Designing of Model Science Technology Learning Cycle (STLC) based Material Teaching to Enhance Student Critical Thinking and Environmental Awareness

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***Abstract*—It is important for prospective elementary school teachers to have critical thinking skills and environmental concerns so that they can better teach their students. Environmental awareness for prospective elementary school teachers can be prepared through appropriate learning models, but the number of learning models is relatively small. The purpose of this research is to design the learning model with the target variable to train critical thinking skills and environmental awareness. The research procedure used is the DBR developed by Reeves (2008). At this stage focus on stage 1 that is initial analysis. The method used is posttest group control design. The sample in this research is divided into 2 groups: the inquiry study group and the learning cycle learning group. A total of 73 students of primary school teachers in this study. The results show that inquiry learning needs to be developed along with learning technology cycle model to be able to empower the critical thinking and environmental awareness.**

Keywords—designing, STLC learning model, material teaching, critical thinking, environmental awareness

I. Introduction

Environmental damage is ignored by education personnel is the beginning of destructive destruction. Through the process of education, one is expected to have a high environmental awareness because it has a good critical thinking skills.

Critical thinking skills are a necessary skill in the 21st century. Critical thinking skills in principle can be trained as other skills [1]. Critical thinking skills need to be trained because it is beneficial to the individual who owns it.This skill as mentioned by Sternberg and Sternberg in [2] has the benefit to: (1) to understand systems and strategies for overcoming unusual problems, and (2) to understand the importance of evidence in building confidence and to reevaluate beliefs when there is conflicting evidence. It is supposed to be everyone who is more likely to be a primary school teacher to master it. Refers to Facione in [3] critical thinking skills consist of 6 sub, namely: interpretation, analysis, inferences, evaluation, explanation, and self-regulation. whereas according to Ennis, critical thinking skill has 5 domains: argue, carry out deductions, carry out inductions, conduct evaluations, decide and execute Paul Elder's critical thinking skill as written by Hohman and Grillo in [4] has 3 main components of asking questions (and noting that questions need to be asked), answering questions

by reasoning through them, and trusting the results of one's reasoning. Various attempts to train critical thinking skills by Tiruneh, *et al.* in [5] there are: problem-centered, activation, demonstration, application, and integration principles

Critical thinking skills have a wedge with the investigation activities in science learning.While inquiri is the basis of science learning [6]. Inquiri learning is a student-centered learning in which students play an active role in the process of knowledge discovery [6]. Based on the history of inquiri learning is based on the concept of active learning developed by John Dewey.

Mastery of technology for prospective primary school teachers in general is still low. The technology in question is the application of science in facilitating human activities, especially on environmental issues such as those related to water purification, composting, utilization of alternative energy sources, etc. [8]. Students are still just memorizing or identifying the types of technology but have not yet applied it. The use of technology as an application of the knowledge (science) he mastered can be trained through inquiry learning.

In the field, the implementation of inquiri in learning still encounters many obstacles. Between the constraints is the weakness of teacher mastery of inquiry itself. In addition to the time factor, the number of students who many, the demands of the material to be solved is a constraint in the implementation of inquiry in the classroom [7]. In order to link the lack of critical thinking skills and environmental care prospective elementary school teachers then the authors propose the concept of learning models to empower the 2 skills is the learning model STLC (Science Technology Learning Cycle). How the concept of STLC learning model, hypothetical concept and hypothetical syntax becomes a problem that will be discussed in this article.

The rest of this paper is organized as follow: Section II is the theoretical background used in this research. Section III describes the proposed method. Section IV presented the obtained results and following by discussion. Finally, Section V concludes this work.

II. Theoretical Background

This section presents the theoretical background.

A. *Inquiry Learning*

Inquiry / inquiry is the essence of science learning [9]. Teacher's understanding of science as an investigation and learning as an inquiry is very important in carrying out its duties. Through inquiry lesson a prospective teacher not only understands the material but also realizes that one's background and belief in knowledge influences the formation of scientific knowledge [10]. The characteristics of instruction inquiry according to NRC (National Research Council) [11] there are 5 namely:

1) Learners are engaged by scientifically oriented questions
2) Learners give priority to evidence, which allows them to develop and evaluate explanations that address scientifically oriented questions
3) Learners formulate explanations from evidence to address scientifically oriented questions
4) Learners evaluate their explanations considering determination explanations, particularly those reflecting scientificc
5) Learners communicate and justify their poposed explanations

Students engage in scientific questions, prioritize evidence to answer these questions, formulate scientifically oriented explanations, evaluate explanations already made and communicate them scientifically.

