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Effects of Learning Environmental Education Using the 5Es-Learning Cycle Approach with the Metacognitive Moves and the Teacher's Handbook Approach on Learning Achievement, Integrated Science Process Skills and Critical Thinking of High School (Grade 9) Students

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Abstract: This study aimed to study the effects of the 5Es-learning cycle using the metacognitive moves and the teacher's handbook instruction on learning achievement, integrated science process skills and critical thinking of 82 high school (Grade 9) students from 2 classes, were selected by the use of the cluster random sampling technique. These students were randomly assigned to an experimental group who learned using the 5Es-learning cycle using metacognitive moves and a control group who learned using the teacher's handbook instruction, 41 students each. Research instruments included, 6 plans of learning organization by using the 5Es-learning cycle with 3 metacognitive moves: intelligibility, plausibility and wide-applicability; 6 plans of learning organization using the teacher's handbook, each plan for 3 h of learning in each week; the learning achievement test with 40 items; the integrated science process skills test with 5 subscales and 30 items and the critical thinking test with 5 subscales and 54 items. The data were analyzed by a percentage, a mean, a standard deviation and for testing hypotheses the t-test and the F-test (Two-way MANCOVA) were employed. The major findings revealed as following: The students as a whole, the male students and the female students in the experimental group showed gains in learning achievement, integrated science process skills in general and in 4-5 subscales and critical thinking in general and in 4-5 subscales from before learning ($p<0.05$). The students with different gender did not statistically indicate those mentioned learning outcomes differently ($p>0.05$). The experimental group indicated more learning achievement, integrated science process skills in general and critical thinking in general and in 3 subscales: interpretation, deduction and evaluation of arguments, than did the counterparts ($p<0.05$) and the statistical interactions of gender with learning model on these 3 learning outcomes were not found to be significant ($p>0.05$).

Key words: Environmental education, metacognitive moves, critical thinking, 5Es-learning, hypothesis

INTRODUCTION

Over the part decade, most of the countries around the world have been focusing on industrial development in regard to improve the national economic status. Therefore, the uses of natural resources are rapidly increased in each country. As the outcomes of increasing industrial development, environment has been changed and health effects of environmental conditions have also been increased. Therefore, providing education in regard to using environmental education and health concern relating to problems reduction which is arise from poor environmental condition should be implemented.

Environmental education is the learning processes which encourage the learners to have an awareness, understanding, concerning and valuing the natural environment. Regarding the learning process, everybody has an opportunity to improve their knowledge, attitude and decision making skill which may changing their attitude and behavior in term of improving and protecting the environment. In order to improve learners' abilities regarding critical thinking, the learning and teaching process of environmental education would concern on practicing and learning activities related to learners experienced.

Learning Cycle is based on constructivism theory and Piaget's development theory (Intellectual development theory), there is enhancing the learners abilities to discover new knowledge by using inquiry approach. The process of learning cycle consist of 5 phases (Bybee *et al*., 1991), engagement phase, exploration phase, explanation phase, expansion phase and evaluation phase. In order to improve the learners abilities about critical thinking process associated with

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their experienced, metacognitive moves should be implemented in each phase of learning cycle approach. Metacognitive moves is important for the learners to have knowledge and thinking which increase their 3 metacognitive moves: intelligibility, plausibility and wide-applicability (Mittlefehldt and Grotzer, 2003), which enhancing the learners for constructing new useful knowledge (Blank, 2000).

- To study and compare the learning achievement, integrated science process skills and critical thinking of the students before and after using the 5Es-learning cycle approach with the metacognitive move of the students as a whole and different gender
- To study and compare the learning achievement, integrated science proces skills and critical thinking of the students before and afte using the teacher's handbook approach of the students as a whole and different gender
- To study and compare the learning achievement, integrated science process skills and critical thinking of the students after learning different gender and different learning model.

MATERIALS AND METHODS

The population included, thestudents were studying in high school (Grade 9), semester 1/2008 all 200 students from 5 classrooms, Nadoonprachasan School, Nadoon District, Mahasarakham Province.

The appropriate sample size of 82 high school (Grade 9) students from 2 classrooms, were selected by the use of the cluster random sampling technique. These students were studying in classroom 3/3, 41 students and classroom 3/5, 41 students.

This study using an experimental design, which 2 methods included; using pretest-posttest equivalent control groups design and using 2×2 factorial experimental design (Completely Randomized Design: CRD; fixed effect model).

Research instruments included; 6 plans of learning organization using the 5E-learning cycle with 3 metacognitive moves assigned to an experimental group and 6 plans of learning organization using the teacher's handbook assigned for a control group, each plan for 3 hours learning week. The evaluation form included 4 parts; test following the teaching in each lesson plan; learning achievement test; integrated science process skills test and critical thinking skills test.

Data collection

Preparing phase: The letter of permission to conduct this research study was obtained from the faculty of graduate studies, Mahasarakham University. The researcher then contacted the director of Nadoonprachasan School for permission to collect data.

The simple random sampling was used to classify students into 2 groups; experimental groups and control groups.

