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Development of Model Design Using Problem-Based Learning to Increase the Scientific Behavior and Critical Thinking Skills

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Abstract— The aim of this study is to increase the scientific behavior and critical thinking skills for senior high school students in Economy subject through the development of learning model design development with problem-based implementation. This study was conducted in Senior High School Stella Duce 1 and 2 Yogyakarta using research and development approaches, and referring to ADDIE model (*Analyze, Design, Development, Implementation, Evaluation Model*). The data was analyzed using descriptive analysis technique and paired sample t-test. This study was started by analyzing the learning media, the process and the evaluation of economy subject of senior high school which was measured by Bloom taxonomy. Furthermore, the researcher devised learning model design development problem-based and liminary tryout. The result shows that basic competencies, indicators, learning objectives in learning media was dominant to the understanding level. The learning process of economy subject had reached a higher level which was analysis level and evaluate level. The critical thinking skills which was needed in daily test and midterm test in economy subject was dominant in the understanding level. The liminary tryout results showed that the implementation of problem-based learning model was proven can develop the scientific behavior and critical thinking skills of students.

Keywords—scientific behavior, critical thinking skills, problem-based learning

I. INTRODUCTION

Scientific behavior and critical thinking skills have become one of the competencies of educational goals in a lot of countries. Scientific behavior and critical thinking skills are reflected in Bloom's Taxonomy that revised by Anderson and his team's 1990s, especially at the level of analysing, evaluating and creating. High-level thinking skills are also reflected in critical thinking skills, creative and innovative [1].

The foundation of constructivism allows students to develop critical thinking skills and solve problems [2]. In Indonesia, critical thinking and scientific behavior has been expressed in the Curriculum 2013 at elementary school until high school levels [3]. Absolute critical thinking skills are

controlled by every citizen because only with the critical thinking skills of a just and civilized nation can be realized [4].

Within the framework of national reforms in several ways including education, critical thinking skills become substantial, if we have a strong desire to address the root of the problems we are facing and to seek and develop alternative solutions to those problems [5]. Thinking skills and recognition must be transformed through a process of education that is through a learning process [6]. To achieve critical thinking skills, students need to be given learning activities that lead to the ability to understand the concepts and skills of critical thinking and based on the meaningfulness of learning tailored to their environment [7].

In practical terms of education, suspected of many students who do not have high order thinking skills [8]. Referring to Bloom's revised taxonomy, some students' current thinking skills are presumably at the remembering and understanding level. The learning process is less directed towards achieving the level of applying, analyzing, evaluating and creating [1]. Praxis learning is still oriented and focused on the paradigm of information tracking which involves only low order thinking skills [9].

This study is focused on the development of model design using problem based learning to improve students' critical and creative thinking skills. Model-based learning is a dominant issue involves students so that it can increase students' thinking skills [10]. The application of problem-based learning model applied to learning in the classroom can improve students' critical thinking ability [11]. The problem-based learning helps students acquire the information already in their minds and construct their own knowledge of the social world around [12].

The problem-based learning model is believed to be suitable for high school economics because the economic lesson contains both contextual and actual issues. For example the problem of economic scarcity, poverty problem, unemployment problem, minimum wage issue, production

efficiency problem, state finance problem, export and import problem, free trade problem, taxation problem and so on. Application of problem-based learning model is believed to be able to facilitate students to think critically and build a scientific attitude in accordance with the current context [13].

The learning focused on simulated problems and provision of multi-site learning resources fosters collaboration among students [14]. The learning process that combines face to face learning methods with online learning into one viable method implemented by utilizing online learning resources [11]. Interaction between students in peer mediated instruction gives students the opportunity to solve complex problems that may not be solved if students work individually [15]. Based on the above background, this research focuses on "Learning Model Design Problem-Based Development to Increase the scientific behavior and critical thinking skills of Students".

The main issues in this study are: 1) Does the lesson planning in economic subjects at senior high school have accommodated the development of scientific behavior and critical thinking skills?; 2) How is the design of problem-based learning model suitable for economics subjects in order to develop scientific behavior and critical thinking skills?; 3) How is the result of the implementation of the limited tryout the design of problem-based learning model on economics subjects to develop scientific behavior and critical thinking skills?

