Problem-Based Learning (PBL) Model with a Realistic Mathematics Education (RME) Approach in Statistics and Probability Courses

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Abstract. In higher education, the focus has shifted towards developing students' critical thinking and problem-solving skills. This transition from teacher-centered to student-centered learning is encapsulated in the Student-Centered Learning (SCL) approach, which emphasizes independent learning. Problem-Based Learning (PBL) is one implementation of SCL, and it is closely related to the Realistic Mathematical Education (RME) approach. This research aims to create a learning model for teaching statistics and probability using a combination of PBL and RME, along with validating the necessary learning tools. The learning model was formulated through literature review, and the development of tools (such as RPS and Student Handouts) followed the R&D design by Borg and Gall. The validity of these tools was assessed by a team of experts. The study resulted in a combined PBL and RME learning model for statistics and probability courses, with the RPS and Student Handouts receiving validity scores of 83.95% (Valid category) and 88.54% (Very Valid category), respectively. This model and its tools were implemented in the statistics and probability course in the Smart City Information Systems study program at Poliban, with the expectation of enhancing the quality of student learning and fostering critical thinking and problem-solving skills.

Keywords: Problem-based learning (PBL), Realistic Mathematic Education (RME), Learning Media, Statistics and Probability Course

1 Introduction

All countries in the world, including Indonesia, are currently facing an industrial revolution that has resulted in labor disruption. The unemployment rate is increasing, and competition for jobs is getting tighter. Therefore, the quality of human resources is very important. Higher education institutions are tasked with preparing graduates to enter the world of work by paying attention to aspects of student life skills, especially the balance of soft skills and hard skills [1]. Included in soft skills here are the ability to work in a team (teamwork), communication skills, discipline, and creativity [2]. With these demands, the implementation of education in universities has undergone a paradigm shift from teacher-centered patterns to self-direction and self-regulation. These self-regulation skills are essential for students to achieve their academic performance [3]. Therefore, as motivators and facilitators, lecturers must be able to carry out the educational process with the right methods and models so that they can

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actively stimulate students' soft skills so that they are able to think critically, innovatively, and independently. This type of student-centered learning is often referred to as Student-Centered Learning (SCL).

The Problem-Based Learning (PBL) model is one of the applications of SCL learning [4]. PBL is a learning method aimed at preparing students for real-world situations[5]. According to Sahbaz & Komur [6], PBL can improve students' problem-solving and critical-thinking skills. Students assume their learning responsibilities so that they become active, independent, and lifelong learners. The problem-solving process makes content knowledge more permanent, and students internalize what they have learned better than in traditional teaching methods.

On the other hand, an approach to mathematics learning known as Realistic Mathematic Education (RME) is also student-centered learning[7]. Realistic Mathematics Education states that learning and developing mathematical concepts are based on, or begin with, real-world challenges. With the assistance of the teacher, students ought to be able to expand their mathematical knowledge [8].

Statistics and Probability, as one of the courses in higher education, needs to be designed to improve students' not only hard skills but also soft skills. Through learning in this course, students can also develop critical thinking skills and solve their problems. Therefore, it is necessary to design plans and learning tools that support this. Through the discussion above, Statistical and Probability learning tools can be developed using a combination of PBL and RME concepts. Therefore, through various searches, the author has yet to find research that explicitly discusses the development of learning tools for Statistics and Probability courses using the PBL & RME approach. This research aims to formulate a statistical and Probability learning model using the PBL and RME approach along with valid learning tools. The learning tools developed include the Learning Implementation Plan (In Indonesian: "Rencana Pembelajaran Semester-RPS) and the students' Handout.

The lesson plan (Next, we will call it by the term"RPS") contains three components in the learning flow: learning objectives, a set of activities or steps that will be taken to achieve the objectives, and hypotheses about how students learn and think. In formulating the learning flow, the learning objectives are first determined, which are described in the sub-objectives.

