Teaching "Global Warming" through Socioscientific Issues-based Instruction

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Abstract

This study aims to investigate effective teaching criterion through socioscientific issues-based instruction "Global warming" at 80/80, to find out effectiveness index of socioscientific issues-based instruction, to compare analytical thinking between before and after students had learned by socioscientific issues-based learning activities, and to study learning satisfaction of fifth grade students after they had learned through socioscientific issues-based instruction. Participants of the study were 24 fifth grade students. Research instruments comprised of 9 lesson plans, 20-item achievement test, 20-item analytical thinking test, and 10-item questionnaire on learning satisfaction. Data were gathered and analyzed by dependent t-test. Results revealed that socioscientific issues-based instruction had effective teaching criterion at 85.38/81.25; effectiveness index of socisocientific issues-based instruction was 0.6959; post test score of analytical thinking higher than those pre test score at .05 statistical significance level; and students had learning satisfaction on socioscientific issues-based learning activities at highest level. This study can be showed that socioscientific issues-based instruction helps students reach to the nature of science. Also, it can promote individuals' development in terms of both cognitive, analytical thinking, and learning satisfaction.

Keywords: Socioscientific issues-based leaning, Analytical thinking, Learning satisfaction, Effectiveness index, Effective teaching criterion

1. Introduction

Today, science teaching is informed decision making, ability to analyze, synthesize, and evaluate information into classroom. It also deals with moral reasoning and ethical issues, try to understand the connections among socioscientific issues. The joint construction of scientific knowledge that is at once personally relevant and socially shared therefore relies on exposure to, and careful analysis of, cases involving considerations of data, evidence, and argumentation that may be in conflict with one's existing conceptions regarding various socioscientific moral and ethical issues. Socioscientific issues may be equated with the consideration of ethical issues and construction of moral judgments about scientific topics via social interaction and discourse (Zeidler et.al., 2005). The instructional activities should inform the nature of science and scientific inquiry, as well as moral and ethical dimensions of science education Students are expected to develop an understanding their conceptual science if they are informed decisions regarding the scientifically based personal and societal issues (Sadler et.al., 2004; Sadler and Zeidler, 2004; Sadler and Zeidler, 2005; Sadler et.al., 2006).

Global warming and climate change are widely talked. The effects can influence to all of area in our society, it need to be instructed in school science, and also let students know and understand about nature of science. This situation, teaching science is not only referring to the lesson, but also social interaction in terms of controversial between science and society are stimulated and need to incorporate into school (Nuangchalerm, 2010). When we have a good science teaching it can help our society to prepare good society and gain community to aware present and future (Tal and Kedmi, 2006). For preparing future students, the way to learn and modify socioscientific issues need to incorporated in school science. Students should be learned toward understanding of concepts related to holistic views in terms of ecosystem dynamics and decision making based on moral and ethic

dimensions (Sadler, 2004; Nuangchalerm, 2009).

In addition, we need to solve social and environmental problems with many methods, especially science education which it is process of science teaching for people have scientific, technological, environmental, and social awareness (Kennedy et. al., 2009). At this point, our students should be known and understandable how to survive in our society with happiness. The way of science education is an appropriate way to promote scientific literacy students because they are growing to work and live in the society (Kollmuss and Agyeman. 2002). Also, the pedagogical aspects in science need to have inquiring mind in science and make them to meet both scientific facts and creativity. The learning perspectives also have all been considered as an important of science education goals (Bell and Lederman, 2003). School science is to enable students to observe their natural environment and to develop skills required to understand and explain both themselves and their environment (Marx et. al., 2004).

The approaches challenges to instructional strategies based on reality of science teaching and moral and ethics aspects. This study aims to (i) investigate effective teaching criterion through socioscientific issues-based teaching at 80/80, (ii) find out effectiveness index of socioscientific issues-based teaching, (iii) compare analytical thinking between before and after students had learned by socioscientific issues-based learning activities, and (iv) study learning satisfaction of fifth grade students after they had learned through socioscientific issues-based instruction. The results of this study can help students meet nature of science and stimulate them to have habit of mind in science.

