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Learning Achievement, Science Process Skills, and Moral Reasoning of Ninth Grade Students Learned by 7e Learning Cycle and Socioscientific Issue-based Learning

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Abstract: Science and technology are very important for living, human resources development, as well as intelligence and reason development. This study aimed to develop lesson plans between 7E learning cycle and socioscientific issue-based learning with an efficiency criterion of 75/75, to study the effectiveness index of both teaching approach, to compare learning achievement, science process skills, and moral reasoning of both teaching approach, to compare learning achievement, science process skills, and moral reasoning between before and after they had learned, and to compare learning achievement, science process skills, and moral reasoning of both teaching approach. Sixty eight students, studying in two classes in the 2nd semester, academic year 2010, at Choomchon Ban Nongyama School, Muang Roi Et Municipality, Roi Et province, obtained through the cluster random sampling technique. The research instruments were lesson plans for the 7E learning cycle and socioscientific issue-based learning approach; an achievement test, a science process skills test, and an moral reasoning test. The findings were revealed that efficiency criterion of lesson plans for 7E learning cycle and socioscientific issue-based learning approach was 76.97/76.14, and 77.81/77.07, respectively. The effectiveness index (E.I.) of the 7E learning cycle and the socioscientific issue-based learning was 0.5550, and 0.5673, respectively. Students who learned by using the 7E learning cycle showed gains in learning achievement at the .01 level of significance. Also, Students who learned by using socioscientific issue-based learning approach showed gains in learning achievement, science process skills, and moral reasoning at the .01 level of significance. Finally, Students can gain more science process skills higher than those 7E learning cycle approach.01 level of significance.

Key words: 7E learning cycle approach, socioscientific issue-based learning, learning achievement, science process skills, moral reasoning.

INTRODUCTION

Learning management of the socioscientific issue-based learning emphasizes learners to participate in perception of and decision-making on the relevant issues between science and social. It also emphasizes personal experience issue to see social value, and appropriately utilizes scientific knowledge and technology to be applied to society. This results in neglect of comprehension of utilizing or applying science, virtue, and ethic; brings conflict in using science in teaching and learning; and ignores the effects of science and technology advances which may have an impact on life, society, economy and environment. Presently, the socioscientific issues seen are usually relevant to biotechnology issues, environmental problem and human genetics (Sadler and Zeidler, 2003). Samples of social issues related to science found at present are cloning, stem cell, genetically modified organism, global warming, or alternative fuel. Therefore, it is essential to encourage learners to understand and perceive science and psychology process, and get ready to solve problems and spend their lives happily using science for decision-making (Nuangchalerm, 2010; Wongsri and Nuangchalerm, 2010).

Additionally, applying scientific issues related to society for using with scientific learning management also supports learners various skills: advanced analytical thinking, decision-making, drawing inferences, and reasonable discussion with empirically scientific principle and evidence, and interpretation for value evaluation and information reliability, as well as questing and answering (Khamwong, 2008).

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Learning cycle is the inquiry learning process pattern for learners to investigate the scientific knowledge through science process skill to search for knowledge or significant self-learning experience based on constructivist theory. Previous learning cycle comprises three steps: surveying, introducing keyword/ building concept for achieving concept, and applying concept. Learning cycle, then, has been adapted into four steps called the 4E learning cycle approach by adding the step of learning presentation. Later, the 4E learning cycle approach has been adapted into the 5E by adding the step of prior knowledge check. Finally, it was extended from the 5E to the 7E learning cycle by including the steps of examining prior knowledge and applying knowledge (Eisenkraft, 2003). Consequently, the 7E learning cycle emphasizes examining the learner's prior knowledge for what they want to know first before learning the new content. This helps make effective learning process through seven steps: examining prior knowledge, motivating interests, surveying and searching, explaining, extending knowledge, evaluating, and applying knowledge (Nuangchalerm, 2007). Learning activity management through seven steps is for learners to search knowledge and experience meaningful learning by themselves. The socioscientific issue-based learning approach is the guideline for learning science through real situations, and promoting advanced analytical thinking which are essential for science learning management (Sadler and Zeidler, 2003). As a result, the researcher for the present study is interested in developing lesson plans for the 7E learning cycle and for the socioscientific issue-based learning approach in order to apply the research results as a model for scientific learning development in the future.

This study aimed to develop lesson plans between 7E learning cycle and socioscientific issue-based learning with an efficiency criterion of 75/75, to study the effectiveness index of both teaching approach, to compare learning achievement, science process skills, and moral reasoning of both teaching approach, to compare learning achievement, science process skills, and moral reasoning between before and after they had learned, and to compare learning achievement, science process skills, and moral reasoning of both teaching approach.

