Development of Karmana-Problem Based Learning Model to Train Problem Solving Skills and Concept Mastery of Biology Teacher Candidates

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Abstract. Problem solving skills and concept mastery are the most essential skills in the 21st century. In relation to that, the purpose of this research is to develop a learning model, namely Karmana-Problem Based Learning (K-PBL) model to train the problem solving skills and concept mastery of biology teacher candidates. This is a research and development by using the Borg and Gall model design, which will produce a product, that is the K-PBL model is valid, practical, and effective. The validity of the model is assessed by validator, practicality is assessed using observation sheet of learning scenario and students activities, and the effectiveness is determined based on pre-test and post-test problem solving skills and biology concept mastery. The data technique analysis is descriptive-qualitative. The results of this research show that the developed learning model (K-PBL) is determined to be valid by the validator with a reliability score of 0.91 (reliable) with the syntax assessment: 1) Knowledge; 2) Advance organizer; 3) Review; 4) Management strategy; 5) Acting; 6) Note and presentation; and 7) Assessment, including learning tools and instruments have been declared valid. Furthermore, the implementation of the learning model (try out) in biology education students of IKIP Mataram is declared to be practical because the percentage of learning implementation reaches 100% with reliability 0.97 (reliable), and the percentage of student activity also reach 100% with reliability 0.98 (reliable). In addition, the obstacles in learning that arise can be overcome. The model was also declared effective due to an increase in problem solving skills with a high grade 0.71 N-Gain score, concept mastery of the students achieve a high grade 0.73 N-Gain score with students responses to K-PBL model categorized positively (91.7%). It can be concluded the K-PBL model is valid, practical, and effective to train problem solving skills and concept mastery of biology teacher candidates.

1. Introduction
Problem solving skills is one of the essential skills that students must have in the 21st century [1]. [2] says that high-order thinking skills, such as problem solving skills, should be the focus of learning development in Indonesia, because it is believed to be potential to make the students have life skills, creation skills, and innovation skills, so that they can solve the increasingly complex life problems in the 21st century.

TIMSS (Trends in International Mathematics and Science Study) and PISA (Program for International Student Assessment) have adopted and used the learning products that direct the students to use their higher order thinking [3]. [4] conducted a comparative research of national examinations
The weaknesses and limitations of the PBL model, which further led to the idea of innovation to develop the Karmana Problem Based Learning (K-PBL) model which is a modification of PBL model and integrates the important aspects of concept mastery, namely prior knowledge, advance organizer, and review to train problem solving skills and environment pollution concept mastery. [12] states in dealing with confusing problems, individuals will try to relate new knowledge with their prior experience (prior knowledge). Advance organizer plays a role in linking the students’ prior knowledge with the new knowledge to be learned and contributes to the improvement of the students’ concept mastery [26]. Reviewing helps students activate their prior knowledge needed to understand the contents of the learning material, and it is essential to make the learning meaningful [27].
2. Method
This research is a development research that produces a product of a new learning model, in this case, the Karmana-Problem Based Learning (K-PBL) model and its learning material.

According to [28], the framework of a quality product meets three criteria, namely validity, practicality, and effectiveness. The development stage of K-PBL model refers to the design by [29] as in Figure 1.

| Pre-Development Stage |
|-----------------------|
| **Step One:** Preliminary research and collection of information that includes literature review, observation, survey, and preparation of reports on the problem of learning. The preliminary research was conducted to find out the learning needs related to the plan of developing K-PBL model |

| Development Stage of the Model |
|------------------------------|
| **Step Two:** Model development planning, the result is in the form of the definition of the model, the formulation of learning objectives, the determination of the learning sequences, the management system and the learning environment of the K-PBL model |

| Step Three: Model Validation |
|-----------------------------|
| 1. Preparing initial product (K-PBL model). |
| 2. Validating the K-PBL model. Validation done by validators (experts and practitioners) This step is in the form of small-scale trial. |
| 3. Revising the Product (K-PBL model) based on the suggestions and inputs from the validators. |
| 4. If the model has been valid, the researcher prepares the learning materials in the forms of: lesson plan, student worksheet, student textbooks, and observation sheet of lesson plan implementation, observation sheet of student activity, questionnaire of student response, test of problem solving skills, and environment pollution concept mastery. |
| 5. Validating the learning materials. Validation done by validator (initial test) |
| 6. Revise the initial product based on the suggestions and inputs from validator until get valid model and device. |

