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Effects of Learning Environmental Education Using the 5E-Learning Cycle with Multiple Intelligences and Teacher's Handbook Approaches on Learning Achievement, Basic Science Process Skills and Critical Thinking of Grade 9 Students

Warapond Budprom, Paitool Suksringam and Adisak Singsriwo
Faculty of Environment and Resource Studies, Mahasarakham University,
Mahasarakham 44000, Thailand

Abstract: This study aimed to investigate and compare the effects of learning environmental education using the 5E-learning cycle with multiple intelligences and the teacher's handbook approaches on learning achievement, basic science process skills and critical thinking of 80 grade 9 students from two classes. They were randomly selected by the cluster random sampling technique and were assigned to an experimental group and a control group, 40 students each. The instruments for the study included 6 plans of learning organization using the 5E-learning cycle with multiple intelligences for the experimental group and 6 plans of learning organization using the teacher's handbook approach for the control group, each plan for 3 h of learning in each week; the learning achievement test with 40 items; the test on basic science process skills with 8 subscales and 40 items and the critical thinking test with 5 subscales and 54 items. The paired t-test and the F-test (Two-way MANCOVA) were employed for testing hypotheses. The major substantive findings revealed that the whole students, the male students and the female students in the experimental group showed gains in learning achievement, basic science process skills in general and in 4-8 subscales and critical thinking in general and in 3-5 subscales from before learning ($p<0.05$). The students with different sexes did not differently indicate basic science process skills in general and in each subscale and critical thinking in each subscale. However, the male students outperformed the female ones in learning achievement and critical thinking in general ($p<0.05$). The experimental group outscored the control group in learning achievement, basic science process skills in the observing subscale and critical thinking in general and in 4 subscales: ($p<0.05$) the statistical interactions of learning model with sex were found to be significant at the 0.05 level in the areas of learning achievement, basic science process skills in general and critical thinking in general and in each subscale.

Key words: Environmental education, learning cycle, multiple intelligences, critical thinking, basic science, subscale

INTRODUCTION

Now a days economy, society, civilization and political affair have been changed and developed by the scientific and technological advances in order to be trendily suitable for all development forms of most countries around the world. The consequences which were from the recent countries development have been operating an administrative policy and management in the aspects of basic structured factor mainly and to orderly develop a better quality of people lives. Natural resources have secondly brought up for feeding countries development and being fully used in every day life without focusing on natural conservation and regenerated parts replacement. All the said reasons have effected an environmental balance especially in the current environmental problems which were caused from the population increment, the expansions of society, residential, public utility system, agricultural and industrial productivity in the inappropriated areas, behavior and activity in every day life operation as well as consumption characteristic is a reactive accelerator that directly or indirectly release the carbon dioxide into atmosphere which causing global warming or climate change. Due to the facts that people would be effected by these environmental crisis which is over an environmental acceptance limitation.

For the result of that the environmental education was then appeared from educational concept in order to solve the environmental problems by setting up learning processes which is coherently and relatively between human and environment or it could be a knowledge

Corresponding Author: Warapond Budprom, Faculty of Environment and Resource Studies, Mahasarakham University, Mahasarakham 44000, Thailand

promotion method about environment for the learners and all people in order to be the highest target in developing the environmental quality which relatively gives an advantage for human by having an effective target in encouraging the learners to have awareness, knowledge, attitude, skill, evaluation ability and participation in order to solve current problems and being able to control the coming problem in the soon future.

Environmental education is the learning process that related to scientific skills of problem solving developing the criticized skill and the learners are participating in all activity areas which causing knowledge in solving problems being able to apply their knowledge with new circumstances. These is an encouragement of intellectual ability (Finley, 1983) which makes learners have more experiences and skill in problems solving (Bruner, 1961).