Research Hypotheses:

1. The students who learned by using the 7E learning cycle showed gains in learning achievement, science process skills, and moral reasoning from before learning.
2. The students who learned by using the socioscientific issue-based learning approach showed gains in learning achievement, science process skills, and moral reasoning before learning.
3. The students who learned by using the 7E learning cycle and the socioscientific issue-based learning approach showed different gains in learning achievement, science process skills and moral reasoning.

Research Methodology:

Population and Sample:

Population in the present study was 135 of ninth grade students from 4 classes studying in the 2nd semester, academic year 2010. The samples were 68 students in two classes obtained through the cluster random sampling technique by drawing lots using the class for random assignment. The two classes were both experimental groups. The first experimental group consisted of thirty-three students learn through 7E learning cycle approach. The second experimental group consisted of thirty-five students learn through socioscientific issue-based learning approach.

Research Instrument:

Lesson plans for the 7E learning cycle and socioscientific issue-based learning approach. There were 6 lesson plans in each approach, and 3 hours were spent for each lesson plan. An achievement test containing 40 test items, with the reliability of each test item between 0.28-0.68; and with the power of discrimination of each test item between 0.36-0.78. The reliability of test was 0.87. A science process skills test containing 30 items in 8 aspects, with the reliability of each test item between 0.37-0.74; and with power of discrimination of each test item between 0.44-0.75. The reliability of the whole test was 0.93. An moral reasoning test containing 30 test items in 11 aspects, with the Reliability of each test item between 0.44-0.72; and with power of discrimination of each test item between 0.48-0.78. The reliability of the whole test was 0.97.

Research Procedure:

Achievement test, science process skills test, and moral reasoning test were used as the pretests with the 2 experimental groups. The first experimental group learned by using 6 lesson plans for the 7E learning cycle approach, and the second experimental group learned by using 6 lesson plans for the socioscientific issue-based learning approach. Three hours were spent for each plan (18 hours in total for each group).

After 12 lesson plans were finished, posttest of achievement test, science process skills test, and moral reasoning test were used with the two experimental groups.

Data Analysis:

After the data collection process, the data obtained analyzed the efficiency criterion of lesson plans for the 7E learning cycle and the socioscientific issue-based learning approach using mean, standard deviation and percentage. Effectiveness index of the 7E learning cycle and socioscientific issue-based learning approach by using the effectiveness index.

To compare the learning achievement, science process skills, and moral reasoning of the two experimental groups before and after learning by using the 7E learning cycle and the socioscientific issue-based learning approach through the use of the paired t-test and the Hotelling T^2 test. Finally, learning achievement, science process skills, and moral reasoning of the experimental group using the 7E learning cycle and the group using the socioscientific issue-based learning approach were compared and tested by Hotelling T^2 test.

Results:

Efficiency Criterion:

The efficiency criterion (E_1/E_2) of lesson plans for the 7E learning cycle and those for socioscientific issue-based learning approach were 76.97/76.14, and 77.81/77.07 respectively, as shown in Table 1.

Table 1: The E_1/E_2 of lesson plans for the two learning approaches.

Assessment	7E learning cycle			Socioscientific Issue-based Learning		
	n	$\overline{X}$	S.D.	N	$\overline{X}$	S.D.
While Learning	33	46.18	1.51	35	46.69	2.08
After Learning	33	30.39	1.07	35	30.93	1.18
	E_1/E_2 = 76.97/76.14			E_1/E_2 = 77.81/77.07		

Table 1 showed that the performance of plan learning activities according to the concept of socioscientific issue-based learning of genetic science. Grade 3 performance criteria The E_1/E_2 = 77.81/77.07 Lesson plan for higher 7E learning cycle effective basis The E_1/E_2 = 76.97/76.14.

Effectiveness Index:

The effectiveness index of the 7E learning cycle and socioscientific issue-based learning approach was 0.5550, and 0.5673, respectively, as shown in Table 2.

Table 2: Effectiveness index of the 7E learning cycle and the socioscientific issue-based learning approach.