Windschitl [12] classifies the inquiry approach into four types: (1) Confirmation Experience, in which case experiments carried out only run procedures like prescription drugs to be spent or prescribed prescriptions; (2) Structured inquiry: on this type the teacher presents a problem in which the student does not know the answer, and gives the student the guidance to complete the investigation tasks already prepared by the teacher; (3) Guided inquiry: The teacher provides questions or questions for students to discuss in order to find a solution using the methods discussed previously without teacher guidance; and (4) Open inquiry: Teachers allow students to develop their own questions, design research steps, conduct checks, and reach their own conclusions. Another case with Wenning in [13] which categorizes the process of inquiri as spectrum as shown in Table I.

Table I. Inquiry Spectrum [13]

Discovery Leraning	Interactive Demonstration	Inquiry Lesson	Inquiry Lab	Real-world Application	Hypothetical Inquiry
Low	Intelectual Sophistication				High
Teacher	Locus of Control				Student

Based on Table I above, student involvement in the highest inquiri learning is the hypotetical inquri position and the lowest position as a consequence of high educational role is at discovery learning level. Wenning also wrote the inquiry learning stages (syntax) at each inquiry level in the five cycles shown in Figure 1.

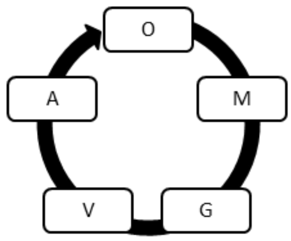

Fig. 1. Syntax Of Inquiry Learning Model [13]
Note: Description: O = Observation, M = manipulation, G = generalization, V = verification, A = application

Students observe phenomena that involve their interests and elicit their responses. Students describe in detail what they see. They talk about analogies and other examples of phenomena. A major question set is worth investigating (observation). Students suggest and debate ideas that might be investigated and develop approaches that may be used to study the phenomenon. They make plans to collect qualitative and quantitative data and then implement the plan (manipulation). Students build new principles or laws for phenomena as needed. Students provide a plausible explanation of the phenomenon (generalization). Students make predictions and perform tests using common law derived from the previous stage (verification). Students express their conclusions that are independently derived and agreed upon. The conclusions are then applied to the additional situation required. (application). Wenning's inquiry learning model is finally used as a foothold for researchers to develop STLC learning model (science technology learning cycle).

B. *Technology Learning Cycle Models*

Learning technology cycle model is not a learning model combination between technology and learning cycle but the learning model of learning cycle technology. This model was first introduced by Marra, *et al.* in [14]. The syntax of the Technology Learning Cycle is shown in Table II.

TABLE II. SYNTAX OF TECHNOLOGY LEARING CYCLE

Syntax	Description
Awareness	Aware about technolgy through friend, family, colega, ect.
Exploration and filtration	examine technologies and select tools that demonstrate potential personal and classroom usage
Learning	developing a level of comfort with technology
Application	Implement a project that uses technology to meet the needs.
Sharing and reflection	Think critically about what has been learned, pass on knowledge to others, and apply it personally to restart the cycle

Based on Table II above, awareness is the initial syntax to develop the technology in solving the problems encountered.

C. Hypothetical Learning Model

Hypothetical model that will be determined based on in-depth study of inquiry learning model and learning cycle technology model obtained both theoretically and conceptually. Hypothetical STLC learning models will then be used to empower critical thinking skills and environmental concerns for prospective elementary school teachers. The hypothetical scheme of the STLC learning model is shown in Figure 2.

