

Susan Loucks-Horsley learning model in light pollution theme: based on a new taxonomy for science education

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Abstract. The curriculum in Indonesia recommended that science teachers in the elementary and intermediate schools should have interdisciplinary ability in science. However, integrated learning still has not been implemented optimally. This research is designing and applying integrated learning with Susan Loucks-Horsley model in light pollution theme. It can be showed how the student's achievements based on new taxonomy of science education with five domains: knowing & understanding, science process skill, creativity, attitudinal and connecting & applying. This research use mixed methods with concurrent embedded design. The subject is grade 8 of junior high school students in Bandung as many as 27 students. The Instrument have been employed has 28 questions test mastery of concepts, observations sheet and moral dilemma test. The result shows that integrated learning with model Susan Loucks-Horsley is able to increase student's achievement and positive characters on light pollution theme. As the results are the average normalized gain of knowing and understanding domain reach in lower category, the average percentage of science process skill domain reach in good category, the average percentage of creativity and connecting domain reach respectively in good category and attitudinal domain the average percentage is over 75% in moral knowing and moral feeling.

1. Introduction

Integrated learning is an instruction that integrates two or more disciplines based on a particular theme. The concept of thematic learning is believed as a model of learning that can provide significant experience and full understanding to students. More meaningful learning experiences demonstrate this relationship among conceptual elements that make the learning process more effective. Acquisition of learning and views integrity on life and natural phenomena can be reflected through integrated learning. Characteristics of integrated learning is student-centered, giving direct experience, meaningful learning, holistic, flexible, effective and efficient in achieving learning objectives [1][2]. Integrated learning model is one model of curriculum implementation recommended to be applied at all levels of education, especially at the elementary and secondary level [3]. Moreover, it is also suitable to the requirement of Indonesia curriculum [3], which emphasizes SETS (Science, Environment, Technology and Society) learning in an integrated manner aimed at learning experience.

Based on the preliminary study conducted in one of the Junior High School in Bandung Regency shows that integrated learning can not be applied yet. This is due to several constraints such as the lack of textbooks presented in an integrated manner, the national exam as a tool of learning evaluation does not present problems in an integrated manner yet, as well as the lack of teachers' ability in mastering



many subjects at once. Whereas the demands of Standards for Science Teacher Preparation [4] recommends that science teachers of elementary and junior high schools should have an interdisciplinary ability.

Science learning is based on three domains in Bloom's Taxonomy namely cognitive, affective, and psychomotor. But in practical it is more emphasis on cognitive domain only, so that learning is less pleasant, monotonous, passive students, does not develop student's creativity and learning process is becoming less effective [5]. To overcome these problems, Allan J McCormack and Robert E Yager [6] introduced the new taxonomy for science education includes knowing and understanding domain, science process skills domain, imagine and creativity domain, attitude and value domain as well as the connection and applying domain. These five domains are an extension, development and deepening of the three domains of Bloom that can improve science learning activities in the classroom and develop a positive attitude towards about the subject [7][8].

Knowledge and understanding domain requires knowledge and understanding of related science-social issues rose in the topic that emphasizes the influence of technology and science in environment that can enhance the moral ethical in social issues. Science process skills domain related to studying the science process, including observation, communication, classification, measurement, to conclude, inference, predicting, preparing hypothesis and conducting experiment. Imagine and creativity domain associated with the ability of imagination, incorporating new objects and ideas in a new way, solve the problem, as well as designing a device and machine. Attitudinal domains include the development of positive attitudes towards science in general, against oneself, extracting humanity emotions, appearance of personal feelings in a constructive way and decision-making on social and environment issues. Connecting and application domain related to the ability for thinking critically, problem solving, decision-making related to personal health, nutrition and lifestyle based on the knowledge of scientific concepts also the ability to make a interdisciplinary relationship among sciences.

As the implementation of taxonomies for science education, here we use the Susan Loucks-Horsley (SLH) learning model through the four stages of learning [7][8]. The first stage, namely invited stage, is the stage when students are invited to learn. This stage can be done through the presentation of discretion event (strange phenomena) or images that raises many questions or astonishment, through hands-on experience, or simply through the teacher's questions. For example, the teacher raises event of over-illumination in urban life that can be used to focus the students' attention to the problem of light pollution in the environment. Through the presentation of some images related to light pollution problem students are triggered to be curious and help them to be focus following the instructions. The second stage, explore and discover stage, the teacher provide opportunities for students to answer questions through observation, measurement or experiment. Students can compare and test the idea and try to understand the data they gather. For example, students are given the opportunity to find a method of prevention of light pollution caused by the use of artificial light through group discussion. Students can actively working on issues of they are interested in, that is moral dilemma about city lighting.