Marks	7E learning cycle					Socioscientific Issue-based Learning				
	n	Marks	$\overline{X}$	Percentage	E.I.	n	Marks	$\overline{X}$	Percentage	E.I.
Before learning	33	612	18.55	46.36	0.5550	35	658	18.80	47.00	0.5673
After Learning	33	1005	46.18	76.97		35	1079	30.93	77.07	

Table 2 showed that the effective index of 7E learning cycle of genetic science. Grade 3 is equal to 0.5550 shows that Student learning plans, 7E learning cycle of genetic science. Grade 3, advanced learning is a 55.50 percent increase in knowledge and effective index of the activity plan to learn the concept of socioscientific issue-based learning of genetic science. Grade 3 is equal to 0.5673 shows that Student learning plans and learning activities according to the concept of socioscientific issue-based learning of genetic science. Grade 3, advanced learning is a 56.73 percent increase knowledge.

Learning Outcome of 7 E Learning Cycle:

The students who learned by using the 7E learning cycle showed gains in learning achievement, science process skills, and moral reasoning at the .01 level of statistical significance as seen in Table 3.

Table 3 showed that students in the experimental 7E learning cycle approach achievement.Learning about genetic science process skills.

Overall and individual aspects. And moral reasoning as a whole and of each side. After two weeks the school. Statistically significant at the .01 level.

Table 3: Students' learning achievement, science process skills, and moral reasoning before and after learning using the 7E learning cycle approach

Learning Outcome	n	Before Learning		After Learning		df	t	p
		$\overline{X}$	S.D	$\overline{X}$	S.D			
learning achievement	33	18.15	1.85	30.39	1.07	32	31.912**	.000
science process skills	33	15.30	1.33	23.18	1.24	32	26.476**	.000
moral reasoning	33	21.03	1.24	26.12	1.22	32	17.973**	.000

Note: ** p<.01

Learning Outcome of Socioscientific Issue-based Learning:

The students who learned by using socioscientific issue-based learning approach showed gains in learning achievement, science process skills, and , and Moral reasoning from before learning at the .01 level of significance, as evidenced in Table 4.

Table 4: Comparison of mean scores of the students' learning achievement, science process skills, and moral reasoning before and after learning using the socioscientific issue-based learning approach.

Learning outcome	n	Before Learning		After Learning		df	t	p
		$\overline{X}$	S.D	$\overline{X}$	S.D			
learning achievement	35	18.80	0.93	30.93	1.18	34	46.113**	.000
science process skills	35	16.29	1.72	23.97	1.29	34	19.677**	.000
moral reasoning	35	21.28	1.94	27.97	1.50	34	22.848**	.000

Note: ** p<.01

Table 4 showed that the experimental group learned the concept of socioscientific issue-based learning approach. Related to the achievement of socioscientific issue-based learning approach about genetic science process skills. Overall and individual aspects. And moral reasoning as a whole and of each side. After two weeks the school. Statistically significant at the .01 level. The students who learned by using the socioscientific issue-based learning approach showed gains in science process skills, as a whole, and in each aspect more than those who learned by using the 7E learning cycleat the .01 level of significance.

Table 5: Learning achievement, science process skills, and moral reasoning of students between the activities of 7E learning cycle and socioscientific issues-based learning by Univariate t test.

Test variables	SOV	SS	df	MS	F	p
Learning Achievement	Contrast	3.483	1	3.483	2.984	.089
	Error	77.032	66	1.667		
Science Process Skills	Contrast	20.246	1	20.246	18.400**	.000
	Error	72.662	66	1.100		
Moral Reasoning	Contrast	.440	1	.440	.621	.433
	Error	46.795	66	.709		

Note: **p<.01

Table 5 showed that students learning through activities, learn the socioscientific issues-based learning on genetic grade 3 student achievement in school. Moral reasoning. Not significantly different from those learned by the activities of 7E learning cycleat of the scientific process skills were significantly different statistically significant at the .01 level

Learning Outcomes Between 7 E Learning Cycle and Socioscientific Issue-based Learning:

Table 6: Comparison of the science process skills between 7E learning cycle and socioscientific issue-based learning by each skills (Univariate t test).

Science process skills	7E learning cycle ($\overline{X}$)	Socio scientific issues ($\overline{X}$)	SOV	SS	df	MS	F	p
1. Observation	3.53	3.63	Contrast	.219	1	.219	.87	.352
			Error	16.414	66	.249		
2. Classification	2.85	3.00	Contrast	.390	1	.390	.911	.343
			Error	28.242	66	.428		

Table 6: Continue.