Teaching phase: The participants were assigned to do pretest an experimental groups and control groups which included learning achievement test; integrated science process skills test and critical thinking test.

The plans of learning assigned to an experimental group who learned using the 5Es-learning cycle approach with the metacognitive moves and a control group who learned using the teacher's handbook instruction and collected data during June until July 2008.

Final phase: After learning completed the plans of learning organization, the students both experimental and control groups were assigned to do the posttest using the same questions as pretest; learning achievement test; integrated science process skills test and critical thinking test. The test results were measured for testing hypothesis.

Data analysis: Marking the test following each lesson plan to evaluate the effective ness index of the 5Es-learning cycle approach with the metacognitive moves and using the teacher's handbook instruction.

The results of pretest and posttest were analyzed by a percentage, a mean and a standard deviation.

The posttest were analyzed of the research assumptions test employed to the normality, homogeneity of variance, homogeneity of variance-covariance matrices. The major findings revealed the following assumptions.

The data were analyzed for testing hypotheses the t-test was used to compare the results of pretest and posttest.

The results of posttest were analyzed the students as a whole and subscales were analyzed by a mean, a standard deviation and F-test (Two-way MANCOVA). Univariate F-test was employed to identify the different of significant factors in each aspect.

RESULTS AND DISCUSSION

The students as a whole, the male students and the female students in the experimental group who learned using the 5Es-learning cycle approach with the metacognitive moves and a control group who learned using the teacher's handbook instruction showed gains in learning achievement, integrated science process skills

in general and in 4-5 subscales and critical thinking in general and in 4-5 subscales from before learning ($p<0.05$).

Regarding research results, the possible factors including; the style of teaching learning cycle which concern about improving students' intelligence using flame work from Piaget's development theory about the assimilation, accommodation and organization use that exploration phase, explanation phase and expansion phase, respectively. Therefore, the students in this study could adapt themselves appropriately (Marek *et al*., 1977). On the other hand, inquiry learning approach is an intellectual procedures which helps students to create knowledge restructuring and clearly understand by using their own thought, as mentioned in constructivism theory; learning activities which encourage students using science process skills (intellectual abilities) by use basic and integrate science process skills, for example, observation, measurement, calculation, collecting and interpreting data could increase students abilities if they practice consistently, these techniques is associated with law of exercise and during learning activity the students were using the 5Es-learning cycle approach with the metacognitive moves (intelligibility, plausibility and wide-applicability), which help learners inquiry approach and other thinking ability encourage them to connection with learning, knowledge about knowledge, thinking about thinking them to apply in their learning process both in small and large groups. These concepts are mentioned in the social constructivism theory take an important part in term of improving learners to have an opportunity to share their ideas, argument, critique between the groups in order to get consensus for new knowledge (Hogan, 1999). The students could have their conceptual change, durability, connection development, higher-ordered thinking and self determination, which help them to develop shown gains in learning achievement through integrated science process skill and critical thinking appropriately.

The students with different gender had learning achievement in general, integrated science process skills in general and subscales and critical thinking in general and subscales did not statistically indicate those mentioned learning outcomes differently ($p>0.05$) (Table 1).

The reason that male students and female students had learning achievement, integrated science process skills and critical thinking in general and subscales posttest not different even though male students and female students with different gender have the ability and skills in variety (Erickson *et al*., 1984) as the result may came from; the male students and the female students in the an experimental group are not able to adjust the study

Table 1: Comparison of learning achievement,integrated science process skills and critical thinking of the students after learning different sexes and learning model (two-way MANCOVA)

Source	DV	Hypothesis df	Error df	F	p
Sexes	-	3.00	73.00	1.212	0.311
Model	3	3.00	73.00	15.616	0.000*
Sex x Model	-	3.00	73.00	1.191	0.319

Table 2: Comparison of learning achievement,integrated science process skills and critical thinking of the students after learning in subscale and different learning model (University test)

Source	SS	df	MS	F	p
Achievement					
Error	373.47	1	373.47	41.604	0.000*
	718.14	80	8.977	-	-
Integrated SPS					
Error	611.90	1	611.90	101.79	0.000*
	480.8	80	6.011	-	-
Critical thinking					
Error	1194.7	1	1194.7	110.35	0.000*
	866.14	80	10.827	-	-

*Significant of statistical level 0.017

Table 3: Comparison of critical thinking ofthe students in subscale different sexes and different learning model (two-way MANCOVA)

Source	Sub scale	Hypothesis df	Error df	F	p
Sex	-	5.00	69.00	1.003	0.422
Model	5	5.00	69.00	6.840	0.000*
Sex x Model	-	5.00	69.00	0.566	0.726

*Significant of statistical level 0.05

program that uses the metacognitive move in the new form which is unable to respond in full capability learning; The 5Es-learning cycle approach with the metacognitive moves concentrating on small group activities and helping each other in studying in order to make relationship between students in the group. For example, exchanging ideas, understanding, explanation to have conference and to give opportunity or the people to share ideas on social constructivism, by let students to participate in hand on activities and cooperative learning (Wheatley, 1991) by having a group of friends to help through critical analysis in steps and continuously, in which this activities have part in develop learning achievement, integrated science process skills and critical thinking of Students in both gender equally.