The Third stage, purpose explanation stage is the stage when students prepare explanations, solutions, and implement what they learned. Students gain new experiences with concepts they learned through group discussion and then communicate their findings and observations. There will be an opportunity for students to trust their own results or their friends who have a conception in line with what they have just found. For example, after making observations on the problem of light pollution in many aspects of life, the students then presented the results of the analysis in front the class followed by question and answer in class discussion. The last stage, taking action stage, students are trying to seek usefulness of their findings and implement what they have learned. For example, students learned that the lampshade can be used to minimize excessive lighting. Students can make their own creations on lampshade innovation from simple materials. In this way students can realize what are the benefits of they have learned and use the knowledge to solve everyday life problems. Based on this background, the authors formulate the problem in this research of how is the implementation of

integrated learning with Susan Loucks-Horsley learning model in light pollution theme by the new taxonomy for science education in junior high school students.

2. Research Method

The research method used is mixed methods with concurrent embedded design. In this research, subjects studied were students of grade VIII (27 students in total) with purposive sampling technique. Student in this class is more active than the other classes. The instruments used consist of test instruments for knowledge and connecting domain. Observation sheet was used for science process skills and creativity domain, moral dilemma test questions for attitudinal domain and control sheet for implementation of Susan Loucks-Horsley (SLH) learning model.

Data processing for knowing and understanding domain was using quantitative analysis to calculate the normalized gain then classifying the result into criteria of low, medium and high [9]. Science process skills domain was using a rubric that has been specified for discussion activity at each meeting with a score range of 1-4. Score for each student in the group comes from the summed scores from each meeting and then the average score for the group can be calculated. After that, we determined the lowest and highest score to construct the score range for category of less sufficient, sufficient and good. Imagining and creativity domain was using a predetermined rubric for assessing students' innovation products in groups with a range of assessment score of 1-4. For attitudinal domain, data processing was using trend analysis of students' answers that meet the criteria for assessment according to the rubric in every moral aspect being measured. However, data processing covers only moral knowing and moral feeling, because the students' moral behaviour should be examined directly whether the students' manner consistent with the answer. Students' integrity ability analysis was used for connecting and application domain through the acquisition of students' scores in each discourse contained in the test with light pollution theme.

Test instrument consist of 28 items had been tested to students of grade IX. Based on the analysis carried out for validity test the score was 0.24 means lower category. The average score of difficulty level was 0.68 means medium category while the average score of distinction power was 0.16 means bad category. As for reliability test, the score obtained was equal 0.75 means high category. Through these various tests, some questions that have validity test and distinction power in lower and bad category was revised in order to not change or reduce the indicators to be achieved, besides also that the instrument would be used during the research was better than the trial.

3. Result and Discussion

In this research we performed three times meetings (three treatments). The first meeting is to discuss the material with title "Familiarization with Light Pollution", covering the definition of light pollution, sources of light, the nature of light, the process of formation and causes light pollution. In the second meeting we discussed the impact of light pollution on the various fields, such as the impact to astronomy, the environment, human health and the economy. Furthermore, the third meeting discussed about the prevention of light pollution, consist of lighting functions, types of light pollution, precautions, lamp types, and the types of lampshade.

Susan-Loucks Horsley (SLH) learning model had been done with the first stage (invited) was giving the demonstration related to light pollution phenomenon. The second stage (explore and discover) were investigating, observing and finding solutions to answer questions related to the demonstration and discussions. During the third stage (purpose explanations), students prepared an explanation and solution with regard to what they had learned. Finally students looked for the usefulness of their findings and apply them in daily life in the fourth stage (taking action). From the analysis, the application of SLH learning models can be done well with a percentage of 75% both on the teachers and students activity.

3.1. Knowledge and Understanding Domain

Based on the post-test score, students were grouped into three group namely higher, intermediate and lower group where each group consists of nine students. The grouping is intended to determine the gain-ratio of each group. The normalized gain for higher group is 0.32 in medium category, for intermediate group is 0.16 in low category and lower group is 0.12 in low category. Overall the normalized gain for this research is 0.22 in low category.

From educational psychology point of view, there are several factors that can affect students' learning process. These factors arise either from outside of the students (social and non-social) as well as from within the students (physiological and psychological). Even with the same media and method, not necessarily produce the same value of normalized gain. It will be influenced by the fast or slow of student learning, different focusing on the lessons, and lesson repetition at home, also different students' interpretation on the exercises and how to formulate the answers. Those factors are quite difficult to be reduced or eliminated by the researchers, so that the resulting score of normalized gain does not match what was expected.

3.2. Science Process Skill Domain

Assessed aspects in this domain are related to how students perform observations, communicating, classifying data and how students make predictions in addressing problems in groups. Table 1 presents a comparison of score of science process skills domain for each group per meeting.

Table 1. Science Process Skill Domain Score

Group	Score per Meeting			Average	Category
	1	2	3		
1	21.20	17.80	18.00	19.00	Good
2	18.00	13.80	14.00	15.27	Fair
3	22.80	19.40	13.00	18.40	Good
4	23.00	18.80	16.00	19.27	Good
5	12.00	12.00	14.00	12.67	Fair
6	16.50	15.75	14.00	15.42	Good
Average	18.91	16.25	14.83	16.67	Good

According to Table I the score per meeting for every group in the first and second meeting are decreasing. In the first meeting, students made a simple experiment to determine the effect of the flashlight against the visibility of stars both in quantity and quality. During this activity the students were interested and motivated to do the experiment. In the second meeting, each group analysed an article about light pollution. Compared to the first meeting, students were less motivated in reading the article. In the third meeting, every group discussed about design of a lampshade. Students looked so enthusiastic but do not meet the specified aspects of assessment, because the discussion seemed less serious.