3. Drawing Inference	3.58	3.66	Contrast	12.834	1	12.834	33.348**	.000
			Error	25.401	66	.385		
4. Measurement	2.58	3.69	Contrast	6.637	1	6.637	25.144**	.000
			Error	17.422	66	.264		
5. Using Numbers	2.67	2.86	Contrast	1.650	1	1.650	2.247	.139
			Error	48.468	66	.734		
6. Organising Data and Communication	3.67	3.71	Contrast	1.429	1	1.429	5.482	.002
			Error	17.203	66	.261		
7. Predicting	1.70	1.74	Contrast	.036	1	.036	.151	.699
			Error	15.655	66	.237		
8. Space/Space Relationship and Space / Time Relationship	1.64	1.72	Contrast	.041	1	.041	.159	.691
			Error	17.179	66	.260		

Note: ** p<.01

Table 6 shows that students learn the concepts socioscientific issue-based learning. Science process skills by the specific measurement is a mean of 3.69 higher than the infer from the data with a mean of 3.66, which differs from student 7E learning cycle .01 level of significance.

Discussion:

The efficiency values (E_1/E_2) of lesson plans for the 7E learning cycle was 76.97/76.14, indicating that mean scores of all activities while learning was 76.97 percent, and mean scores of the post-test of the achievement test was 76.14 percent. The efficiency values (E_1/E_2) of lesson plans for the socioscientific issue-based learning approach was 77.81/77.07 indicating that mean scores of all activities while learning was 77.81 percent, and mean scores of the post-test of the achievement test was 77.07 percent. This means that the efficiency value of the developed lesson plans for the 7E learning cycle and for the socioscientific issue-based learning approach on the topic of "Heredity" in science learning strand, Mattayomsuksa 3, was higher than the required criteria of 75/75. This may be because the lesson plans for the 7E learning cycle and for the socioscientific issue-based learning approach on the topic of "Heredity" was developed systematically, based on the curriculum analysis. First, guidelines for the lesson plans according to learning outcomes were studied before developing. Then, they were checked by the experts and the researcher's adviser. Finally, all aspects developed in the lesson plans: learning outcomes, contents, activities, materials, and assessment were carefully checked before the experimental stage to avoid some mistakes. It can be said that the systematically developed lesson plans met the efficiency value (E_1/E_2) of 75/75, and could be used to serve the particular purpose of the present study. The results of the present study were consistent with research conducted by Phinyodom (2008) who compared the learning achievement students learning by the 4 MAT learning cycle approach and the 7E learning cycle with regard to integrated science process skills and attitude towards science.

The results of the effectiveness index of the 7E learning cyclewas 0.5550, indicating that the students who learned by using the 7E learning cycleon the topic of "Heredity" showed 55.50 percent of learning progress or knowledge gain. The effectiveness index of the socioscientific issue-based learning approach was 0.5673, indicating that the students showed 56.73 percent of learning progress or knowledge gain. This may be because activities in the 7E learning cycle and in the socioscientific issue-based learning approach created student-centred learning: a learning process involving and serving the students' basic learning, learning need, brain development, senses, perception, experience, knowledge acquisition process skills, thought, and other learning activities. These varied and flexible activities can create lively, enjoyable learning, avoiding a dull and pedagogic atmosphere, and result in a gain of learning achievement. The findings of the present study were consistent with the study by Prathomwong (2008), who compared learning outcome of students learned by the 5E learning cycle approach and the 7E learning cyclewith regard to analytical thinking ability, basic science process skills, and learning achievement in science on the topic of "Substances in Daily Life". Her research objectives were to 1) develop lesson plans for the 5E learning cycle approach and the 7E learning cyclewith an efficiency value of 75/75; 2) study the effectiveness index of the 5E learning cycle approach and the 7E learning cycle approach; 3) compare mean scores of the students' analytical thinking ability, basic science process skills, and learning achievement between using the 5E learning cycle approach and the 7E learning

cycle approach; and 4) compare ability in analytical thinking, basic science process skills, and learning achievement of the students learning using 5E learning cycle approach and the 7E learning cycle approach. Her findings revealed that the effectiveness index of the 7E learning cyclewas 0.6361. Besides, as evidenced in the study by Nuangchalerm and Kwuanthong (2010), who studied development of learning management based on the socioscientific concept on the topic of "Global Warming", in the career and technology learning strand of Prathom Suksa 5 students, her findings revealed that the effectiveness index (E.I) of learning management was 0.6959.

