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A development of knowledge and understanding, critical thinking, awareness, environmental conservation behaviors of grade 12 students using the good science thinking moves method with metacognition techniques

Charinrat Ladawan [a], Department of Environmental Education, Faculty of Environment and Resource Studies, Mahasarakham University, 44150, Bangkok, Thailand.

Adisak Singseewo [b*], Department of Environmental Education, Faculty of Environment and Resource Studies, Mahasarakham University, 44150, Bangkok, Thailand.

Paitool Suksringarm [c], Department of Environmental Education, Faculty of Environment and Resource Studies, Mahasarakham University, 44150, Bangkok, Thailand.

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Abstract

This research aimed to study and compare knowledge and understanding, critical thinking, awareness and environmental conservation behaviors of the students who learned using the good science thinking moves method with metacoginitive techniques and those students using the traditional teaching method. Seventy - four grade 12 students from 2 classes were participated in the study. These students were selected using the cluster random sampling technique from NadoonPhachasan School in Nadoon District, MahaSarakham province. They were assigned to an experimental group of 40 students learned using the good science thinking moves method with metacognitive techniques and a control group of 34 students learned using the traditional teaching method. Research instruments included (1) learning plans entitled Human and Environmental Sustainability for two groups of students (2) a test on knowledge and understanding; (3) a test on critical thinking; (4) an awareness questionnaire; and (5) a questionnaire on environmental conservation behaviors. The major findings revealed that the lesson plans using the good science thinking moves method with metacognitive techniques had an effectiveness index of 0.7290. The whole students, the male students and the female students of the experimental group showed gains in knowledge and understanding , critical thinking, awareness and environmental conservation behaviors from before learning ($p<0.001$). The students with different sexes statistically do not indicate these mentioned learning outcomes differently. However, the experimental group evidenced more previously mentioned learning outcomes than the control group students ($p<0.001$). Also, there were statistical interactions of sex with learning model only on awareness in the reception area and on environmental conservation behaviors in the area of effective and valued of resources usage ($p<0.05$).
Keywords: Good science thinking moves; metacognition techniques; critical thinking; awareness; environmental conservation behaviors.

* ADDRESS FOR CORRESPONDENCE: **Adisak Singseewo**, Department of Environmental Education, Faculty of Environment and Resource Studies, Mahasarakham University, 44150, Bangkok, Thailand.
E-mail address: singseewo@yahoo.com / Tel.: +65 5654 532

1. Introduction

Recently our world has been being impacted from environmental problems continuously including the problems which may expand and affect humans and living things (Gore, 1993). These problems are climate change, the depletion of natural resources, more destructive natural disasters, and extensive environmental pollution with give direct impacts on our lives and the quality of life. At present, humans change their roles as a natural control by using their knowledge and abilities in making technologies for response to population growth and to unlimited demand for consumptions and facilities (The Office of Health and Environment. 2011). In order to sustainably solve the environmental problems, we must resolve the human attitudes toward environments by making them valued and aware of environments as well as understandable of relationships between humans and environments and ready to protect and conserve the environments. Provision of environmental education for people at any education level is eventually necessary (Huckle, 1991). Environmental education is the organized processes of education or the means of changing people by the study of relationships between human and environments, conservation and environmental development and conditions of occurred problems in order to develop the awareness, knowledge and understanding, attitudes, skills abilities in evaluating and participating in solving environmental problems (UNESCO, 1976). An environmental education is the most factor for preventing environmental problems. The process of environmental education can be used in many forms both direct such as camping, seminar, article, fieldtrip as well as lecture; and indirect such as for young children by using cartoon, toils, outdoor activities; and for adults using presenting explanations through various media such as newspaper, television and public services (Rider, 2005). An environmental education also is a means for making people know about their important roles in prevention of environmental problems (UNESCO-UNEP, 1991) which lead to an environmental literacy. In general, there are five objectives of an environmental education, namely, awareness, knowledge, attitude, skill and participation (Wisconsin Department of Public Administration, 1991). Individuals with environmental literacy have various experiences and understandings of the fundamentals of problems related to environments, have values and concerns as well as motivation to active participation in prevention and improvement of environments, have skills in diagnosis and solving problems, have opportunities for active participation working at any level and orientation to recovery and improvement of environmental problems.(Federal Interagency Committee on Education, 1978) Basic components of an environmental education program is the study of natural sciences and science education (UNESCO-UNEP, 1983; Braus & Wood, 2005; Schneider, 1977) Learning activities for environmental education at the basic education schools during the education reform period is the process of the development of the learners' thinking process (Abraham et al., 1990; Renner & Marek, 1990).In order to effectively teach environmental contents, the proper method of teaching should be developed and implemented. The good science thinking moves method using metacognitive techniques is the integration of a metacognition with an inquiry teaching method. It is an intellectual process developed by Mittlefehldt and Grotzer (2003). The teaching consisted of 5 stages: connection, questioning in learning, self-reflection, questioning the truth or believes-ability, and comparing your idea with other idea; and using three metacognitives moves: intelligibility , plausibility and wide-applicability. The author hypothesized that the implementation of the good science teaching move method using the metacognitive techniques in teaching environments could develop desired characteristics of environmental education including knowledge and understanding, critical thinking, awareness and environmental behavior conservation of the students.

