The Effectiveness of Problem-Based Learning Models in Improving Students Scientific Thinking Skills

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Submission date: 15-Feb-2019 04:01PM (UTC+0700)
Submission ID: 1078615051
File name: IJSDR1810003_Okt-2018.pdf (210.99K)
Word count: 4001
Character count: 22345

ISSN: 2455-2631 © October 2018 IJSDR | Volume 3, Issue 10

The Effectiveness of Problem-Based Learning Models in Improving Students Scientific Thinking Skills

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***Abstract*: This study aims to describe the effectiveness and practicality of problem-based learning models that have been developed to improve students' scientific thinking skills. This research is part of developing problem-based learning models which have produced learning tools that met valid criteria. In measuring effectiveness and practicality, this research applied quasi-experiments. Research subjects were students of the Family Welfare Education Department even semester 2016/2017 academic year as many as 35 students. The results showed that the problem-based learning model developed has improved students' scientific thinking skills in the Food Material Knowledge subject. It is seen in the indicator of the effectiveness and practicality of the model.**

***Index Terms*: Development, Learning Model, Problem-Based Learning, Scientific Thinking Skills.**

I. Introduction (Heading 1)

Barron et al., [1] study revealed that models or patterns of learning carried out by teachers which not varied and still centered on the teacher. Underutilized learning media worsens this condition. Its causes students uncreative and un-skills in critical thinking. Loss of reason and creativity in thinking and acting is certainly a problem that needs to be solved through a new creative and innovative learning model. One of the intended learning models is problem-based learning (PBL) model [2].

Problem-based learning (PBL) model is one of the models and approaches where students faced with problems then accustomed to solving through their knowledge and skills. This activity will develop inquiry, familiarizing them to develop critical thinking and skill in problem-solving. Problem-based learning aims to create students independence in dealing with various problems and solve it with themselves rationally without depending on others.

PBL is essentially bringing students closer to the real reality of the environment. The interaction between stimulus and response is a relationship between two directions of learning and the environment. The environment provides input to students in the form of assistance and problems, while the neuronal system of the brain functions to interpret the aid effectively. So that, the problems faced can be investigated, assessed, analyzed, and appropriately resolved [3]. The problem learning model answers the doubts so far that students today are less independent and tend to be weak in facing problems, whereas decision making is to solve inherent problems in every activity of human life. Problem-solving skills are part of the key to success, but these skills are born due to outside influences or stimuli. Decision-making and problem-solving skills obtained from structured and systematic habits and practices [4].

PBL repeated structurally and systematically. It will provide knowledge and experience to students, and even more than will provide critical thinking skills of scientific thinking of course in solving problems related to decision making. Many experts have explained that problem-based learning identical to the curriculum. Van Berkel & Schmidt [5] stated that PBL is a curriculum and learning process. The curriculum designed in various problems that require students to gain essential knowledge, make them proficient in solving problems, and have their learning strategies and have the skills to participate in teams. The learning process uses a systemic approach to solve problems or face challenges that will be needed in career and daily life and develop independence and confidence.

Furthermore, Ibrahim & Nur [6] and Yackel, Cobb, & Wood [7] argue that PBL is a learning model in which students engage in trying to solve problems with several stages of scientific methods. The students were expected to be able to learn knowledge related to the problem and expected to have problem-solving skills. PBL will be a learning approach that seeks to apply problems that occur in the real world, as a context for students to practice how to think critically and gain skills to solve problems.

The subject of food ingredients is a prerequisite subject that provides a strong foundation for an advanced subject. This subject often taught with a teacher-oriented learning approach. The learning result shown the students are less creative and innovative. They also cannot adjust to advanced courses either both theoretical and practical. The development of the PBL model in the Food Material Knowledge subject is to improve students' problem solving and scientific thinking skills of the students of Family Welfare Education Faculty of Engineering Universitas Negeri Makassar. This course requires not only the creativity, innovation, and skills of students to make decisions, but also required to be skilled in thinking using the principles of science. Based on that background, this research has developed learning tools which need to explore the effectiveness and practicality of the learning tools.

II. Research Method

This research is part of Research and Development which adapts to the model of Semmel, Semmel, & Thiagarajan [8]. This research was carried out in four stages: define, design, development and disseminate stages. The Defining stage is defining the learning requirements, which begins with the analysis of the objectives of the limits of the material developed by the device. This

stage includes five main steps, namely: 1) front-end analysis; 2) student analysis; 3) concept analysis; 4) task analysis and 5) formulation of learning objectives.