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 orderly consists of 5 phases as following (Bybee, 1989) Engagement phase, Exploration phase, Explanation phase, Expansion phase and Evaluation phase. The learning management concept is new for learners multiple intelligence which would relatively respond in between their brains and learning which indicates a various differential intellectual of each person's intelligences or a working dimension in all areas which is called Multi Intelligence which Howard Gardner has classified his outstanding ability and cleverness accordingly to the 8 aspects of personal differential intelligence which are linguistic intelligence, logic/mathematical intelligence, spatial intelligence interpersonal intelligence, intrapersonal intelligence and naturalist intelligence. In each aspects of intelligence are able to interact (Armstrong, 1994) and build up relationship in between group and outer group and at the same time is able to build up knowledge in the social constructivism (Ernest, 1996) learning outline concept. From the qualitative evaluation results on institutions and learners has found that the learners are able to have consideration, analysis, synthesis and vision in the level that must be improving which indicates that Thai children are lack of intellective skill.

As the result of that researchers are interested in bringing the 5E-learning cycle by using multiple intelligence to compares with teacher's instruction handbooks about the environmentals in order to be knowing that the said learning activities result does or does not help the learners to be intellectually capable in learning achievement basically scientific intelligence skill and as well as critical thinking. This research would appropriately be an useful basic information for the environmental and scientific learning developments for teachers and would make learners achieved in learning and able to greatly use in every day life and the environmental problems solution.

The research's purposes:

- To study and compare the learning achievement, integrated science process skills and critical thinking of the students before and after using the 5E-learning cycle approach with the multiple intelligences
- To study and compare the learning achievement, integrated science process skills and critical thinking of the students before and after 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 the students were studying in high school (Grade 9), semester 1/2008 in the amount of 242 students from 6 classrooms, Nong Phok Vitthaya School, Nong Phok District, Roi-Et Province.

The appropriate sample size of 80 high school (Grade 9) students from 2 classrooms were selected by cluster random sampling technique. These students were studying in classroom 3/1, 40 students and classroom 3/2, 40 students. This study using an experimental design which are 2 methods included of using pretest-posttest equivalent control groups design and using 2×2 factorial experimental design (completely randomized design: CRD; fixed effect model).

Research instruments are included of the 5E-learning cycle organization plan by using multiple intelligence with basic scientific learning, life and environment was assigned for the experimental group for 6 plans and each plans use 3 h per learning week and learning management in teacher's handbooks was assigned for the control group for 6 plans and each plans use 3 h per learning week 3 experimentalsets are learning achievement test, integrated science process skills test and critical thinking skills test.

Experiment and 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 Nong Phok Vitthaya School for a permission to collect data. The simple random sampling was used to classify students into two groups of experimental groups and control groups.

Teaching phase: The participants were assigned to do pretest an experimental groups and control groups which included of learning achievement test, integrated scientific process skills test and critical thinking test and had the test results score-counted.

The plans of learning management was experimented in teaching accordingly to the normal schedule by the experimental group who learned to use the 5E-learning cycle by using the Multiple Intelligence and control group to learn with teacher's instruction handbooks through out all plans during June until July, 2008.

Final phase: After the teaching scheduledly completed, researchers had secondly done posttest with both of the experimental group and control group by using learning achievement test, integrated scientific process skills test and critical thinking test and the test results were measured for testing hypothesis.

Data analysis: The tested scores of learning achievement test, integrated scientific process skills test and critical thinking test were measured an average value, mean and standard deviation. Effectiveness index of the 5E-learning cycle was found by multiple intelligence and Teacher's instruction handbooks usages.

The posttest scores of learning achievement test, integrated scientific process skills test and critical thinking test were brought to analyze primary variance analysis (Two-way MANCOVA) by testing on normality, homogeneity of variance and variance-covariance matrices which data was showed similarly to the primary accordance in all aspects.

Pretest and posttest of learning achievement test, integrated scientific process skills test and critical thinking test were tested with paired t-test. The pretest scores of learning achievement test, integrated scientific process skills test and critical thinking test were brought to analyze Two-way MANCOVA.