The experimental group indicated more learning achievement, integrated science process skills in general and critical thinking in general and in 3 subscales: interpretation, deduction and evaluation of arguments, than did the counterparts ($p<0.05$) (Table 2-5).

The reason that students have in learning achievement, critical thinking in general and in 3 subscales: interpretation, deduction and evaluation of arguments than did the teacher's handbook instruction (Table 3-4) may result the 5Es-learning cycle approach with the metacognitive moves it is not only making student to get integrated science process skills but also

Table 4: Comparison of critical thinking of the students in subscale after different learning model (Univariate test)

Source	SS	df	MS	F	p
Inference					
Cont	8.673	1	8.673		
Error	236.44	73	3.239	2.678	0.106
Recognition of assumptions					
Cont	0.004	1	0.004		
Error	91.470	73	1.253	0.004	0.953
Deduction					
Cont	15.104	1	15.10		
Error	137.30	73	1.881	8.030	0.006*
Interpretation					
Cont	13.034	1	13.03		
Error	138.06	73	1.891	6.892	0.010*
Evaluation of arguments					
Cont	24.079	1	24.07		
Error	98.928	73	1.355	17.76	0.000*

*Significant of statistical level 0.01

Table 5: Comparison in integrated science process skills of the students in subscale different sexes and different learning model (two-way MANCOVA)

Source	Sub scale	Hypothesis df	Error df	F	p
Sex	-	5.00	69.00	0.327	0.895
Model	5	5.00	69.00	1.378	0.243
Sex x Model	-	5.00	69.00	0.813	0.544

students can practice questioning about things that they learned or intelligibility, plausibility and wide-applicability could develop the students' critical thinking greater than did the teacher's handbook instruction.

Whatever, it may be, the students in the experimental group and a control group were integrated science process skills do not statistically indicate those mentioned learning outcomes differently (Table 5). Even though, the 5Es-learning cycle approach with the metacognitive moves has learning activity for integrated science process skills especially in every steps of activities, for example; in exploration phase and explanation phase including using with the metacognitive moves. It may be result from the students in a control group, which study inquiry approach by using and practice science process skills same as the experimental group. Even though, it doesn't specified the kind of skills used each time clearly. This may conform to belief that study of science must use scientific process so that they can develop their intelligence and scientific attitude (Speece, 2000). Therefore, have the result for the students in both groups able to develop their ability intelligence or their science process skills did not differently. Since, the time of experimentation was too short, students were not able to develop their ability science process skills in the experimental group because science process skills is an intelligence skills, it must develop gradually and must prepare specific activities so that students can develop their skills.

The statistical interactions of gender with learning model on these 3 learning outcomes were not found to be significant ($p>0.05$) (Table 1).

The statistical interactions of sex with learning model were not found to be significant, regarding research results the possible including different sexes had received education in inquiry approach which use science process skills before so that students can develop their skills intelligence to a level and not difference.

Furthermore, the 5Es-learning cycle approach with the metacognitive moves in majority there are teaching activities similar to learning through teacher's handbook instruction. So that the result may increase will not depend on variable in sex and variable in learning model together.

CONCLUSION

The students as a whole, the students as a whole who learned using the 5Es-learning cycle approach with the metacognitive moves showed gains in learning achievement, integrated science process skills in general and subscales and critical thinking in general and all subscales from before learning ($p<0.05$).

The students as a whole who learned using the teacher's handbook instruction showed gains in learning achievement, integrated science process skills in general and in 4 subscales (except defining operationally) and critical thinking in general and all 5 subscales from before learning ($p<0.05$).

The experimental group indicated more learning achievement, integrated science process skills in general and critical thinking in general and in 3 subscales interpretation, deduction and evaluation of arguments, than did the counterparts ($p<0.05$).

Classify by gender: The male students in the experimental group showed gains in learning achievement, integrated science process skills in general and in 4 subscales (except interpreting data and making conclusion) and critical thinking in general and in 4 subscales (except evaluation of arguments) from before learning ($p<0.05$).

Those the male students who learned using the teacher's handbook instruction showed gains in learning achievement, integrated science process skills in general and in subscales (except defining operationally and identifying and controlling variables) and critical thinking in general and in 2 subscales include inference and recognition of assumptions from before learning ($p<0.05$).

The female students in the experimental group showed gains in learning achievement, integrated science process skills in general and all 5 subscales and critical thinking in general and all 5 subscales from before learning ($p<0.05$).

Those the female students who learned using the teacher's handbook instruction showed gains in learning achievement, integrated science process skills in general and in 4 subscales (except defining operationally) and critical thinking in general and all 5 subscales from before learning ($p<0.05$).

The students with different gender did not statistically indicate those mentioned learning outcomes differently ($p>0.05$)

The statistical interactions of gender with learning model on these 3 learning outcomes were not found to be significant ($p>0.05$).

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