2 Method

This study was based on Research and Development (R&D) design. The main purpose of this study was to develop valid learning tools (RPS and Students' Handout) for Statistics and Probability courses using the PBL & RME approach.

This research was conducted in statistics and probability courses taught in the study program Smart City Information Systems (Sistem Informasi Kota Cerdas-SIKC), Politeknik Negeri Banjarmasin, Indonesia.

This research uses the R&D design of Borg & Gall, which has been modified into seven steps, as can be seen in Fig. 1.

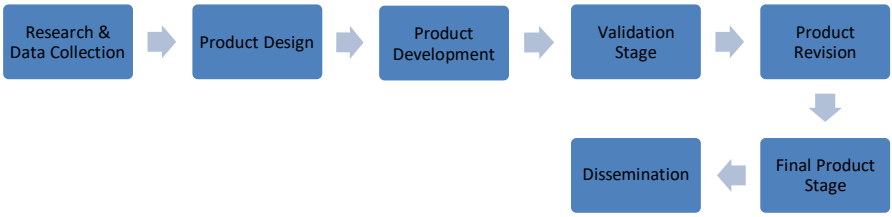

Fig. 1. Modification of the Bord & Gall design

2.1 Research & Data Collection

Research and data collection was carried out using literature studies and field surveys. The literature review was carried out by looking for various sources of information and research regarding various learning models that can improve students' critical thinking and problem-solving abilities. Through this literature review, the application of the PBL and RME learning models could be a solution. Through various searches, the author has yet to find research that explicitly discusses the development of learning tools for Statistics and Probability courses using the PBL & RME approach. A field survey was conducted in the Statistics and Probability course in the SIKC study program to determine the need to develop learning tools. The learning tools developed include the Learning Implementation Plan (In Indonesian: "Rencana Pembelajaran Semester-RPS") and the students' Handout.

2.2 Product Design

Product design is done by planning RPS and Handouts. This planning stage is done by Analyzing, The Curriculum, Learner Analysis, and Concept Analysis. Curriculum Analysis is carried out by reviewing the curriculum used to study Learning Outcomes, material coverage, learning objectives, and strategies chosen as the basis for developing the expected product. Student analysis is carried out to determine the needs of students who are the target users of the Handout created, in this case, students of the SIKC study program. Concept analysis aims to determine the materials needed to develop learning tools to realize the Learning Outcomes of the courses that have been selected.

2.3 Product Development

Statistics and probability learning tools were developed by compiling initial products in the form of RPS and Student handouts.

2.4 Validation Stage

Learning tools were consulted and validated by three experts. Two experts in mathematics/statistics and one Expert in educational management.

2.5 Product revision

Based on suggestions from the validator, the research team made improvements and additions to the learning tools created.

2.6 Dissemination

The dissemination stage is the final stage of development research, which has produced the final product. Dissemination is done by disseminating the products developed to enable related parties to utilize them. In this case, dissemination was done through the BIS 2023 conference.

The validity of learning tools is calculated using a validation sheet by three experts in the fields of statistics and education.

To calculate the validity of each Expert, use the formula (1) and then the final formula in (2).

$$V_{e1,2,3} = \frac{Media\ expert\ score}{Maximum\ score} \times 100\% \quad \textbf{(1)}$$

$$V = \frac{V_1+V_2+V_3}{3} \quad \textbf{(2)}$$

Calculation results using this formula can be compared with the following criteria in Table 1.

Table 1. Criteria of Validity

Criteria of Validity	Validity
85%≤V≤100%	Very Valid, or can be used without revision
70%≤V<85%	Valid or usable but requires minor revisions
50%≤V<70%	Less valid or not recommended for use because it requires major revisions
0%≤V<50%	invalid, or may not be used

3 Result

3.1 RPS Validation Result

The RPS validation sheet instrument consists of 27 indicators categorized into ten assessment aspects. Three experts carried out the assessment. The results of calculating the validity of the RPS can be seen in Table 2.