RESULTS AND DISCUSSION

The students as a whole, the male students and the female students in the experimental group who learned using the 5E-learning cycle approach with the multiple intelligence 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 4-8 subscales and critical thinking in general and in 3-5 subscales from before learning ($p<0.05$). Regarding to the research results of the possible factors are included of the 5E-learning cycle is the investigated learning management that emphasized the learners to be a center in learning and knowledge self-making which were developed from Piaget's intellectual development in assimilation, accommodation, organization which were brought to develop in exploration phase, Explanation phase, Expansion phase (Marek *et al*., 1990) to be parts in each learning steps in order to use a scientific skill which is the same of intellectual ability (Finley, 1983). This is caused learners an opportunity to train the intellectual system and are able to develop all of the learning achievement test, integrated scientific process skill test and critical thinking test appropriately and increasingly more than before learning which accordingly to scientists believes in scientific accordance with learning scientific management by investigated teaching which uses integrated scientific process skill would be able to develop intellectual ability and scientific attitude greatly (Tamir, 1983) with personal differences (Gardner, 1993). During each learning activities which emphasizingly use multiple intelligence in each aspects of linguistic intelligence, logic/mathematical intelligence, spatial intelligence, bodily-Kinesthetic intelligence, musical intelligence, interpersonal intelligence, intrapersonal intelligence and naturalist intelligence (Gardner, 1993) make students developed their intelligences ability more often than the general learning. Then students who learned with the 5E-learning cycle by using multiple intelligence have developed their intelligence through learning activities which in each steps were put development skill activities and multiple intelligence that are able to develop the learning achievement, integrated scientific process skill and critical thinking more effectively and increasingly than before learning.

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	Hypothesis df	Error df	F	p-value
Sexes	3.00	71.00	6.96	0.000
Model	3.00	71.00	21.88	0.000
Sex x model	3.00	71.00	2.74	0.000

*Significant of statistical level 0.05

The students with different gender had the learning achievement in general, integrated science process skills in general and subscales and critical thinking in general and subscales were not different but male students had the learning achievement and critical thinking in general are more than female students at the statistical level of ($p>0.05$) (Table 1). The reason that both male students and female students were indifference of learning achievement, integrated scientific process skill and critical

Table 2: Comparison of integrated science process skills of the students in subscale different gender and learning model. (two-way MANCOVA)

Source	Hypothesis df	Error df	F	p-value
Sex	8.00	61.00	0.899	0.531
Model	8.00	61.00	3.432	0.033*
Sex x model	8.00	61.00	0.155	0.996

*Significant of statistical level 0.05

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

Source	Hypothesis df	Error df	F	p-value
Sex	5.00	67.00	26.5210	0.531
Model	5.00	67.00	21.5210	0.000*
Sex x model	5.00	67.00	2.5140	0.038*

*Significant of statistical level 0.05

thinking as a whole and aspectively but as a whole male students have learning achievement and critical thinking more than female students which accordingly to Erickson and Erickson (1984) found that male and female students have many different characteristics and abilities its because both of male and female students who investigationally learned science have the same level of intellectual development and also have the same level of mental structure (Marek *et al*., 1990) knowledge structure (Ausubel, 1968) and achievement motivation (Atkinson and Brich, 1964) which is able to adjust themselves to be harmonized with the learning that emphasized learners to investigate answers by themselves. This caused the said learning as a whole is not different although most of male students are more accurate in Intellectual process than female students. Erickson and Erickson (1984) which is able to express their ability in analyzing critical thinking at the same time making operational group a knowledge creativity-scientific ideological understanding which accordingly to the ideas of social constructivism (Ernest, 1996) and achievement motivation (Atkinson and Brich, 1964). Then the male students are able to develop critical thinking better than male.

The students who learned the 5E-learning cycle by using multiple intelligence have achieved in learning as a whole integrated scientific process skill especially in the aspects of observation and critical thinking as a whole and aspectively 4 aspects have more estimation aspect, deduction aspect, interpretation aspect and argument evaluation aspect more student's who learned by teacher's instruction handbooks at statistical level of ($p<0.05$) (Table 2 and 3).