The design stage is done to prepare prototype models and learning tools. This stage consists of 3 steps, namely: 1) Formulation of concepts related to learning plan, modules, and model manuals. This step is the first step that connects to define and design stages. Outlines of learning material, as well as steps for implementing the practice, are prepared based on the results of the formulation of specific learning objectives; 2) Selection of references and media that are appropriate for the purpose, to convey the subject matter; and 3) Selection of formats that adapted to the format of the existing and applicable devices at the University.

The next step is the Development Phase. Thiagarajan divides the development phase into two activities, namely: 1) expert appraisal is a technique to validate or assess the feasibility of product design. In this activity, evaluation was conducted by experts in their fields. The suggestions given are used to improve the material and learning designs that have compiled; 2) Developmental testing is the activity of testing product designs on the real subject target. Trials are conducted to obtain information and response data, reactions or comments from the target users of the model. Test results are used to improve the product. Then, after the product repaired, it is re-tested until it has useful results.

Develop activities are carried out with model validation by experts. Validated matters include learning model tools including learning plan modules and model manuals. The expert team involved in the validation process consists of learning experts and vocational experts (cooking). The steps taken in this development are the preparation of the device draft, validation and revision. The validation of the learning model and device includes a review by experts, testing of models and devices using one class of learning (small groups). Data from the review of learning devices were analyzed descriptively to see the validity of the device. Validity criteria for the device if the average score of each aspect/indicator that is measured is in the minimal Good category. Analysis of the results of the review is also directed to examine aspects that require attention in order to improve or revise the device. The validity of the device was consulted with the standard index to test the validity of the model and device according to Gregory Index. This development phase aims to produce learning models and tools that have revised and validated based on input from experts.

Dissemination Stage in this study was carried out in the form of the implementation of learning tools. This stage was the stage of using a learning plan, modules and models manual in the broader group. The aim is to test the practicality and effectiveness of using the device in the learning process. Based on the needs of the development of this learning model and device, the subject is a student of the Family Welfare Education Department in the even semester of the 2016/2017 academic year. The research subjects were 35 students.

III. Result

PBL models and tools that have designed must meet the level of validity, level of effectiveness and level of practicality in order to disseminated widely. The validity level based on the validator's assessment shows that the learning models and devices that have previously designed are categorized as valid with a level of validity of the learning tools average on 3.15. For more details can be seen in the following table:

Table 1 Validators assessment of the learning tools

No	Tools	Average Value	Category
1	Model manuals	3,13	Valid
2	Learning Plan	3,25	Valid
3	Modul	3,10	Valid
Average		3,15	Valid

Learning tools that meet the Validity category, then, experiment to lecturers and students who are the subjects to get data on the effectiveness and practicality of the developed model. Model effectiveness data are set out in Table 2.

Table 2. The effectiveness of the learning tools

No	Aspect	Percentage	Category
1	Students learning activity	86,11	Most Active
2	Conceptual of food material knowledge	53,59	Improve
3	Students scientific thinking skills	20,50	Improve
4	Students respond	85,71	Very Good
5	Lecturer respond	83,33	Very Good

Table 2 above shows that student learning activities become very active with the implementation of PBL models. The mastery of the concept of students has increased to 53.59%, while in scientific thinking skills practice an increase of 20.50%. Both respondents' (students and lecturer) response to the implementation of the model reached the category of Very Good. Thus it can be said that the problem-based learning model developed met the Effective criteria.

Learning practicality is measured by using the Learning Implementation observation sheet, through the implementation of the learning tools from both sides (students and lecturer). Observation results are set out in Table 3.

Table 3. The practicality of the learning tools

No	Observe aspect	Average	Implementation
1	Implementation of the lecturer side	100,00	Very good
2	Implementation of the student's side	85,71	Very good

Based on the data in Table 3, it can be stated that PBL models and tools in food material courses are practically used. Practicality was also seen from the appreciation of the lecturers of food ingredients knowledge on learning models and devices which stated that the models and tools were Very Good.

The implementation of the model and the use of learning devices from the response of the lecturer (2 respondents) averaged a score of 100% or performed very good, while the implementation of the model and the device from the student side obtained a score of 85.71% and it also very good implemented. Besides practicality seen from the student's perspective, practicality was also seen from the appreciation of the lecturers in the model and learning tools; it turned out that the implementation of the PBL Model had a score of 87.55, the use of Module 83.33, and RPP 91.67. Based on the appreciation of data or perceptions of the subject of knowledge of food ingredients, it can be stated that the models and devices are Very Good. These results indicate that PBL-based learning models and devices for practical knowledge materials for food use.