| Step Four: Practicality (model implementation) |
|-----------------------------------------------|
| 1. Implementing K-PBL model which is developed in step 3. This stage is the main try out of the product. |
| 2. Evaluating the implementation of learning scenario, student worksheet, and student textbook |
| 3. Revising the main product / operational product. (K-PBL model and learning materials) |
| 4. Operational product try out, followed by evaluation of learning scenario implementation, student worksheet, student textbook and its revision to produce final product. |

| Fifth Step: Effectiveness of model |
|-----------------------------------|
| Evaluating the effectiveness of the K-PBL learning model that has been developed in improving problem solving skills, and environment pollution concept mastery including student responses during the learning process. |

![Figure 1. Development Stage of K-PBL Model](image)

3. Result
This study produces a model of learning that briefly elements can be described as follows.

The name of the learning model produced is the Karmana-Problem Based Learning Model or abbreviated K-PBL. This model is a modification of Problem Based Learning (PBL) which is integrated with important aspects of teaching concept (prior knowledge, advance organizer, and review). The purpose of the model is to train problem solving skills, and concept mastery of biology teacher candidates. The theory foundation of the model is advance organizer theory, John Dewey's view, cognitive and constructivist learning theory, discovery learning, Vygotsky's social learning
theory, and information processing theory. The syntax of the K-PBL model is: (1) Knowledge, (2) Advance organizer, (3) Review, (4) Management strategy, (5) Acting, (6) Note and Presentation, (7) Assessment. Social interaction / learning environment model of K-PBL is the interaction between lecturer with student, student with student, student with the community and learning resources. Characteristics of the model that is problem oriented actual and authentic, interdisciplinary, strengthening the concept / initial provision, based on investigation, collaboration, produce product and presentation.

The data of the research results on the validity of K-PBL model and the learning materials can be seen in Table 1.

| No | Models and Learning Material | Average Score | Category   | Reliability |
|----|------------------------------|---------------|------------|-------------|
| 1  | K-PBL Model                  | 3.64          | Very valid | 0.91 (reliable) |
| 2  | Lecture Course Unit (Learning scenario) | 3.60 | Very valid | 0.98 (reliable) |
| 3  | Student Worksheet            | 3.54          | Very valid | 0.92 (reliable) |
| 4  | Student Learning Materials   | 3.25          | Valid      | 0.93 (reliable) |
| 5  | Problem Solving Skills Test  | 3.50          | Very valid | 0.92 (reliable) |
| 6  | Concept Mastery Test         | 3.70          | Very valid | 0.90 (reliable) |

The data of the research results on the practicality of K-PBL model can be seen in Table 2.

| No | Parameter                     | Percentage | Category   | Reliability |
|----|-------------------------------|------------|------------|-------------|
| 1  | The Implementation of Learning Scenario | 100%       | Very good  | 0.94 (reliable) |
| 2  | Student Activities            | 100%       | Very active | 0.96 (reliable) |

The practicality of K-PBL model, in addition to assessing the aspects of the implementation of learning scenario and the student activities in the learning process, also observed the obstacles found during the try out. Some of the obstacles found and the alternative solutions can be seen in Table 3.

| No | Obstacles                                                                 | Alternative Solutions                                                                                       |
|----|---------------------------------------------------------------------------|---------------------------------------------------------------------------------------------------------------|
| 1  | Students still need adjustment with the implementation of K-PBL model, so that the learning efficiency is not maximal and exceeds the time allocation provided. | Try to implement the steps of K-PBL as efficient as the time allocation provided.                             |
| 2  | Students still have difficulties in implementing the steps of problem solving. | Providing more guidance to the students in solving problems.                                                   |
| 3  | Students are not able to perform some problem solving skills properly/maximally namely formulating problems and hypotheses. | Intensifying the guidance in solving problems, especially on problem solving skills which are not optimal and still lacking namely formulating problems and hypotheses. |

The data on the effectiveness of K-PBL model are presented in Table 4.
4. Discussion

The learning model produced in this study is that the K-PBL model has met the criteria for a good learning model because it has a purpose, theoretical foundation, syntax, management (social interaction) and a clear learning environment. This is as stated by [12] and [27] that learning models must contain goals, theoretical foundation, syntax, and social interaction and a clear appropriate learning environment.