The students who learned by using the 7E learning cycleshowed gains in learning achievement from before learning at the .01 level of significance. This may be because learning activities in the 7E learning cycle emphasized learning transfer, background or prior knowledge check that can help the teacher realise what the students need to learn first, and this can help the students learn efficiently. More importantly, learning activities in the 7E learning cyclecontain learning process focusing on what is most advantageous for the students to improve their learning abilities, use skills for knowledge acquisition through various learning sources, and be able to apply learning methods in real life situations. Both the teacher and the students are attentive in every learning process, so the students are eagerly interested in learning and practically develop their knowledge skill. In addition, they can observe, question, assume, acquire new knowledge by themselves, summarise, and comprehend what they have discovered.

Learning activities not only support the students to experience real performance, but also allow them to learn methods of knowledge acquisition. Consequently, the students are able to apply their learning practically in real life. The findings were consistent with the study by Srilardlao (2008) who compared the 7E learning cycle and the 5E learning cycle approach in respect of learning achievement, analytical thinking, and scientific attitude. The findings revealed that the students who learned by using the 7E learning cycleshowed gains in learning achievement, as a whole and in each aspect; and scientific attitude, as a whole and in each aspect, more than before learning at the .05 level of significance.

4. The students who learned by using the socioscientific issue-based learning approach showed gains in learning achievement, science process skills, and moral reasoning from before learning at the .01 level of significance. This may result from the fact that the socioscientific issue-based learning approach applies real life situation to teaching and learning activities in a classroom giving the students more opportunities to learn science from real situation. Furthermore, the students realise the existence of science and the relation between science and real life. The socioscientific issue-based learning approach also supports high analytical thinking skill and life-long learning which are necessary for dealing with changes and science development in society. Additionally, the socioscientific issue-based learning approach is a tool that creates meaningful scientific learning which is relevant to the students' real life (Sadler & Zeidler, 2003), makes the students search for knowledge and discussion; gives supporting reasons; and makes a decision about the issues studied, and finally results in supporting and developing the students' skills to handle and organise scientific issues effecting on the students themselves both at present and in the future.

As a result, the students will be qualified with high responsibility for society, and able to apply scientific knowledge in real life. The research findings are consistent with the study by Pangvong (2007) who studied learning outcome of 24 students learned science subject by using local wisdom through the science, technology, and society (STS) approach. The research results revealed that 95.83 percent of the students showed gain in learning achievement more than 70 percent, which was higher than the required criteria.

Owing to a comparisons of the 7E learning cycle and the socioscientific issue-based learning approach with regard to learning achievement, science process skills, and moral reasoning, the research results demonstrated that the students who learned by using the socioscientific issue-based learning approach showed no different learning achievement, and moral reasoning from those who learned by using the 7E learning cycle approach, both as a whole, and in each of the 11 aspects: mercy, gratefulness, justice, unity, economising, honesty, devotion, responsibility, reasonability, discipline and industry. Besides, the students who learned by using the socioscientific issue-based learning approach showed mean scores in respect of science process skills, as a whole and in each aspect, more than those who learned by using the 7E learning cycleat the .01 level of significance.

They were observation, classification, measurement, drawing inference, space/space relationship and space/time relationship, using numbers, predicting, and organising data and communication, respectively, with the total mean scores of 23.97. This is probably because the socioscientific issue-based learning approach brings social issues related to science to be used in teaching and learning management. Consequently, the students have more opportunities to learn science from real situations, which make them realise the existence and relation of science in real life.

Moreover, the socioscientific issue-based learning approach encourages and supports the students advanced analytical thinking skill (Pedretti, 1999; Lewis, 2003); life-long learning which is essential for organising scientific changes and development in society; skill for decision-making and drawing inferences (Lewis, 2003); skill for discussing reasonably based on scientific and empirical evidence, interpretation skill for value evaluation and information reliability (Sadler, 2000; Sadler & Zeidler, 2003); and skill for questioning and answering (Pedretti, 1999). Furthers, the socioscientific issue-based learning approach helps the students understand nature of science, view and understand the complicated relation among science, society and human beings (Sadler & Zeidler, 2003). Due to the study and discussion about the socioscientific issue-based learning approach, the students will see that science is from human beings' activities. Therefore, the influences of society and culture usually effect on interpreting science, and whether or not accepting science. Moreover, it was found that applying the socioscientific issue-based learning approach to teaching and learning activities in class aims to support the students' science learning achievement in many aspects, as well as to build up understanding with regard to scientific issue being studied. Generally, the socioscientific issue-based learning approach is usually relevant to discussion, argument, giving opinion, and finally making inferences. This learning approach encourages the students to search for knowledge so that they can discuss reasonably, and build up understanding of the nature of science, and finally results in more efficient learning and science process skills.

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