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Effects of Environmental Education Learning by Using the 7Es-Learning Cycle with Multiple Intelligences and the Teacher's Handbook Approaches on Learning Achievement, Critical Thinking and Integrated Science Process Skills of High School (Grade 10) Students

Nida Kitjinda-Opas, Paitool Suksringarm and Adisak Singseewo
Faculty of Environment and Resource Studies, Mahasarakham University,
Mahasarakham 44150, Thailand

Abstract: This study aimed to investigate and compare the effects of learning environmental education using the 7Es-learning cycle with multiple intelligences and the teacher's handbook approaches on learning achievement, critical thinking and integrated science process skills of 100 grade 10 students in high school. They were randomly selected by the cluster random sampling technique and were assigned to an experimental group and a control group which were 50 students in each group. The instruments for the study were included: 7 plans of learning organization using the 7Es-learning cycle with multiple intelligences for the experimental group and 7 plans of learning organization by using teacher's handbook approach for the control group, each plan was a 2 h weekly learning, the learning achievement test, the critical thinking test and the test on integrated science process skills. The collected data were analyzed by using a percentage, mean, standard deviation and for testing hypotheses the paired t-test and the F-test (Two-way MANCOVA) were employed. The major findings have been revealed that the whole students were male and females students in the experimental group have shown that they gains learning achievement, critical thinking in general and in each subscale and integrated science process skills in general and in 4 subscales from before learning is at the significant level of 0.05. The experimental group indicated more learning achievement, critical thinking in general and in 2 subscales and integrated science process skills in general and in 2 subscales than the control group. The students with a different gender which did not differently have an evidence in learning achievement, critical thinking in general and in almost subscales and integrated science process skills in general and in each subscale. However, the male students showed critical thinking in the deduction subscale more than the female. Statistical interactions of gender with learning model were found to be significant ($p<0.05$) only in 3 subscales of the critical thinking.

Key words: 7E-learning cycle with multiple intelligences, critical thinking, integrated science process skills, environmental education, statistical interactions

INTRODUCTION

Learning cycle is a learner-centered inquiry teaching approach with having learners built knowledge by themselves, using conceptual framework or learners' prior knowledge. This is in accordance with Piaget (1964) intellectual development theory in terms of assimilation and accommodation. Piaget (1964) believes that students act or perform by themselves in learning different things or students build the meaning of experience received by themselves according to the constructivism theory. In the early period the learning cycle had 2 stages: exploration and explanation. Robert Carplus extended it to 3 stages: exploration, concept introduction and concept application. All the stages mentioned were ranked to be in accordance with Piaget (1964) intelligence development theory.

Later, a group of students applied and developed this method for its stages to be 4Es-learning cycle comprising exploration, explanation, expansion and evaluation (Barman, 1997). In the same year they have had 5Es-learning cycle comprising engagement, exploration, explanation, expansion and evaluation (Lawson, 2001) Finally, Eisenkraft (2003) extended the model to be 7Es-learning cycle comprising these phases: elicitation phase, engagement phase, exploration phase, explanation phase, expansion phase/elaboration phase, evaluation phase and extension phase. The multiple intelligences

Corresponding Author: Nida Kitjinda-Opas, Faculty of Environment and Resource Studies, Mahasarakham University, Mahasarakham 44000, Thailand

learning model is one used for learning and teaching environmental education. Gardner (1993) explains that each human has ability or intelligence in different aspects at a certain level.

Individually, humans do not have an equal level of ability in each aspect; also integration of different abilities themselves is different, these abilities can be developed. Gardner (1993) defines that intelligence in people generally have intelligences in a various aspects and each aspect depends on ability and will express in a different forms. They are in these aspects: verbal/linguistic intelligence, logical/mathematical intelligence, visual/ spatial intelligence, musical/rhythmic intelligence, bodily-kinesthetic intelligence, interpersonal intelligence, intrapersonal intelligence and naturalist intelligence.

Gardner (1993) believes that each person does not have intelligence in each aspect at an equal level but it can be developed. As for these types of intelligence, the intelligence in each aspect does not work separately form each other. These aspects will integrate the usage of intelligence in a different aspects into one another.

From reviewing research studies of 7Es-learning cycle with the theory of multiple intelligences by comparing learning achievement, critical thinking and science process skills, it was found that the students who learned using 7Es-learning cycle with multiple intelligences had a critical thinking after learning as a whole and in each aspect higher than those who learned by using ISTP (Institute for Science and Technology Teaching Promotion) inquiry approach.

Since environmental education has been assigned in the learning-teaching curriculum, 7Es-learning cycle with multiple intelligences should be employed which can develop abilities in a different aspects of learners. Therefore, the researcher was interested in examining the effects of learning environmental education using the 7Es-learning cycle with multiple intelligence and the teacher's handbook approaches on learning achievement, critical thinking and integrated science process skills of high school (grade 10) students. The researcher wanted to find out whether students are taught using the mentioned 2 approaches which would differently have learning achievement, critical thinking and integrated science process skills or not and how, in order for teachers to use the obtained results as information for developing a model of organization of environmental education learning-teaching activities and for learners to have desirable characteristics. These things would bring an accomplishment in learning teaching organization and would be enable for students to develop their own intelligences, problems solution and environmental development. These would be greatly beneficial to the environment and mankind.

