	3.78	0.92
29	The teacher supports students who try new ways of learning science	3.64	0.97
30	The teacher encourages students to talk with each other about how they learn science	3.45	0.97
	Total	3.66	0.96
	Emotional support M:R		
31	Students are treated fairly	3.56	1.04
32	Students' efforts are valued	3.66	0.97
33	Students' ideas are respected	3.59	0.99
34	Students' individual differences are respected	3.57	1.03
35	Students and teacher trust each other	3.59	1.03
	Total	3.59	1.01
	Total	**3.59**	**1.01**

The overall finding indicated that the participants as be sufficiently oriented to developing and enhancing students' metacognition. However, there were two dimensions about students' voice in item 18 "It is OK for students to suggest alternative science learning activities to those proposed by the teacher" and students' distributed control in science classroom in items 21-25 that the participants expressed not be sufficiently oriented to developing and enhancing students' metacognition, that is, item 21 "Students help the teacher plan what needs to be learned", item 22 "Students help the teacher decide which activities they do", item 23 "Students help the teacher to decide which activities are best for them", item 24 "Students help the teacher decide how much time they spend on activities", and Item 25 "Students help the teacher decide when it is time to begin a new topic". The participants holistically had be sufficiently oriented to developing and enhancing students' metacognition. The participants had as not be sufficiently oriented to developing and enhancing students' metacognition only item 18 and item 21-25 are students' contribute control. Because, in Thai science classroom, Thailand science curriculum, and Thailand education system do not opened chance students' planning and control about how their will learn science. Science curriculum and activities create by teacher and educator. Contextual and cultural factors potentially influenced the participants' metacognition orientation of the classrooms. Implications regarding students' metacognition and contextually and culturally-based teaching and learning about metacognition are also discussed.

About the relationship among of the participants' school, grade, gender, and age school. The one-way ANOVA, as Table 3, also revealed that the participants with different school, grade, gender and age did not significantly have different metacognitive orientation of the classrooms there were no interaction among school, grade, gender and age variables.

Table3. The participants' metacognitive orientation of the classrooms on MOLES-S.

Source	SS	df	MS	F	p
School	0.212	1	0.212	0.802	0.371
Gender	0.580	2	0.290	1.101	0.333
Grade	0.000	1	0.000	0.001	0.971
Age	1.727	3	0.576	2.190	0.087
Error	360.388	1370	0.263		
Total	15033.417	1376			

* $p < .05$

II) Results of the Second Phase of the Study

1) The metacognition.

1.1) The metacognitive knowledge

Table 4 showed that the most of participants had their metacognition knowledge in 0 score. Some participants had their metacognitive knowledgw in 1 score, and few of participants of them had their metacognitive knowledge in 2 score.

Table4. The participants' score of metacognitive knowledge

STSE issues	Metacogntive knowledge score	Number of Students on Metacognitive knowledge (%)		
		Declarative Knowledge	Procedural Knowledge	Conditional Knowledge
1) Nuclear Energy	0*	70*	80*	87.5*
	1	20	20	12.5
	2	10	0	0
2) Serious Diseases "AIDS"	0*	85*	87.5*	90*
	1	17.5	12.5	7.5
	2	2.5	0	2.5
3) Dug and Sports Technology	0*	87.5*	92.5*	92.5*
	1	7.5	7.5	7.5
	2	5	0	0
4) Communication	0*	87.5*	87.5*	92.5*
	1	12.5	12.5	7.5
	2	0	0	0
5) Global Warming	0*	87.5*	95*	98*
	1	17.5	2.5	2
	2	0	0	0

Declarative knowledge, the most of participants had their declarative knowledge in 0 score. Participants were nothing relevant to the task. They do not describe what the task related to. Some participants had their declarative knowledge in 1 score. Participants write nonspecific statements that are related to their life, but they are not related to the question. Few of participants of them had their declarative knowledge in 2 score. Participants have a clear overview of what the task is related to. For example on nuclear energy, they did not regarding to their prior knowledge. When to consult or talk in-depth interview with them, they were interested in nuclear energy topic but were not interested in the topics not at

hand. They did not pay attention and aware of nuclear energy in their life. They did not what they already knew and wanted to know. They could not write how they understand and could not clarify the topics.

Procedural knowledge, the most of participants had their procedural knowledge in 0 score. The participant does not describe which strategy they use to solve a problem, and how they solve that problem. Some participants had their procedural knowledge in 1 score. Participants seem to understand of the task purpose, but they make nonspecific statements that are not interrelated or connected between given information and the question. Few of participants of them had their procedural knowledge in 2 score. Participants have clearly defined which strategy they use. Participants explicitly consider the implications between given information and the question.