The reason that research results were appeared like this might because of the 5E-learning cycle (Bybee, 1989) is an investigated learning form of Intellectual Process that uses adaptation ideal outline and knowledge organization and intellectual skill (Welch, 1981). This caused students have an opportunity to constantly and inclusively train and develop their intellectual abilities which makes learners have more experiences and skill in problems solving (Bruner, 1961) and which is able to develop all the said 3 kinds of intellectual process more that the control group who learned a normal investigation.

In each steps of the 5E-learning cycle (Bybee, 1989), students would be accepted a various intellectual ability development according to the idea of multiple intelligence (Gardner, 1993) which each of intelligence aspects are able to co-working interaction (Armstrong, 1994) which caused student learning groups are able to have relation in the groups till they have got knowledge understanding built up in whatever they learn according to the ideas of social constructivism (Ernest, 1996) and knowledge structure (Ausubel, 1968) as well as developed more intellectual ability which caused learning achievement, integrated scientific process skill and critical thinking than students who were in the control group.

Relation between genders and the forms of learning achievement and integrated scientific process skill and critical thinking as a whole and aspectively (Table 1). To have relationship between genders and student's learning forms indicated that the development results of learning achievement, integrated scientific process skill and critical thinking would be varied according to the learning forms and genders which is useful in learning activities preparation which is mainly focused on the learners by providing a learning form which appropriately to students gender making them learn happily, believing, active and inspired an achievement in the learning.

CONCLUSION

The students as a whole who learned using the 5E-learning cycle by using the multiple intelligence showed gains in learning achievement, integrated scientific process skill as a whole and aspectively and critical thinking as a whole and aspectively all aspects have increased from before learning are at the statistical level of ($p<0.05$).

The students as a whole who learned the teacher's instruction handbooks showed gains in learning achievement, integrated science process skill as a whole and aspectively all of 7 aspects (except relationship using between time and dimension) and critical thinking as a whole and aspectively which increased from before learning are at the statistical level of ($p<0.05$).

The students who learned the 5E-learning cycle by using multiple intelligence have the learning achievement, integrated science process skills as a whole and critical thinking as a whole and aspectively all of 4 aspects: interference, deduction, interpretation and evaluation of arguments more than the students who learned with

teacher's instruction handbooks are at the statistical level of ($p<0.05$). The students are classified by gender. The male students who are in the experimental group who learned the 5E-learning cycle using multiple intelligence have the learning achievement, integrated science process skills as a whole and aspectively all of 4 aspects (except the aspects of classification, measurement, predication and estimation) and critical thinking as a whole and aspectively all of 3 aspects (except the aspects of primary acceptation and evaluation of arguments) which increased from before learning are at the statistical level of ($p<0.05$).

Those male students who were in the control group have learned using the teacher's instruction handbook showed gains in learning achievement, integrated science process skills as a whole and aspectively all of 6 aspects (except the aspects of relationship using between time and dimension and interference) and critical thinking as a whole and aspectively all of 4 aspects of interference, deduction, interpretation and evaluation of arguments which were increased from before learning are at the statistical level of ($p<0.05$).

The female students in the experimental group who learned using the 5E-learning cycle by using learning achievement, integrated science process skills and critical thinking both as a whole and in each aspects were increased from before learning are at the statistical level of ($p<0.05$). Those female students who were in the control group have learned by teacher's instruction handbooks gained in learning achievement and integrated science process skills as a whole and aspectively all of 6 aspects (except classification and relationship using between time and dimension) and critical thinking as a whole and acpectively which increased from before learning are at the statistical level of ($p<0.05$).

The students with different gender have integrated science process skills as a whole and aspectively and each aspects of the critical thinking are not different but those male students have more learning achievement than female students are at the statistical level of ($p<0.05$). The interactions between gender and learning forms to the learning achievement skills and integrated science process skills as a whole and the critical thinking skills in both as a whole and aspectively are at the statistical level of ($p>0.05$).

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