- To investigate and compare environmental education learning achievement, critical thinking and integrated science process skills before and after learning using the 7Es learning cycle with multiple intelligences of the students as a whole and classified in each gender
- To investigate and compare environmental education learning achievement, critical thinking and integrated science process skills before and after learning by using the teacher's handbook of students as a whole and as classified into each gender
- To investigate and compare environmental education learning achievement, critical thinking and integrated science process skills of the students with differences in gender and learning approach

MATERIALS AND METHODS

Research and planning for statistical experiment: the population which was used in this study had consisted of 350 high school (grade 10) students from 7 classrooms who enrolled science stream in the first semester of the academic year 2008 at Wapipathum school, Mahasarakham Province.

The sample which was used in this study had consisted of 100 high school classes 4/9 and 4/10 students enrolling science stream at Wapipathum school, Mahasarakham Province. In the first semester of the academic year 2008, randomly selected by the cluster random sampling technique.

This study was a true experimental design using 2 research plans as following: Plan 1 used pretest-posttest equivalent groups design, Plan 2 used 2×2 factorial experiment in the completely randomized design of the fixed effect model. There were 2 factors: gender and learning approach.

The instruments that were used in this experiment included of: 7 plans of learning organization using the 7Es-learning cycle with multiple intelligences entitled Living Things and the environment, taught for 14 h to an experimental group and 7 plans of learning organization using the teacher's handbook, taught the control group for 14 h; 4 tests comprising quizzes at the end of each learning organization plan, an achievement test, a critical thinking test and a test of integrated science process skills.

For experiment and data collection, the researcher conducted the study as following:

Preparation stage: The researcher took a letter form Graduate school, Mahasarakham University and asked for help from Wapipathum school in trying out the plans of learning organization and data collection.

Randomly selected the classrooms to divide students into 2 groups: a control group and an experimental group.

Teaching stage: Pretested the students in the experimental group and the control group using an achievement test, a critical thinking test and a test of integrated science process skills. Then the testing results were checked for counting scores.

The plans of learning organization were experimented according to the regular time table. The experimental group used the plans of learning organization based on the 7Es-learning cycle with multiple intelligences and the control group learned using the plans of learning organization based on the teacher's handbook. All the plans were taught completely from June to September 2008.

After-teaching stage: When the teaching completed as having been assigned, the researcher administered posttesting with the experimental group and the control group using the achievement test, the critical thinking test and the test of integrated science process skills. The answers were scored and the obtained scores were analyzed through statistical usage for testing hypotheses.

Stage of data collection: The answers to the quizzes on learning achievement at the end of each plan were scored and the scores were calculated for the plans' efficiencies: plans of learning organization taught by using the 7Es learning cycle with multiple intelligences and plans of learning organization by using the teacher's handbook.

The scores obtained from posttesting learning achievement, critical thinking and integrated science process skills were calculated for mean, percentage and standard deviation.

The scores obtained from posttesting learning achievement, critical thinking and integrated science process skills were analyzed for basic assumptions of two-way MANCOVA by testing frequency as a curve of population normality, homogeneity of variance and homogeneity of variance-covariance matrices of the data, appeared that the data were in congruence with the basic assumptions.

The scores obtained from testing differences between pretest mean scores and posttest mean scores on learning achievement, critical thinking and integrated science process skills were tested using paired t-test.

The scores obtained from testing learning achievement, critical thinking and integrated science process skills after learning in general and in each aspect were analyzed for testing hypotheses by using mean, standard deviation and F-test (two-way MANCOVA).

The results of analyzed according to the variables which the result of testing hypotheses had a statistical significance were used for analyzing differences of characteristics in each aspect by using univalent F-test.

RESULTS AND DISCUSSION

The students as a whole and classified according to gender who learned using the 7Es-learning cycle with multiple intelligences, had increased their learning achievement, critical thinking and integrated science process skills as a whole and in each of the 4 aspects (expect in the aspect of determining action definition) from before learning at the 0.05 level of significance. The result of the study was so perhaps because the 7Es-learning cycle was the inquiry learning which was the intellectual procedure by using the conceptual framework of Piaget's Theory of Development concerning adaptation. Also, determination of each learning stage to have insertion of activities for developing intelligence ability could cause learners to receive development of various forms of intelligence ability. In addition, the 7Es-learning cycle still emphasized students to have group work with discussions in order to build knowledge-understanding that according to the concept of social constructivism. (Ernest, 1996). This could cause students to develop their learning achievement, science process skills and critical thinking more appropriately and better than before learning.