Conditional knowledge, the most of participants had their conditional knowledge in 0 score. The participant do not explain when and why to use strategies to solve problem. Some participants had their conditional knowledge in 1 score. Participants list general strategies used to solve problem, but they do not explain only when or why to use that strategies or nonspecific statement. Few of participants of them had their conditional knowledge in 2 score. Participants generate clearly when and why to use strategies they use to solve problem. The overview of their strategy connects concretely to the given information and the question.

The overall finding indicated that the participants had not their metacognition knowledge on STSE issues all in declarative, procedural, and conditional knowledge. Participants write nonspecific statements that are related to their life, but they are not related to the question. They did not describe which strategy they use to solve a problem, and how they solve that problem and do not explain when and why to use strategies to solve problem.

1.2) The metacognitive control

The component of metacognitive control are planning, mornitoring, and evaluating. Table 5 showed that the range of means of the participants' metacognitive control was 3.38 to 3.74. The overall mean and standard deviation of attitudinal scores were 3.53 and 0.081, respectively.

Table 5. The participants' metacognitive control.

	Statement	Mean	SD
1	I try to predict possible problems that might occur with my learning.	3.62	0.766
2	I assess how much I am learning during a learning task	3.52	0.786
3	I evaluate my learning processes with the aim of improving them.	3.39	0.846
4	I adjust my plan for a learning task if I am not making the progress that I think I should.	3.56	0.773
5	I try to understand clearly the aim of a task before I begin it.	3.64	0.792
6	I stop from time to time to check my progress on a learning task.	3.74	0.779
7	I consider what type of thinking is best to use before I begin a learning task.	3.54	0.867
8	I plan to check my learning progress during a learning task.	3.42	0.894
9	I consider whether or not a plan is necessary for a learning task before I begin that task.	3.38	0.817
	Total	**3.53**	**0.813**

The overall finding indicated that the participants holistically had sufficiently students' metacognitive control. That mean the participant can control their own learning. They had to monitoring and maintaining their own when they learning science. All of time when they learn science they had evaluated how to think and how they learn science. But

when to in-depth interview all of the participants did not specify goal or objective and selected their thinking techniques. They did not review learning activities. They did not making decision and talked to the next step of learning. They could not to talk about how to review the activities and shared knowledge with each other for collect the information. When talk to make learning plan by themselves, they felt very difficult and did not want to do it. They performed only easy action and did not foresee the answer in advance, organize problems, and obstacles. Contextual and cultural factors potentially influenced the participants' metacognitive control. Implications regarding students' metacognition and contextually and culturally-based teaching and learning about metacognition.

About the relationship among of the participants' school, grade, gender, and age. The one-way ANOVA, as Table 6, also revealed that the participants with different school, grade, gender and age did not significantly have different metacognitive control classrooms there were no interaction among school, grade, gender, and age variables.

Table6 . The participants' metacognitive control.

Source	SS	df	MS	F	p
School	0.989	1	0.989	3.481	0.063
Gender	0.623	1	0.623	2.189	0.141
Grade	0.930	1	0.930	3.269	0.072
Age	0.697	2	0.349	1.216	0.298
Error	61.931	216	0.287		
Total	2794.210	219			

* $p < .05$

1.2) The metacognitive awareness

Table 7 showed that the range of means of the participants' metacognitive awareness was 3.44 to 3.68. The overall mean and standard deviation of attitudinal scores were 3.62 and 0.875, respectively.

Table 7. The participants' metacognitive awareness.

	Statement	Mean	SD
1	I am aware of when I am about to have a learning challenge.	3.62	0.766
2	I am aware of when I am not concentrating.	3.64	0.803
3	I am aware of when I have learning difficulties	3.68	0.898
4	I am aware of when I don't understand an idea	3.52	0.895
5	I am aware of when I am about to lose track of a learning task	3.44	0.948
	Total	**3.62**	**0.875**

The overall finding indicated that the participants holistically had sufficiently students' metacognitive awareness. That mean the participant can control their own learning. They had to monitoring and maintaining their own when they learning science. All of time when they learn science they had evaluated how to think and how they learn science. When to in-depth interview all of the participants interested in every topic of STSE. Their opinion showed the consciousness and realization. For example, when to talk about AIDS, they were very serious and think hard how protect their own, their friend, and their family. It is a serious disease to close lay people.