From discussion activity had been carried out per meeting, overall average score was 16.67 in good category. This indicates that most students have the ability to do basic science process activities related to the theme of light pollution. Students are considered to have a pretty good ability of learning outcomes in science process skill domain.

3.3. Imagining and Creativity Domain

Measured aspects in this domain include how students' imagination appear in the form of product innovation, how students within the group can solve problems and combine ideas in a new way as one of the efforts to find a solution to prevent light pollution to the environment.

Table 2. Imagining and Creativity Domain Score

Group	Aspects of Assessment			Total	Category
	Design	Process	Product		
1	3.00	3.75	3.50	10.25	Good
2	2.75	3.25	2.50	8.50	Fair
3	3.25	3.00	3.00	9.25	Good
4	2.50	3.00	2.50	8.00	Fair
5	3.25	2.75	2.50	8.50	Fair
6	2.50	2.50	3.00	8.00	Fair
Average	2.87	3.04	2.83	8.75	Fair

Data in Table 2 shows that the creativity of the students is quite high, with the average score of the three aspects of assessment is 8.75 in fair category. The scores are obtained based on observation and assessment conducted by researchers on students' activity report and presentation of product innovation. Students were very enthusiastic when presented their innovative lampshade design. Students looked so happy to make a lampshade by using materials can be found surroundings.

3.4. Attitudinal Domain

Moral Dilemma test (MDT) to measure attitudinal domain were given at the end of each meeting. The character which is embeded was measured using moral dilemma test, spesifically by analyzing the tendency of students' answers to moral problems. Measured character is divided into three aspects as proposed by Lickona [10], those are moral knowing, moral feeling and moral action. Which moral aspect is owned by students can be determined by knowing students' moral decision when they face dilemmas and the reasons they have. Table 3 shows the classification of the students' answers (in %) on moral dilemma test.

Table 3. Students' Moral Aspects Percentage

<i>Moral Knowing (%)</i>				<i>Moral Feeling (%)</i>			
Aspect	Test 1	Test 2	Test 3	Aspect	Test 1	Test 2	Test 3
<i>Moral awareness</i>	41	71	37	<i>Conscience</i>	11	15	30
<i>Knowing moral values</i>	15	0	4	<i>Self esteem</i>	30	37	37
<i>Perspective taking</i>	4	4	0	<i>Empathy</i>	15	22	19
<i>Moral reasoning</i>	0	0	4	<i>Loving the good</i>	7	4	0
<i>Decision making</i>	0	0	0	<i>Self control</i>	15	11	7
<i>Self knowledge</i>	19	15	48	<i>Humility</i>	0	4	0
Total	78	93	93	Total	78	93	93

Students' moral knowing and feeling was appearing in their answers on three questions of moral dilemma test when they were confronted with a problem that concerns about light pollution. There are at least two aspects appear either on moral knowing (moral awareness and self-knowledge) and moral feeling (conscience, self-esteem, empathy, and self-control).

3.5. Connecting and Application Domain

Measured aspect for connecting and application domain is related to how students can find relationship among subjects they have learned. Based on pretest and posttest had been conducted, it can be seen gain and normalized gain score for every reading material as shown in Table 4.

Table 4. Gain and Normalized Gain Score for Connecting and Application Domain

No	Reading Material	Average (%)		Gain	N-Gain
		Pre-test	Post-test		
1	Reading I	71.42	76.19	4.77	16,68
2	Reading II	75.66	73.54	-2.12	-8,70
3	Reading III	38.09	48.67	10.58	17,08
4	Reading IV	68.25	86.77	18.52	58,33
Average		63,35	71.29	7.94	21.66

From the increased value obtained by the fourth reading contained in an integrated matter, it can be said that through this light pollution thematic learning, students' ability to integrate or make the connection between a sciences with other sciences has been good.

To find out how the connection or relationship between the other domains in the new taxonomy of science education, used the analysis of patterns of linkages between the domains with a view of the acquisition value of each domain. The results of the analysis of the pattern of linkages between domains shows that students who have a high understanding of the concept does not necessarily have the capability of science process, and high creativity as well as many aspects of the moral of the students.

4. Summary

The implementation of integrated learning in light pollution theme can improve students' learning outcomes based on the new taxonomy of science education with the result as follows: for knowing and understanding domain with normalized gain score of 22% in lower category; the average percentage of science process skill domain reach 78 % in good category, and the average percentage of creativity domain and connecting domain reach 73% and 71% respectively in good category. For attitudinal domain the average percentage is over 75% in moral knowing and moral feeling.

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