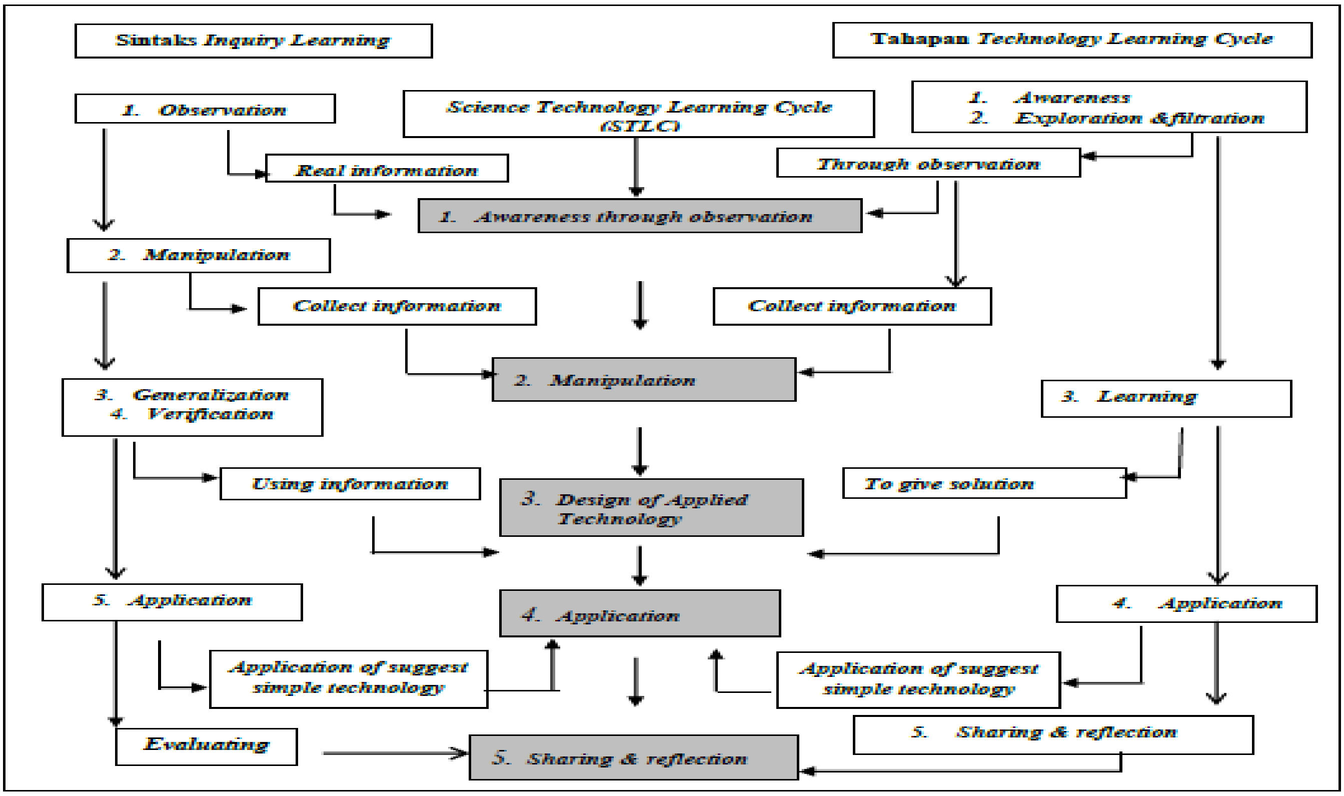

Fig. 2. The Schema of Hyphotetical Models

D. Syntax Model of Learning STLC

From the hypothetical model then described in the syntax of the learning model as shown in Figure 2 above. In the execution of syntax STLC learning model consists of activities outside the classroom and in the classroom. Activities outside the classroom can be done in an integrated meeting on each subject, or separately to obtain preliminary data to be discussed at the next meeting. Discussion of the findings obtained was finally applied in real conditions to solve the previously observed problem. Therefore, STLC learning model is cycle, cycle implementation to apply its knowledge in technology as solution for environmental problem such as pollution, natural disaster, energy scarcity, and environmental awareness behavior. Through the STLC learning model which is done in its hope cycle can empower critical thinking ability and environmental awareness to the prospective elementary school teachers.

To know the execution of STLC model then need to develop instrument to test it. Learning devices, observation instruments, interview instruments, and test instruments are things that need to be prepared at a later stage.