2. Purpose of Research

This study aimed to investigate and compare knowledge and understanding, critical thinking, awareness and environmental conservation behaviors of the students learned using the good science thinking moves method with metacognitive techniques and the traditional teaching method.

3. Population and Sample

The sample consisted of 74 grade 12 students from 2 classes, attending Nadoonprachasan School in MahaSarakham province, Thailand, obtained using in cluster random sampling technique from a population of 189 students from 5 classes.

4. Procedures

1. Experimental design

This study used a Quasi-Experimental Research with a 2x2 Factorial Experiment in a Completely Randomized Design with a Fixed Effect Model. There were 2 factors: sex and learning model.

2. Research instruments

Five instruments employed for these study included.

- Lesson plans with 2 types; 6 lessons plans using the good science thinking moves method with metacognitive techniques and other 6 lesson plans using the traditional teaching method,each for 3 hours of teaching in a week.

- An environmental knowledge and understanding test with 40 items difficulties ranging from 0.26-0.78, discriminatingvalues ranging from 0.24-0.82, and reliabilities of 0.7918.

- A critical thinking test with 4 areas: credibility of sources and observation, deduction, induction, and identification of assumptions, 10 items each; and with difficulties ranging from 0.23 - 0.57, discriminatingvalues ranging from 0.26 – 0.74 and each area and total reliabilitiesranging from 0.7320 - 0.8580.

- An environmental awareness questionnaire with 3 stages:receiving, responding and valuing, 5items each ; and with item-discriminating values ranging from 0.28 - 0.87, and each stage and total reliabilitiesranging from 0.6390-0.8820.

- An environmental conservation behaviorsquestionnaire:with 3 areas : effective and valued resource usage, environmental conservation, and participation in protection of self and social benefits, 10 items each ; and with item-discriminating values ranging from 0.28- 0.70 and each area and total reliabilities of 0.7096 -0.7966

5. Data Collection

The data were collected as the following:

The researcher randomly assigned the two sample classes to an experimental class of 40 students who learned using the good science thinking moves method with metacognitive techniques and a control class of 34 students learned using the traditional teaching method. Prior to the experimentation, the researcher gave the pretest instruments: the knowledge and understanding test, the critical thinking test, the awareness questionnaire and the environmental conservation behaviors questionnaire to the 2 classes of the students. Each class of the students was taught by the researcher for 6 weeks, 3 hours each, according to the assigned lesson plans. These two classes of the students were immediately posted using the first three instruments of the pretest period. Also, they were given a one-month delayed posttest using the environmental conservation behaviors questionnaire.

6. Data Analysis

All data collected were analyzed as the following.

The answer-sheets of the knowledge and understanding test and the critical thinking test were tested with correct answer for 1 mark and incorrect answer for zero mark. The answer-sheets of the two questionnaires were cheeked using this criteria :5 marks for strongly agree/always, 4 for agree/almost, 3 for uncertain/ frequent, 2 for disagree/ rare, and 1 for strongly disagree /never. Also, the research set the criteria for interpreting the mean scores as the following:

meaninterval	meaning
4.51 – 5.00	strongly Agree /always
3.51 – 4.50	agree/almost
2.51 – 3.50	uncertain/frequent
1.51 – 2.50	disagree/ rare
1.00 – 1.51	strongly disagree/never

All scores from each instrument were analyzed and tested the assumptions of the Two-way MACOVA and ANCOVA. These assumptions were relationship between the dependent variables, homogeneity of variance, homogeneity of regression slope and homogeneity of variance-covariance matrices. All data supported the assumptions.

The differences between the pretest scores and the posttest score were tested using the paired t – test. The F-test (Two-way MANCOVA and ANCOVA) were employed for testing the differences of 4 dependent variables of the students with different sexes and learning models.