IV. Discussion

Based on the results of the study, it can be stated that the model and learning tools with the PBL model in the knowledge of food ingredients have valid, effective and practical criteria and is appreciated both by the lecturer subject of knowledge of food ingredients so that this learning tool can be used. Problem-based learning model reinforces the notion that problem-based learning is one solution in providing quality learning. This model also applies to student-centered learning (SCL) [9].

Problem-based learning is a model that can contribute to efforts to create quality and independent human resources. It directed at reality and instead avoid utopian concepts, meaning that this model is more directed at efforts to provide learner life skills than to give theory or broad concepts. This is relevant to the direction of the problem-based learning model that wants to give students the skills to solve their problems without being too dependent on the teacher or lecturer [10], [11].

Duch, Groh, & Allen [12] and Yackel et al., [7] suggest that PBL is a learning model that involves students to try to solve problems with several stages of the scientific method. This model expects students to learn knowledge related to the problem and have the ability in problem-solving skills. PBL will approach to apply problems that occur in the real world, as a context for students to practice how to think critically and gain skills to solve problems. PBL model not only can improve problem-solving skills but also can improve students' scientific thinking skills, thinking based on the principles of science that are objective, methodological, systematic and universal [13].

The development of the PBL learning model is appropriate to improve students' problem solving and scientific thinking skills. It is matched to apply to students because this model is not only useful for students who are skilled in making decisions but also skilled at thinking using scientific principles that systematic and objective and methodological course. By itself, this learning model can reduce the habits of students to solve problems and make decisions based on feelings that are not measurable. [14] argues that scientific thinking is logical and empirical thinking. Logical means reasonable, and empirical means to be discussed in depth based on facts that can be accounted for.

It is relevant to the characteristics of problem-based learning models as stated by Arends [15]. The learning models are based on the problem of organizing real problems that are socially important and beneficial for students. Problems faced by students in the real world cannot be answered with simple answers. Furthermore, according to Ibrahim & Nur [6] and Jones & Idol [16] that this model is better used in interdisciplinary focus so that learners learn structural thinking and learn to use various scientific perspectives. This is very important because people tend to solve partial problems, based on momentary interests and trends in the sectoral ego due to the partiality of being given partial education which results in the person having only certain points of view, even ignoring the opinions of others.

Syamsidah (2017) explain that problem-based learning will take learners to be more authentic, solve problems and make decisions authentically. It is obligatory to find a real solution. Students are required to analyze and determine the problem, develop hypotheses and make predictions, collect and analyze information, carry out experiments, make inferences, and draw conclusions. Authentic factors are very important because problem-solving must be based on three practical abilities, namely descriptive ability, analytical ability, and predictive ability. After being given learning with a problem model, a learner will be proficient in describing problems, analyzing problems. It is also good in predicting what will happen later after the decisions have been taken. If this is done well, the learner will produce an observation product. The product can be in the form of paper described and demonstrated to others. Ultimately, problem-based learning will create collaboration that can encourage joint inquiry and dialogue to develop thinking skills and social skills.

Albanese & Mitchell [4] explain that the characteristics of PBL, namely: Learning is student-centered which is supported by constructivism theory where students are encouraged to develop their knowledge. Thus according to the author, PBL learning that tends to a behavioral approach will reduce too much intervention from the teacher that has been widely applied in learning. PBL also has authentic problems as the form of organizing focus for learning, similar to that stated by Arends above that the problem presented to students is an authentic problem so that students can easily understand the problem and can apply it in their professional life later. This, according to the author PBL, contains future-oriented learning, especially when the outcomes of educational institutions are directly involved in real life, especially in the workplace.

Furthermore, the PBL model Albanese & Mitchell [4] characterized in new information is acquired through self-directed learning. The problem-solving process and the prerequisite knowledge maybe unknown by the students, they try to find the solving through the source, either from books or other information. Thus, problem-based learning not only can improve student creativity but can further increase motivation to always look for additional learning resources, even more than what the lecturer has given.

PBL learning models are characterized also in learning occurring in small groups. Scientific interactions occur and exchange ideas to build collaborative knowledge. Therefore, the learning process is carried out in small groups. The group made demands clear division of tasks and clear goals. This is, of course, interesting because with this learning students or students from the beginning are accustomed to working together, helping and understanding each other, so that they are used to solving problems and making decisions in the midst of different members of the background [18].

Albanese & Mitchell [4] describe five steps through group activities: (1) Defining the problem. Formulate problems from certain events that contain conflict until students are clear with the problem being studied. In this case, the teacher asks the students' opinions about the problems being studied. (2) Diagnosing problems, namely determining the causes of problems. (3) Formulating alternative strategies. Test every action that has been formulated through class discussion. (4) Determine & apply choice strategies. Decision making about which strategy is carried out. (5) Conduct evaluation. Both process evaluation and outcome evaluation.