Based on the research data that have been analyzed as presented in the results section above, it is known that the K-PBL model and the learning materials (learning scenario, student worksheet, student textbooks) are declared valid. The instruments of problem solving skill test, concept mastery test, and questionnaire of student’s responses are also declared valid by the validators. The modes of all the five validators provide valid assessment, although there are few minor revisions. This shows that the developed K-PBL learning model and the learning materials have fulfilled one of the quality product criteria from [28], which is the product must meet the validity criteria. The validity is caused the K-PBL model has fulfilled the content validity and construct validity. In addition, the development process is carried out through good stages starting from the design, review, revision, focused group discussions (FGD). The process or mechanism for developing the PBM-K model is also carried out by other researchers who aim to develop a learning model or develop a learning tool in the field of education such as research conducted by [30],[31], and [32].

The K-PBL learning model that has been declared valid is then implemented (try out) in the learning process to determine the level of practicality. After the try out of the K-PBL model that has been operated into learning materials in the form of learning scenario, student worksheet, student text books, it is known that the mean percentage of learning implementation (learning scenario) based on the scores of two observers has a percentage of 100% with very good category. The reliability of learning implementation from the observation results of two observers is 0.94 (reliable). Furthermore, the student activity in the learning process as the characteristics of the model has a percentage of 100% with very active category. The reliability of the student activity is 0.96 (reliable). In the implementation of the learning process, there were several obstacles, and some solutions had been performed in order to reduce and minimize the obstacles. Referring to the results of the try out, in which the parameters of learning implementation have a percentage with very good category, and the reliability is included as reliable, and the parameters of the student activity in the learning process have a percentage with very active category and the reliability is included as reliable, it can be said that the implementation of K-PBL learning model is practical. This shows that the developed K-PBL learning model not only meets the validity criteria of a quality product but also fulfils the practicality criteria [28]. Practicality is caused by the simulation (modeling) before the trial. The implementation of this simulation is accordance with Bandura's social learning theory that modeling will have a good or positive effect.

The effectiveness of the K-PBL learning model can be seen from three parameters, namely the improvement of problem solving skills and the improvement of the concept mastery from the pretest
to the posttest. In addition, it can also be seen from the questionnaire of the student responses toward the learning process using the K-PBL model. The data of the research results with the analysis on problem solving skills show that the average score of the pretest score 1.83 with less good category, had an increase to 3.37 on the posttest with very good category. The N-Gain value of the increase is 0.71 which is included as high category. This is in accordance with [33] that the N-Gain value greater than 0.70 is included as high category. The increase of the problem solving skill is not only because K-PBL model contains the syntax of PBL model which has been modified (stage 4, 5, 6, 7), but also because of the integration of new stages which play a role to strengthen the students’ concept mastery in order to be able to solve problems, namely stage 1 knowledge (prior knowledge), stage 2 advance organizer, and stage 3 review. To solve problems, individuals try to associate the new knowledge with their prior knowledge [12]. The amount of the students’ prior knowledge will determine the effectiveness of the problem-solving strategy [27]. Advance organizer highlights the relationship between ideas to be presented, and reminds of relevant information that students have [26]. Reviewing the prior knowledge is necessary in solving problems [27]. The integration of these three new stages not only improves the students’ problem solving skills but also increases the students' concept mastery. This is important because it can overcome the weaknesses and limitations of PBL model which requires adequate mastery of the materials/concepts [21], as well as the lack of concepts in PBL implementation [25]. Increased concept mastery is also in line with the research results in which there is a change/increase in the average score of concept mastery from 1.71 in the pretest with less good category to 3.36 in the posttest with very good category. In addition, the N-Gain of the score increase is 0.73, which is included in the high category. Thus, the developed K-PBL model can be said to be effective to train problem solving skills and biology (environment pollution) concept mastery, and it has met the criteria of quality products based on the criteria by [28], namely the criteria of effectiveness.

5. Conclusions

Based on the research results, research analysis, and discussion in this research, it can be concluded that the developed learning model, Karmana Problem Based Learning (K-PBL) is valid, practical, and effective to train problem solving skills and concept mastery of biology teacher candidates.

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