The problem-based learning is one model of learning which involves predominantly student activity [16][25]. The educator acts as a facilitator and a dynamicator [17]. Problem-based learning applied to classroom learning can improve students' critical thinking skills [11]. This problem-based learning helps students construct their own knowledge of the social world around [12].

The steps of problem-based learning activities are as follows: 1) The educator explains the competence to be achieved; 2) Educators motivate students to engage in selected problem-solving activities; 3) Educators help students organize learning tasks related to the problem; 4) Educators encourage students to gather relevant information; 5) Educators assist students in planning to prepare appropriate reports; 6) Educators help students reflect or evaluate [18]. If these steps are applied systematically, then students' thinking skills will increase [19].

Reflective thinking is an active, persistent and conscientious consideration of a belief, in terms of the reasons that support it and the follow-up conclusions [11]. Critical thinking is an active process when one deeply thinks about things, asks a reflective question, and finds relevant information. Critical thinking is to think reasonably and reflectively with emphasis on making decisions about what to believe or do [14].

Creative is to perform an activity characterized by four components, namely: fluency, flexibility, originality and elaboration. Fluency means dropping many ideas. Flexibility

means changing perspectives easily. Originality means composing something new. Elaboration means developing another idea of an idea. In short, the ability to think creatively is the ability to think of new things acquired by experimentation and characterized by fluent, flexible, original, and elaborate thinking skills [22].

In this study, critical thinking skills use Bloom's revised taxonomic criteria. The level of thinking skills in the Bloom's revised taxonomy is: 1) remembering (C1); 2) understanding (C2); 3) applying (C3); 4) analyzing (C4); 5) evaluating (C5); 6) creating (C6). The remembering level contains memories of things that have been previously learned. The level of understanding contains the ability to describe a material into another material. The applied level contains the ability to use the learned material into something concrete, real or new. The level of analysis contains the ability to decipher the material into parts or components that are more structured and easy to understand. The rate level contains the ability to estimate or test the value of a material for a particular purpose. Creating levels contain the ability to collect part by part into a whole and comprehensive form. Level analyzing, evaluating and creating this demands higher order thinking skill [1].

A preliminary study at Senior High School Stella Duce 2 in February 2016 shows that over 80% of learning tools and learning processes at Senior High School Stella Duce 2 are aimed at reaching remember and understanding levels, and less than 20% of the learning process is aimed at achieving the level of applying. There is no operational verb in the learning device that reaches the level of analyzing, evaluating or creating. The results of the preliminary study indicate that it is necessary to design a learning model that can accommodate the development of critical thinking skills and scientific behavior among high school students.

II. METHOD

This study uses research and development approach [23]. This research and development approach forms a cycle that begins with a preliminary study, then develops a learning design that is tested, revised and re-tested until it continues with trials and revisions to obtain the final design.

This development research is conducted in Senior High School Stella Duce 1 and 2. This research development is designed to analyze the extent to which the implementation of problem-based learning design can develop scientific behavior and critical thinking skills (level of analyzing, evaluating and creating in Bloom's taxonomy). This model includes a series of development stages that include preliminary studies, assessment of instructional tools, observation of learning execution, analyzing evaluation of learning in economics subjects. The development of scientific behavior and critical thinking skills is implemented through the application of problem-based design learning models.

The implementation of study on problem-based learning design development follows the following steps: 1)

Preliminary study stage; 2) Learning planning analysis stage; 3) Observation stage; 4) evaluation questions stage; 5) Stage of designing problem-based learning model. Data analysis using descriptive analysis technique and paired sample t-test. Descriptive analysis techniques used to provide a description of the extent to which planning, and the learning process undertaken in economic subjects has accommodated the development of scientific behavior and critical thinking skills. Paired sample t-tests were used to analyze whether there were significant differences in thinking skills and scientific behavior of students before and after the implementation of problem-based learning models.