The students who learned using the 7Es-learning cycle with multiple intelligences had higher learning achievement, critical thinking as a whole and in each of these 2 aspects: acceptance of basic assumptions and deduction and integrated science process skills as a whole and in each of these 2 aspects: experiment and interpretation and inference than the students who learned using the teacher's handbook at significant level of 0.05. The results of the study were so probable because the students who learned using the 7Es-learning cycle with multiple intelligences developed the building of knowledge-understanding according to the theory of social constructivism, which was in conformity with the law of practice and the principle of learning transference. Also the students have practiced developing intellectual abilities in terms of science process skills, intelligences and critical thinking, which could generate higher

achievement motivations, intention and self-confidence in learning. They would be able to develop more learning achievement, science process skills and critical thinking than the students in the group that learned using the teacher's handbook.

The students with a different gender did not have different learning achievement, critical thinking as a whole and integrated science process skills as a whole and in each of the 5 aspects. However, male students had higher critical thinking only in the aspect of estimation than female students at significant level of 0.05 (Table 1).

The results of the study appeared that male students and female students had intellectual development at the same level and had similar mental structure, knowledge structure and achievement motivation. When the students received organization of activities emphasizing development of intellectual ability in terms of intellectual process skills, multiple intelligences ability and critical thinking, they would be able to build knowledge-understanding by themselves according to the theory of constructivism (Table 2 and 3).

Therefore, the students of both genders did not have different learning achievement. However, male students had higher ability to estimate than female students, because male students had higher aptitude for reasoning than female ones. Thus they could develop the aspect mentioned better than females.

There interactions between the learning approach and gender only in critical thinking in each of these 3 aspects: estimation, acceptance of basic assumptions and interpretation at the significant level of 0.05. There were no interactions between gender and learning approach in learning achievement and integrated science process skills.

The results of the study were reflected that in the learning-teaching organization for developing students' abilities in a different aspects, the learning-teaching approach might have effects jointed with students' gender on development of students' abilities in some aspects, for example: in critical thinking. However, there were no joint influences between the 2 variables on development of science process skills.

Therefore, science teachers should have knowledge and understanding of having joint influences or having interactions between variables, learning-teaching approach and some factors of the students. Then they should choose learning-teaching guidelines to be appropriated for the development of students' abilities in the future.

Table 1: Comparisons of learning achievement, critical thinking and integrated science process skills after of the students with differences in gender and learning approach (two-way MANCOVA)

Source	No. of aspects	Hypothesis df	Error df	F	p
Gender	-	3.00	91.00	2.66	0.053
Learning approach	3	3.00	91.00	31.37	0.000*
Learning approach	-	3.00	91.00	2.30	0.082
*Gender	-	-	-	-	-

Table 2: Comparisons of critical thinking in each aspect of the students with differences in gender and learning approach (two-way MANCOVA)

Source	No. of aspects	Hypothesis df	Error df	F	p
Gender	-	5.00	87.00	5.15	0.000*
Learning approach	5	5.00	87.00	7.89	0.000*
Learning approach	-	5.00	87.00	5.81	0.000*
*Gender	-	-	-	-	-

Table 3: Comparisons of integrated science process skills in each aspect of the students with differences in gender and learning approach (two-way MANCOVA)

Source	No. of aspects	Hypothesis df	Error df	F	p
Gender	-	5.00	87.00	1.09	0.370
Learning approach	5	5.00	87.00	13.94	0.000*
Learning approach	-	5.00	87.00	0.45	0.811
*Gender	-	-	-	-	-

CONCLUSION

Students in general: The students in general who learned using the 7Es-learning cycle with multiple intelligences increased their learning achievement, critical thinking as a whole and in each of the 5 aspects and integrated science process skills as a whole and in each of the 4 aspects (except in determination of action definition) from before learning at the significant level of 0.05.

The students as a whole who learned using the teacher's handbook increased their learning achievement, critical thinking as a whole and in each of the 5 aspects and integrated science process skills as a whole and in each of the 3 aspects (except in determination of action definition and determination of variables) from before learning at the significant level of 0.05.

The students as a whole who learned using the 7Es-learning cycle with multiple intelligences had higher learning achievement, critical thinking as a whole and in each of the 2 aspects: acceptance of basic assumptions and deduction and integrated science process skills as a whole and in each of the 2 aspects: experiment and interpretation and inference than the students who learned using the teacher's handbook at the significant level of 0.05.

The students were classified by their genders: Male and female students who learned using the 7Es-learning cycle with multiple intelligences increased their learning achievement, critical thinking as a whole and in each of all

the 5 aspects, integrated science process skills as a whole and in each of the 4 aspects (except in determination of action definition) from before learning at the significant level of 0.05.

Male and female students who learned using the teacher's handbook increased their mean scores on learning achievement, critical thinking as a whole and in each of the 4 aspects, integrated science process skills as a whole and in each of the 3 aspects (except in determination of action definition and determination of variables) from before learning at the 0.05 level of significance.

The students with a different gender did not have different learning achievement, critical thinking as a whole and integrated science process skills as a whole and in each of all the aspects. However, male students had higher critical thinking only in estimation than female students at the significant level of 0.05.

There were interactions between learning approach and gender only in critical thinking in each of the 3 aspects: estimation, acceptance of basic assumptions and interpretation at the significant level of 0.05.

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