7. Results

The results of the study as shown in table 1-4, were presented as the following.

1. The developed lesson plans using the good science thinking moves method with metacognitive techniques had an effectiveness index of 0.7290. Each plan showed the effectiveness index ranged from 0.6321 – 0.8109, showing that the students progressed their learning at 63.21-81.09 percent. In addition, the developed lesson plans using the traditional teaching method had a total effectiveness index of 0.6452, and an effectiveness index of each lesson plan ranged 0.5291 – 0.6414, showing that the students progressed their learning at 52.91-64.14 percent.

2. The students with different sexes did not statistically indicate different knowledge and understanding, critical thinking, awareness, and environmental conservation behaviors (p .079).

3. The experimental class students statistically showed more knowledge and understanding , critical thinking, environmental awareness and environmental conservation behaviorsthan the control class students (p .001).

4. There were statistical interactions of sex with learning model only in the receiving stage of awareness (p<.016), and in the area of effective and valued resource usage (p<.038), in favor of the experimental class students.

Table 1. Comparison of learning overall knowledge and understanding, critical thinking, environmental awareness, and environmental conservation behaviors of the students with different sexes and learning models (Two – way MANCOVA)

Source of Variation	Wilks' Lambda	Hypothesis Df	Error df	F	*P*-value	Partial Eta Squared
Knowledge and Understanding (pretest)	.900	4.000	63.000	1.746	.151	.100
Critical Thinking (pretest)	.818	4.000	63.000	3.504	.012*	.182
Environmental Awareness (pretest)	.975	4.000	63.000	0.403	.805	.025
Environmental Conservation - Behaviors (pretest)	.814	4.000	63.000	3.603	.010*	.186
Sex	.878	4.000	63.000	2.197	.079	.122
Model	.076	4.000	63.000	191.624	.000*	.924
Interaction	.887	4.000	63.000	1.997	.106	.113

* Statistically significant at 0.05

Table 2. Comparison ofcritical thinking in each area of the students with different sexes and learning models (Two – way ANCOVA)

Area	Source of Variation	SS	df	MS	*F*	*P*	Partial Eta Squared
Credibility of sources and observation	Pretest	12.550	1	12.550	7.371	.008	.097
	Sex	.285	1	.285	.168	.684	.002
	Model	173.414	1	173.414	101.845	<.001*	.596
	Interaction	.039	1	.039	.023	.880	.000
Deduction	Pretest	11.280	1	11.280	9.347	.003	.119
	Sex	.215	1	.215	.178	.675	.003
	Model	109.982	1	109.982	91.130	<.001*	.569
	Interaction	.001	1	.001	.000	.984	.000
Induction	Pretest	26.423	1	26.423	22.776	<.001*	.248
	Sex	.175	1	.175	.151	.699	.002
	Model	149.636	1	19.636	128.984	<.001*	.651
	Interaction	3.931	1	3.931	3.389	.070	.047
Identification of assumptions	Pretest	15.316	1	15.316	16.336	<.001*	.191
	Sex	2.920	1	2.920	3.115	.082	.043
	Model	131.405	1	131.405	140.157	<.001*	.067
	Interaction	3.251	1	3.251	3.468	.067	.048

* Statisticallysignificant at 0.05

Table 3. Comparison of environmental awareness in each stage of the students with different sexes and learning models (Two – way ANCOVA)

Stage	Source of Variation	SS	df	MS	F	*p*	Partial Eta Squared
Receiving	Pretest	2.827	1	2.827	54.276	<.001*	.440
	Sex	.127	1	.127	2.437	.123	.034
	Model	12.859	1	12.859	246.918	<.001*	.782
	Interaction	.315	1	.315	6.052	.016*	.081
Responding	Pretest	1.887	1	1.887	24.222	<.001*	.260
	Sex	.020	1	.020	.262	.611	.004
	Model	.5369	1	5.369	68.936	<.001*	.500
	Interaction	.024	1	.024	.311	.579	.004
Valuing	Pretest	1.971	1	1.971	37.562	<.001*	.352
	Sex	.054	1	.054	1.027	.314	.015
	Model	5.328	1	5.328	101.563	<.001*	.595
	Interaction	.110	1	.110	2.105	.151	.030

* Statistically significant at 0.05

Table 4. Comparison ofenvironmental conservation behaviorsin each area of the students with different sexes and learning models (Two – way ANCOVA)