2. Method

The participants of this study were 24 fifth grade Thai students, which were learned science topic, "global warming". They were studying in first semester, academic year 2009. The research tools consisted of 9-hour socioscientific issues-based learning lesson plan, 20-item achievement test, 20-item analytical thinking test, and 10-item leaning satisfaction on socioscientific issues-based learning. The details of research tools construction were provided here.

- Socioscientific issues-based learning lesson plan: researchers constructed learning activities based on instructional theory by employing theme "global warming", especially socioscientific issues-based instruction and nature of science education were studied (figure 1). Nine lesson plan, 9-hour learning activities were developed. Then, 3 experts seek a validity of lesson plan and provide suggestion delicately. The lesson plan had index of congruency 0.67-1.00 and average of appropriateness value 4.90. Pilot study was allowed to conduct with 37 students of fifth grade students. Finally, the lesson plan was approved and prepared for experimentation.

Insert Figure 1 Here

- Achievement test: researchers constructed 4-choice of 30-item achievement test. Then, 3 experts seek a validity of test. The index of congruency was calculated, its range was 0.67-1.00. Then, pilot study was allowed to conduct with 37 students of fifth grade students who had learned by socioscientific issues-based learning activity. The researchers selected 20 items which discriminating power (B) was 0.21-0.74. Reliability was also calculated and reported 0.66. Finally, achievement test was approved and prepared for experimentation in respectively.

- Analytical thinking test: researchers constructed 4-choice of 30-item achievement test. Then, 3 experts seek a validity of test. The index of congruency was calculated, its range was 0.67-1.00. Then, pilot study was allowed to conduct with 104 students of fifth grade students. The researchers selected 20 items which difficulty was 0.42-0.77 and discriminating power (r) was 0.27-0.77. Reliability (KR-20) was also calculated and reported 0.72. Finally, test was approved and prepared for experimentation in respectively.

- Learning satisfaction questionnaire: researchers studied theories related learning satisfaction, 5-level of 15-item Likert scale was developed. Then, 3 experts seek a validity of test. The index of congruency was calculated, its range was 0.67-1.00. Then, pilot study was allowed to conduct with 37 students of fifth grade students who had learned by socioscientific issues-based learning activity. Then researchers selected 10 items which discriminating power (r_{xy}) was 0.47-0.80. Reliability (Cronbach alpha coefficient) was also calculated and reported 0.87. Finally, questionnaire was approved and prepared for experimentation in respectively.

In the research, one group pretest-posttest design was employed. Researchers clarified a purpose of this research for data collective cooperation with participants. Pretest is conducted, then during 9 hours socioscientific issues-based learning activities, researchers collected data to seek effective teaching criterion level of socioscientific issues-based learning activities. Finally, posttest is followed. Data of learning achievement and analytical thinking scores were analyzed by dependent t-test statistics. Then, students response their learning

satisfaction to this approach, the data have been defined and interpreted. The level of satisfaction to be consider with Likert's five-point rating scale. Each respondent is asked to rate each item on some response scale. Data were analyzed by mean and standard deviation.

Finally, the researcher analyzed collected data by using a computer program, checked the completeness of the data and then obtained data from responses to the questionnaire.

3. Resuts

3.1 Effective teaching criterion of socioscientific issues-based teaching

Performance score of activities were measured during socioscientific issues-based classroom, nine lesson plans were conducted and data were collected and calculated based on performance and worksheet performance. Effective teaching criterion of process (E_1) was 85.38 and effective teaching criterion of outcome (E_2) was 81.25. It can be showed that the effective teaching criterion of inquiry based teaching for second grade

Effective teaching criterion was 85.38/81.25 (see Table 1).

Insert Table 1 Here

3.2 Effective index of socioscientific issues-based learning

This study employed Effectiveness Index (E.I.) methodology, which developed to measure students' cognitive development. The E.I. is useful in comparing program effects in two groups of similar size and with similar baseline prevalence of a desired program outcome, in which a larger E.I. suggests a larger program effect. This study showed that 24 students had pre-test 184 of total score and post-test 390 of total score. Data were interpreted and calculated. It can be considered at 0.6959 (see Table 2).