Table 2. RPS Validation Result by Three Expert

Validator	Score	Maximum Score	Percentage
Validator 1	83	108	76.85%
Validator 2	92	108	85.18%
Validator 3	97	108	89.81%

Total	**272**	**324**	**83.95%**
			VALID

3.2 Handout Validation Result

The assessment by three validators (Table. 3) of the Handout includes 16 indicators in four assessment aspects.

Table 3. Handout Validation Results by three Expert

Validator	Score	Maximum Score	Percentage
Validator 1	60	64	76.85%
Validator 2	52	64	85.18%
Validator 3	58	64	89.81%
Total	**170**	**192**	**88.54%**
			VERY VALID

4 Discussion

4.1 Development of PBL Learning Model with RME approach applied to student RPS and Handouts.

Experts regarding the steps in PBL present many theories. Hung believes there are nine steps in implementing PBL [9]. The PBL model proposed by Wood is based on the elaboration of a scenario that includes 7 steps [10]. On the other hand, the book "Introduction to Problem-based Learning - A Guide for Students" describes PBL in seven cycles [11]. Barrows proposed six essential characteristics of PBL [12].

Based on the various theories above, modifications are made, by taking steps from the PBL model to be applied are as follows: 1) student orientation to the problem The teacher explains learning objectives, explains the equipment needed, shows phenomena to give birth to problems, and motivates students to play an active role in problem solving; 2) organizing students to learn i.e. the teacher forms several small groups then helps students to understand the intent of the problem; 3) guiding individual / group experiences i.e. the teacher guides students to dig up information about the problem discussed, then students work on and solve the problem; 4) develop and present the results of work, namely the teacher assists students in sharing assignments with their friends to prepare assignments to be presented, and helps develop presentation results; 5) analyze and evaluate the problem-solving process, the teacher evaluates the problem-solving process and straightens out differences of opinion from all groups, and provides material reinforcement regarding the results of the presentation.

The steps of the RME approach are as follows: 1) understand the daily problem/context, i.e., the teacher explains examples of daily life problems that are often encountered; 2) explain contextual problems, the teacher divides the group and explains the discussion tools, discussion procedures, students conduct discussions, then the teacher distributes discussion tasks and discusses and expresses information about learning problems; 3) solving problems by utilizing tools; 4) compare and discuss

answers i.e. the teacher guides and directs in solving problems; and 5) conclude, which the teacher evaluates and provides input on the simulated learning task.

So that the combined steps of the PBL model with the RME approach are as follows:

a. Student orientation to the problem, that is, the teacher explains examples of contextual problems that relate the subject matter to problems that students experience (activities) in everyday life. Teachers provide opportunities for students to form their concepts of mathematical ideas through solving real-world problems;
b. Organizing students, i.e., teachers forming several small groups;
c. Explain the rules of discussion, divide tasks for discussion, and discuss problems;
d. Guiding individual/group experiences;
e. Students present the results of the work;

These five steps form the basis for the preparation of RPS and Handouts.

1. RPS Validation Test

Based on calculations in Table 2, the RPS is declared valid, which means that the RPS can be used but requires minor revisions. The Validators suggest some revisions related to incorrect writing and layout. Based on the results of calculating the validity of the Handout above, it can be seen that the results are in the "Very Valid" category, meaning that the Handout can be used without needing revision. The author then makes improvements according to the validator's directions.

2. Handout Validation Test

Based on the results of calculating the validity of the Handout in Table 3, it can be seen that the results are in the "Very Valid" category, meaning that the Handout can be used without needing revision.

5 Conclusion

This development research succeeded in producing Statistics and Probability learning tools in the form of RPS and student handouts. The learning tools created are proven valid through the assessment of three experts. RPS has a score of 83.95% (Valid category), and Handout has a score of 88.54% (Very Valid category). Suggestions for improvements from the validator have been implemented at the Product Revision stage so that they have reached the final product stage.

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