III. RESULT AND DISCUSSION

This study was conducted to answer three problems, namely: 1) the lesson planning in economics subject matter have accommodated the development of scientific attitude and critical thinking skill; 2) the design of problem-based learning model suitable for developing scientific behavior and critical thinking skills; 3) the result of the implementation of the tryout limited the design of problem-based learning model on economics subjects matter to develop scientific attitude and critical thinking skills.

The level of knowledge and thinking skills required in the planning of learning in the eyes of economics class X high school can be observed in the following table:

Table 1. Thinking Ability in Basic Competence and Indicator

No	Thinking Ability	Level of Cognitive in Basic Competencies and Indicators					
		C1	C2	C3	C4	C5	C6
1.	In the formulation of Basic Competence	5	8	0	0	0	0
	Sub-total & Percentage (%)	5 (38.5%)	8 (61.5%)	0 (0%)	0 (0%)	0 (0%)	0 (0%)
2.	In the Formulation of Indicators	6	17	9	0	0	0
	Sub-total & Percentage (%)	6 (18.8%)	17 (53.1%)	9 (28.1%)	0 (0%)	0 (0%)	0 (0%)
	Total Operational Verbs in Basic Competencies and Indicators (%)	11 (24.4%)	25 (55.6%)	9 (20%)	0 (0%)	0 (0%)	0 (0%)

Source: secondary data, processed 2017

Table 1 present that 61.5% of Basic Competence formulas use verbs at understanding level (C2), and 38.5% use verbs at the remembering level (C1). None of the operational verbs in the Basic Competency are more than C2 level. For operational verbs in the formulation of indicators 53.1% are at the level of understanding (C2), 28.1% are at the applying level (C3) and the remaining 18.8% is at the remembering level (C1). Thus, it

can be concluded that the planning of learning on the subjects of economy only focuses on lower order thinking skills and has not been directed to the development of critical thinking skills and scientific behavior.

This fact is concern because at senior high school level, it should be developed that is critical thinking skill and scientific attitude that is level C4 until C6. Several underlying causes of the phenomenon. First, the lack of educators' understanding of critical thinking skills and scientific behavior. Educators rarely reflect more deeply about the importance of developing critical thinking skills and scientific behavior. In addition, instructional tools are often structured to meet administrative requirements so that they are poorly thought out. Operational verbs formulated in Basic Competencies and Indicators in learning tools often use operational verbs that are considered easy to teach that is at the level of C1 and C2.

Educators often tend to underestimate the intellectual ability of students so that they do not dare to demand critical thinking skills and develop scientific behavior. If it refers to the category of knowledge dimension in Bloom's taxonomy, it can be said that the planning of learning in economics subject is included in the category of factual knowledge, conceptual knowledge, but not yet the knowledge of produral and metacognitive knowledge.

Based on the reflection on field findings, a suitable learning design for improving critical thinking skills students' scientific attitude in economic lessons is the implementation of Problem Based Learning. Based on the characteristics of high school economics subjects that are potentially directed to concrete issues, including human needs, production, production costs, economic system, consumer behavior, producer behavior, economic actors, demand, supply, equity price, and market Factors of production.

Problem-based learning is a learning that uses real-life problems in an open-ended everyday life to develop critical thinking skills and scientific behavior [24]. The design of problem-based learning model that is implemented to improve critical thinking and scientific attitude in economic learning process follows the following stages.

Table 2. Implementation Stages of PBL Model

Stage	Description
Stage 1. Orientation to the problem	Teachers present real problems related to economic subject matter to students.
Stage 2. Organizational learning	Teachers facilitate students to understand the real issues related to selected economic learning. Students share roles to resolve the issue.
Stage 3. Individual and group investigations.	Teachers guide students to collect data/ information related to economic cases through various ways to find alternative solutions to problems.
Stage 4. Development and presentation of problem solving results	The teacher guides the student to determine the most appropriate problem solving of the various problem solving alternatives found. Students develop problem solving reports, for example in the form of ideas, models, charts, or power point slides.

Table 2. Cont.