About the relationship among of the participants' school, grade, gender, and age. The one-way ANOVA, as Table 8, also revealed that the participants with different school,

grade, gender and age did not significantly have different metacognitive orientation of the classrooms there were no interaction among school, grade, gender and age variables.

Table 8. The participants' metacognitive awareness.

Source	SS	df	MS	F	p
School	1.354	1	1.354	5.878	0.161
Gender	0.016	1	0.016	0.66	0.797
Grade	0.675	1	0.675	2.892	0.090
Age	0.193	2	0.096	0.407	0.666
Error	51.136	216	0.237		
Total	2919.723	219			

* $p < .05$

Conclusion:

I) Conclusion of the first phase of the study

The overall finding indicated that the participants as be sufficiently oriented to developing and enhancing students' metacognition. However, there were two dimensions about students' voice and students' distributed control in science classroom that the participants expressed not be sufficiently oriented to developing and enhancing students' metacognition. About the relationship among of the participants' school, grade, gender, and age school. The one-way ANOVA, as revealed that the participants with different school, grade, gender and age did not significantly have different metacognitive orientation of the classrooms there were no interaction among school, grade, gender and age variables. Because, in Thai science classroom, Thailand science curriculum, and Thailand education system do not opened chance students' planning and control about how their will learn science. Science curriculum and activities create by teacher and educator. Contextual and cultural factors potentially influenced the participants' metacognition orientation of the classrooms. Implications regarding students' metacognition and contextually and culturally-based teaching and learning about metacognition are also discussed.

II) Conclusion of the second phase of the study

The overall finding indicated that the participants had not their metacognition on STSE issues. Participants had not their metacognition knowledge metacognitive control, and metacognitive awareness on STSE issues. And, about the relationship among of the participants' school, grade, gender, and age. The one-way ANOVA, as revealed that the participants with different school, grade, gender and age did not significantly have different metacognition there were no interaction among school, grade, gender, and age variables.

Implications:

The researcher had recommendations which would be useful for those who studied or were interested in the science learning for using to development students' metacognition as follows:

1. In science classroom, should to let the learner relative thinking and deliberative thinking on student's interesting issues and close their life. Students interpreted the phenomena that they learn around them with existing knowledge. They will attempt

construct the knowledge with science student interesting, motivation, be curious, can be seen clearly, and relate science classroom knowledge.

2. Thai students are embedded in Thai culture, tradition, Buddha, and farming. Students interpreted the phenomena that they learn around them with existing knowledge they will attempt construct the knowledge with science student interesting, motivation, be curious, can be seen clearly, and relate science classroom knowledge. Moreover, Thai contextual and cultural is the factors potentially influenced the participants' metacognition because when they learn science they do not discussion and interaction with other students. Teacher's thinking, parent's thinking, Thai culture and tradition may cover student's head and their thinking to the factors will withdraw into themselves and become silent to protect themselves from criticism with attempt abandon their previous identity and mould themselves. That let Thai students did not participation. Thai science student should to regarding collaborative activity with their group and how this might change ideas. The collaboratively reflective inquiry is a collaboration of the learners reflection that their inquiry and open a chance with discussion, evaluation, and reflection. Because, the participants' metacognition there were no interaction among school, grade, gender and age. Contextual and cultural factors potentially influenced the participants' metacognition.

3. The arrangement of teaching sequence for students' metacognotion should be gradually systematically performed and systematically thinking.

Research Questions:

This is a research question as follow:

What is the current situation of teaching and learning about metacognition and STSE issues in Thailand?

Aims of the Research Study:

The purpose of the research study was to explore students' metacognition and the current situation of teaching and learning about STSE issues.

Operational Definition of Terms:

Four important terms introduced in this study are operationally defined as follows.

Metacognition is a process with in-depth thinking of oneself in a situation and effective from thinking process of oneself (Flavell, 1976). It is defined as the ability of individuals to reflect, understand, and control their own thinking, learning, and acting. It is the cognitive process of controlling their own thinking activity with planning, monitoring, and evaluating (Brown, 1987). Metacognition refers to an individual's knowledge, awareness, and control of his/her thinking and learning strategies (Thomas, 2009). Metacognition consists of three strategies during their learning science are metacognitive knowledge, metacognitive control, and metacognitive awareness (Thomas, 2003).

STSE issues relevant to the students' everyday life or social situation. Thailand presented in the press, generally relate to environment, alternative energy (e.g., nuclear power plant), diseases, dug and sports technology, materialism, communication, global warming, and others.

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