Insert Table 2 Here

3.3 Analytical thinking score

Researchers analyzed analytical thinking score of fifth grade students who had learned through socioscientific issues-based learning activities between before and after by dependent t-test statistics (see Table 3). The mean score of pre-test score was 6.33 and post-test score was 13.04. It can be summarized that post-test score had higher score than those pre-test at .05 statistical significant levels.

Insert Table 3 Here

3.4 Learning satisfaction on socioscientific issues-based instruction

Twenty four of fifth grade students were asked to rate their learning satisfaction with various aspects of feelings after they had learned through socioscientific issues-based learning activity. Levels of learning satisfaction were recorded across a range of indicators. They were all satisfied with the level of learning activities at highest level ($\overline{X}$ = 4.84) (see Table 4).

Insert Table 4 Here

4. Discussion

The findings of this study can be discussed that effective teaching criterion for fifth grade students who had learned by socioscientific issues-based instruction was 85.38/81.25.

It seems to study that students had 85.38 percent of performance score and 81.25 percent of outcome score. It means that students can build new understanding through interactions with their environment, that is, Vygotsky's concept of the zone of proximal development explained how students develop conceptions of what they learned. Allal and Ducrey (2000) supported that it is possible to measure ZPD as an individual trait which is showing a certain stability across instructional settings and decisions regarding to educational intervention and placement. In addition, ZPD which is, created by ongoing interactions in a given instructional setting and optimizes the teaching–learning processes that are specific. Effective teaching within socioscientific issues-based instruction requires teacher resources in addition to subject-matter knowledge, complex subjectspecific knowledge for teaching, and also relevant to teaching identities (Nuangchalerm, 2010). Students can build their learning experiences and also need to have understanding about contents, nature of science, and development in science in a conceptual sense (Zoller, 2001).

Students make a consideration of what they learned in terms of a variety of scientific methods related to process skills based on socioscientific decision making in which is, they interacted with other areas (Tytler, 2001). They can draw different kinds of knowledge and ideas in what they learned through socioscientific issues-based instruction. The critical examination of newspaper, magazines, and internet articles can be brought to classroom

and also let them know nature of science, scientific content knowledge, and way of decision-making based on moral and ethics. They used of knowledge in various kinds of sources of scientific information. Students used their awareness of the need for references to sources and further documentation, and argumentation in which need to be presented with enough details to make critical examination possible (Kolsto, 2006).

The effectiveness index was 0.6959, students can gain their knowledge and experiences 69.59 percent of scientific conception after learned through socioscientific issues-based instruction. Based on psychological and epistemological principles, it can explain that structure of knowledge and understanding about scientific information be developed through socioscientific issues-based instruction. The resources for supporting reasons, personal experiences, and scientific belief engaged students to have more understandable in subject matter and process of thinking (Chang and Chiu, 2008). Dynamic process in science classroom can be resulted from interactions with individuals and the environment, cognitive growth as autonomous which include both social settings and the physical environment of the learning. It can be understandable that students' prior knowledge and experiences are grown. Science teachers should address when establishing this type of learning environment, need to develop an understanding of the way in which students learn. In addition, science teachers should understand that provide meaning to teaching and learning by beginning lessons with what students know and understand can stimulate students' cognitive process, it also gain students' thinking ability as well as learning opportunity allowed (Sadler et.al., 2006).

The result of analytical thinking by comparison between pre-test and post-test score can be considered that post-test score had higher than those pretest score at .05 statistical significant levels. Mean score of pretest was 6.33 while posttest score was 13.04. Socioscientific issuses-based instruction can improve students' analytical thinking by engaging students in science classroom (Wongsri and Nuangchalerm, 2010). This phenomenon can be explained that learning activities allow students to have thinking process by them based on critical examination relevant to evidence-based science. Sternberg (2003) suggested that conventional instruction emphasizes the development of an expert knowledge base, primarily through the application of memory and analytical skills. In this study, socioscientific issues-based instruction is implemented by integrating teaching for thinking and practical skills with teaching for memory and analytical skills. The result make it differently than those conventional instruction because socioscientific issues-based instruction aware in both cognitive domain and thinking process skills.