Stage 5. Analysis and evaluation of problem solving process	Teachers facilitate students to reflect or evaluate the problem-solving process related to the economic lesson material that is implemented.
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Source: adapted from [24]

Implementation of this problem-based learning model encourages the growth of creativity, independence, responsibility, self-confidence, and critical and analytical thinking in students. Students gain a more meaningful learning experience as they are facilitated to think critically and be scientific. Through the process, students are prepared to enter the real life school.

The limited tryout results of the implementation indicate that there is an increase in critical thinking skills and scientific behavior among Stella Duce 1 and 2 high school students. Students cooperate seriously in the group and are actively involved in the economic learning process associated with the settlement of the given cases. Students can choose the way of presentation for example by using posters, video clips, role playing methods, tabloids, talk shows, newsreader models, and variety show models. Through presentations by various means, the students are facilitated to develop the ability to think.

After statistical testing using descriptive analysis and paired sample t-test, the level of thinking skill before and after tryout 4 limited implementation of problem-based learning model can be observed in the following table.

Table 3. Skills of thinking before and after

PBL implementation

No	Level of Thinking Skills	Before the PBL	After the PBL
1	Remembering (C1)	24.2%	0%
2	Understanding (C2)	55.6%	0%
3	Applying (C3)	20%	11.1%
4	Analysing (C4)	0%	66.7%
5	Evaluating (C5)	0%	22.2%
6	Creating (C6)	0%	0%
	Mean	1.96	4.11
	t-value	18.155	
	Probability	.000	

Source: primary data, processed 2017

A limited tryout indicates that there is an increase in the level of thinking skills before and after the implementation of the PBL learning model. Before PBL implementation, the dominant level of thinking skill was understanding (C2) was

55.6%, while after PBL implementation, the dominant thinking skill level was analysing (C4) of 66.7%. Judging from the mean value, there was an increase from 1.96 to 4.11. Thus, it can be concluded that there is a significant increase in thinking skills that are shown by the value of t arithmetic 18.155 and probability value $0.000 < 0.05$.

Students feel happy because their crativity in conveying ideas during presentation is greatly appreciated. Students are given the opportunity to present a critical review of presentation materials from the presenter group. Presenters are also given the opportunity to respond to questions and statements from the discussion group. Thus, the implementation of the limited tryout of the learning process using problem-based learning models has developed critical thinking skills and scientific behavior.

IV. CONCLUSIONS

It can be concluded that the lesson planning on economic subjects before implementation of the PBL model, has not accommodated the development of scientific attitude and critical thinking skills. The dominant cognitive domain demanded before PBL Implementation is the understanding level (C2). Planning learning prior to PBL implementation only focuses on lower order thinking skills. This happens because educators do not understand the importance of equipping students with higher order thinking skills. Learning tools are often arranged ahead of the beginning of the semester so they are poorly thought out.

Design learning suitable for economic subjects is model problem-based learning. Problem-based learning provides students with opportunities to link the material learned with concrete and contextual problems in the economy, including human needs, production, production costs, economic systems, consumer behavior, producer behavior, economic actors, demand, supply, equilibrium, and production factor markets. Implementation of the PBL learning model provides more opportunities for students to develop critical thinking skills and scientific behavior.

The result of limited tryout from the implementation shows that there is an increase in critical thinking skills and scientific attitude. Before PBL implementation, the dominant level of thinking skill is understanding (C2), whereas after PBL implementation, the dominant thinking skill level is analysing (C4). Students can choose the way of presentation for example by using posters, video clips, role playing methods, tabloids, talk shows, newsreader models, and variety show models. Students feel happy because their crativity in conveying ideas is appreciated.

Some suggestions that can be submitted: First, economic subject teachers should be more courageous in designing learning tools that focus on developing higher order thinking skills. Operational verbs in basic indicators and competencies should be more dominated by thinking skills at C4

(analysing), C5 (evaluating), and C6 (creating).

Second, economic subject teachers should be more courageous in conducting varied learning processes and focus on developing high-level thinking skills especially C4, C5, and C6 levels. Learning should be packaged in an interesting, contextual, and varied manner, for example by the method of presentation varies.

Third, economic subject teachers should be more daring to apply instructional design using Problem Based Learning Model Learning. Thus, students get more opportunities to develop critical thinking skills and scientific attitudes.

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