III. PROPOSED METHOD

The procedures in this research use DBR (design-based research) procedure developed by Amiel and Reeves in [15]. The procedure consists of 4 steps, namely: (1) Analysis of practical problems by researcher and practitioners in collaboration, (2) Iterative cycles of testing and refinement of solutions in practice, and (4) Reflection to produce "design principles" and enhance solution implementation. In this article new in the first stage is the phase of analysis of practical problems by researchers and practitioners in collaboration. The method used in this early stage is posttest group control design. There are 2 classes as sample to apply inquiry learning model and TLC learning model (technology learning cycle).

A. Participant

The population in this study as many as 480 students prospective elementary school teachers PGRI University Semarang lesson 2017/2018 semester even. While the sample consists of 73 students 61 women and 12 men. For subsequent participant demographics are shown in Table III.

TABLE III. PARTICIPANT DEMOGRAPHICS

Aspect	Inquiry	Technology Learning Cycle
Total	35	38
Gender	Female: 31	Female: 30
	Male: 4	Male: 8
Background High School	Natural Science: 19	Natural Science: 20
	Social Science:9	Social Science: 14
	Other: 7	Other: 4
Father's occupation	Entrepreneur: 17	Entrepreneur: 12
	Teacher: 9	Teacher: 8
	Government Employee: 5	Government Employee: 8
	Farmer: 2	Farmer: 2
	Other: 7	Other: 8
Mother's occupation	Housewife: 12	Housewife: 10
	Entrepreneur: 5	Entrepreneur: 6
	Teacher: 9	Teacher: 13
	Government Employee: 6	Government Employee: 5
	Farmer: 1	Farmer: 2
	Other: 2	Other: 1
Father's Education	S2:2	S2:1
	S1:7	S1:11
	D3:1	D3:4
	SMA:16	SMA:14
	SMP:2	SMP:6
	SD:6	SD:2
Mother's Education	S2:2	S2:0
	S1:15	S1:15
	D3:1	D3:2
	SMA:10	SMA:12
	SMP:4	SMP:6
	SD:3	SD:3

B. Procedure

The researcher collaborated with the lecturer of the subjects of basic science concept development to apply 2 models of learning in 2 different classes using the same study material, which is about the concept of energy. In the inquiry class students are given pictures of the relation of environmental pollution and the effects of energy use then the students are asked to identify their findings about the cause and the solution. In TLC classes, students are asked to perform documented observations in the form of videos on environmental pollution and energy use, then students are asked to analyze the causes, solutions, and technologies that can be developed. At the end of the lecture students fill out a questionnaire that has been prepared by researchers.

IV. RESULTS AND DISCUSSION

Based on Questionnaire to measure knowledge about energy, the results obtained are shown in Figure 3.

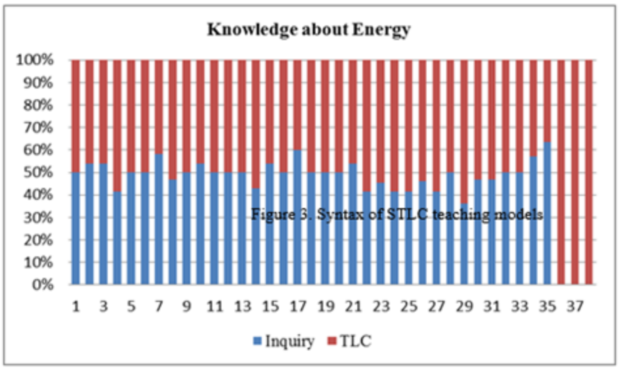

Fig. 3. Knowledge about Energy

The result of post-test about energy science at the Table IV below:

TABLE IV. THE RESULT OF POST-TEST ABOUT ENERGY SCIENCE

	Learning Model Inquiry	Learning Model TLC
N	35	38
Mean Score	70	72
SD	10.06	11.17

V. CONCLUSION

This paper has designed a model science technology learning cycle (STLC) based material teaching to enhance student critical thinking and environmental awareness. It is shown that inquiry learning needs to be developed along with learning technology cycle model to be able to empower the critical thinking and environmental awareness.

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