The science teachers have a crucial role here because students' ways of examining scientific claims and arguments need to be engaged (Kolsto, 2006). When students have working on critical examination in the classroom that is, relied on students' ways of assessing scientific information. Sadler and Zeidler (2005) suggested that decision making influences, including morality, personal experiences, emotive factors, and social considerations, are subsumed in more complex patterns of informal reasoning. Students decision making on socioscientific issues and evaluation of contradictory scientific information are complex, they are led to emphasize personal experiences or values. Students' interpretation and evaluation of contradictory were influenced by their personal opinions and scientific knowledge (Sadler, 2004). The results of this study can be concluded that socioscientific issues-based instruction promote the cognition and analytical thinking, also learning satisfaction of fifth grade students were responded at highest level. Teachers should play varied roles for growing essentials of developmental learning by supporting students' skills as much as they can.

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Table 1. Showing score to calculate effective teaching criterion of inquiry-based classroom

Evaluation	Total score	Mean score	SD	%
Process (E_1)	584	24.33	3.70	85.38
Outcome (E_2)	390	16.25	2.15	81.25

Table 2. Effectiveness Index of socioscientific issues-based classroom

n	Total score	Mean score		Percentage		E.I.
		Pre-test	Post-test	Pre-test	Post-test	
24	20	184	390	36.33	81.25	0.6959

Table 3. Comparisons of analytical thinking score between pre-test and post-test

N	Mean score		SD		df	t
	Pre-test	Post-test	Pre-test	Post-test		
24	6.33	13.04	2.63	2.49	23	47.61*

Table 4. Students' learning satisfaction on socioscientific issues-based learning activity

Item	X	SD	Level of response
I like what teacher introduces behavioral objective of teaching and learning activities	4.92	0.28	Highest
I prefer teacher' s techniques of teaching through questioning classroom	4.75	0.53	Highest
I happy with classroom learning environment	4.67	0.64	Highest
I feel more comfortable when teacher brings various kind of learning media into classroom	4.88	0.34	Highest
I like to have learning experiences by employing socioscientific issues into science hour	4.92	0.28	Highest
I am ready to participate learning activities	4.71	0.62	Highest
I like to have learning assignment	4.92	0.28	Highest
I prefer, this activity allows me to learn science in creatively	4.88	0.33	Highest
I like generated question by teacher and clarifying feedback	4.92	0.28	Highest
I prefer when teacher brings various kind of learning assessment into classroom	4.83	0.38	Highest
Total	4.84	0.40	Highest

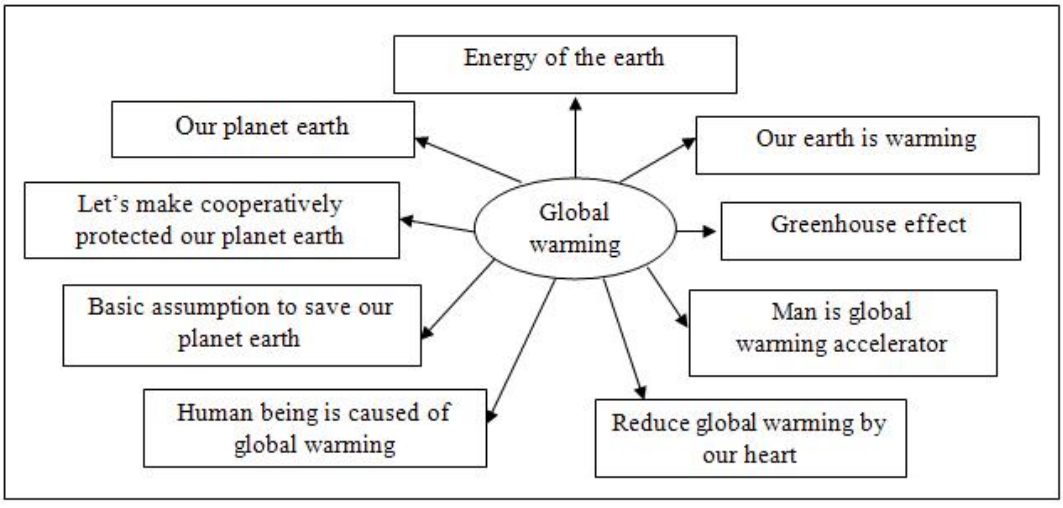

Figure 1. Content of the study