Area	Sourced of Variation	SS	df	MS	F	*p*	Partial Eta Squared
Effective and Valued Resources Usage Environmental Conservation Participation in Protection of Self and Social Benefits	Pretest	15.975	1	15.975	36.870	<.001*	.348
	Sex	.004	1	.004	.009	.923	.000
	Model	.277	1	.277	.639	.427	.009
	Interaction	1.934	1	1.934	4.464	.038*	.061
	Pretest	7.289	1	7.289	21.936	<.001*	.241
	Sex	.030	1	.030	.092	.763	.001
	Model	.092	1	.092	.276	.601	.004
	Interaction	.722	1	.722	2.172	.145	.031
	Pretest	6.243	1	6.243	19.324	<.001*	.219
	Sex	.249	1	.249	.770	.383	.011
	Model	.438	1	.438	1.356	.248	.019
	Interaction	.549	1	.549	1.701	.197	.024

* Statistically significant at 0.05

8. Discussion

1. The developed learning plans using the good science thinking moves method with metacognitive techniques had an effectiveness index of 0.7290 showing that the students progressed their learning at 72.90 percent was supported by the research results which showed that the developed lesson plans using the good science thinking moves method with metacognitive techniques for grade 10 students had effectiveness index between 50.00-70.97 percent (Siwina, Suksringarm & Singseewo, 2009; Sihaponge, 2009). This might be due to the good science thinking moves method and the metacognitive techniques were the intellectual procedures which can facilitate and develop knowledge and understanding as well as higher order thinking especially the critical thinking of the students (Mittlehldt & Grotzer, 2003).

The stages of teaching through the good science thinking moves method with three metacognitive techniques; intelligibility, plausibility and wide-applicability, can make the student actively learn individually and in small group. This learning is a type of learner-centered activity. They can interact with peers, learning materials and the teacher. They can learn by experiencing and thinking which facilitate their progress of learning as found in this research.

2. The students who learned using the good science thinking moves method with metacognitive techniques evidenced more knowledge and understanding, critical thinking, awareness and environmental conservation behaviors than those students learning using the traditional teaching method. The result was supported by the research findings found that grade 5 and grad 10 students who learned using the good science thinking moves method with metacognitive techniques showed more critical thinking than those students learned the traditional teaching method (Siwina, Suksringarm & Singseewo, 2009, Budtha, 2004).The grade 9 students who learned using the good science thinking moves method with metacognitive techniques indicated more awareness of conservation and improvement of environments than the control group students (Sihawonge, 2009). This might be due to both good science thinking moves and metacognitive techniques are intellectual procedures in which each stage of learning and each type of metacognitive techniques can facilitate higher order thinking (Livingston, 1999), awareness knowledge and understanding, as well as environmental conservation behaviors of the students. The students can have a role in knowledge-building by using argumentation and critical thinking (Blank, 2000; Georgniader, 2000) can transfer of learning and thinking (Mittlehldt & Grotzer, 2003).The students, also can use these techniques during their study which supported by learning by law of exercise (Thorndike. 1939). The experimental class students were assigned to learn by a co-operative learning approach (Scanlon, 2000).They can practice thinking about thinking when interacted with one another of the group (Hennessey, 1999).

3. The students with different sexes did not statistically show different knowledge and understanding, critical thinking, awareness and environmental conservation behaviors. This finding was supported by the finding found that grade 9 students who learned using the good science thinking moves method with metacognitive techniques did not indicate different learning achievement critical thinking and awareness of conservation and improvement of environments (Sihapong, 2009). This might be due to both sexes of the students showed the same learning attention and had an equal knowledge structure (Ausubel, 1968). Each student regardless of sex in each small group based on a co-operative learning could share and discuss one's idea with another students members and the group could reach a final answer or knowledge according to the social constructivist philosophy by Hogan (1999). Each student can appropriately benefit the learning outcomes by co-operative learning regardless of sex.

9. Conclusion

The good science thinking moves method with metacognitive techniques could develop better learning outcome of students than the traditional teaching method. The findings revealed that the students learned using the previously mentioned method showed more knowledge and understanding, critical thinking, awareness and environmental behaviors than the control group students. Interesting the male and female students could equally benefit from learning.

10. Recommendation

The good science thinking moves Method is the Inquiry model and the metacognition techniques is the higher order thinking which can be implemented

In learning and teaching environmental education for facilitation the students, learning outcomes to meet the requirement of an environmental education and literacy. These approach should be supported to be used in teaching and learning environments in any grade level.

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