Finally, PBL learning is characterized by Teachers act as facilitators wherein the teacher only acts as a facilitator [19]. However, even though the teacher must always monitor the development of student activities and encourage students to achieve the targets to be achieved. This is also interesting because besides the teacher gives the opportunity for students to explore their abilities so that the burden of the lecturer becomes lighter and can think of other tasks in developing their students' knowledge and skills.

In order to implement PBL model effectively, John Dewey recommends 6 (six) steps in this problem-based learning: (1) Formulating problems. The teacher guides students to determine problems that will be solved in the learning process, even though the teacher has determined the problem. (2) Analyzing problems. Steps for students to review problems critically from various perspectives. (3) Formulating hypotheses. The steps of the students formulate various possible solutions by their knowledge. (4) Collect data. Steps for students to find and describe various information needed to solve problems (5) Testing hypotheses. Steps of students in formulating and drawing conclusions by the acceptance and rejection of the proposed hypothesis (6) Formulating problem-solving recommendations. Steps students describe recommendations that can be done according to the formulation of the results of testing hypotheses and conclusions formulation [20]

Generally, the steps of this learning model are: (1) Realizing the Problem. This step starts with awareness to solve the problem. The ability that must be achieved by students is that students can determine or capture the gaps perceived by humans and the social environment. (2) Formulating Problems. The formulation of the problem is related to the clarity and similarity of perceptions about the problem and related to the data that must be collected. It is hoped that students can determine the priority of the problem. (3) Formulating Hypotheses. The students are expected to determine the cause and effect of the problem they want to solve and can determine various possible solutions to the problem. (4) Collecting Data. In this step, the students are encouraged to collect relevant data. The expected ability is that students can collect data, mapping, and present in various views to be understandable. (5) Testing Hypotheses. Students are expected to have the ability to study and discuss to see the relationship with the problem being tested. (6) Determining Settlement Options. The ability to choose possible alternative solutions can be done and can take into account the possibilities that can occur in the alternatives chosen.

V. Conclusion

The research results showed that the PBL model where elaborate on learning tools could improve students' scientific thinking skills for students of Family Welfare Education in the Food Material Knowledge subject. Learning tools that have been compiled meet Valid criteria. The tools also are arranged to be effective and practical categories to be further disseminated.

VI. Acknowledgment

The author would like special thank you for Direktorat Penguatan Riset and Pengembangan (DPRM) Ministry of Research Technology and Higher Education of Indonesia which funding this research.

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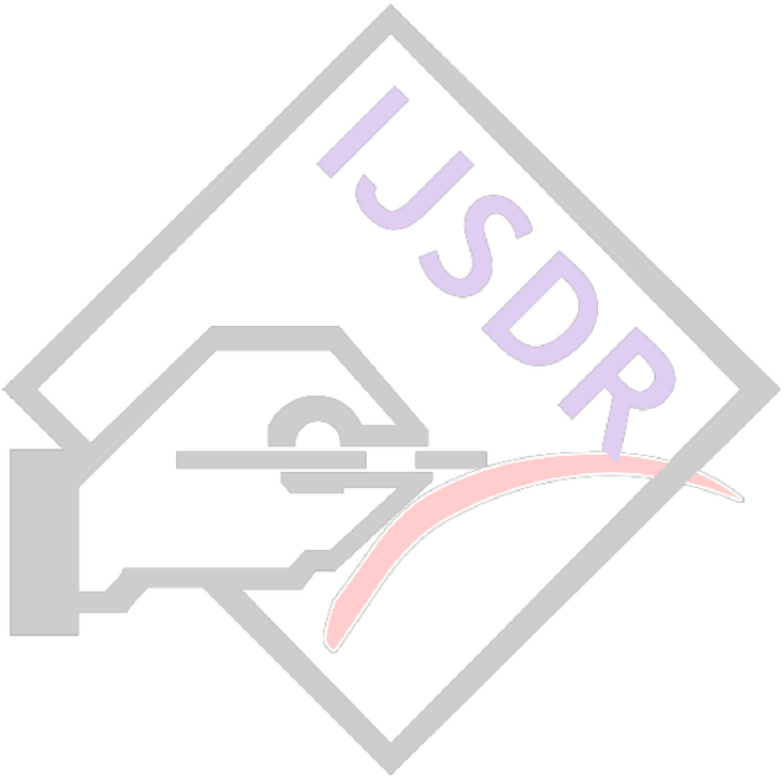

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