

Lecture Design for Strengthening Concepts Understanding of School Mathematics for Prospective Teachers

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Abstract— This study aims to produce lecture design for school mathematics courses. The impact of this research is strengthening to understanding of concepts for prospective teacher. The true concept is absolutely necessary so that it isn't wrong to solve the problems. If there is a conceptual error, the following errors will occur at a higher level. One of the factors causing misconception is the way teachers teach. Therefore prospective teacher must master the concept well and be able to teach it appropriately. This study uses a research and development approach that refers to stages developed by Borg and Gall (1983). There are 7 steps in this study, namely: (1) preliminary study, (2) planning research, (3) initial design development, (4) limited field testing, (5) revision of field test results, (6) main field test, (7) revision the main field test. There are ten prospective teachers as subjects. The results showed that lecture design with a topic test model was able to improve understanding of concepts, so that conceptual errors could be avoided. In this model, we can find out the causes of conceptual errors experienced by each prospective teacher. This research produces one way to design of lecturing that has steps: summarize presentation, written test, oral test, and microteaching.

Keywords: *lecture design, concept, prospective teachers*

I. INTRODUCTION

It is often found that some students do not complete math learning. This is not because the student cannot complete the problem, but because the student is wrong in understanding the concept. The correct concept is absolutely necessary for students to not be wrong in finding solutions to problems. If misconceptions are not resolved immediately, subsequent errors will occur to a higher level of education. One of the factors causing misconceptions is the way teachers teach. When the teacher conveys a concept, students catch it differently so that the conception built by students becomes a misconception. Therefore prospective teacher students must master the concept well and be able to teach it properly.

Prospective mathematics teacher candidates from STKIP Al Hikmah come from various regions in Indonesia with various levels of education starting from high school, vocational school, and MA. Therefore their initial abilities as candidates for mathematics teachers also vary. Their understanding of mathematical concepts is also diverse. There

are those who understand the mathematical concepts correctly and some are still wrong. This causes students as prospective teachers to also experience misconceptions which have a very significant impact on their students later.

A. Learning Design

The basic concept of mathematics material must be mastered by students. But the concepts conveyed by teachers are not all well received by students. The inability of students to master the concept correctly is not the difficulty of the concept itself but sometimes comes from the failure of the teacher to convey the concept correctly. So the conception (way of looking at a concept) learners become less clear. Therefore the strategy to convey the concept is sometimes more important than the concept itself.

In order for the concept planting strategy to work well, a good learning design is needed. The purpose of designing learning is so that learning runs effectively and efficiently and is able to reduce learning difficulties. The learning design function is (1) increasing the ability of learners (lecturers, teachers, instructors), (2) producing learning resources, (3) developing teaching and learning systems, and (4) developing organizations so that they become learning organizations.

B. Maintaining the Integrity of the Specifications

School mathematics has a strategic role for students. It contributes to the formation of attitudes and mindset. Students need mathematics for practical needs and solve various problems in their lives [1]. By studying mathematics, students are expected to be able to master a set of competencies that have been set. Thus mastery of mathematical concepts and material is not the ultimate goal of learning mathematics but only a way to master a certain competency. Therefore the scope of school mathematics is adjusted to the competencies that must be achieved.

There are two learning objectives in school, namely (1) formal goals, emphasizing structuring reasoning and shaping personality, (2) material goals, emphasizing the ability to solve problems and apply mathematics. Mathematical skills or skills expected are (1) showing understanding of the concept, the relevance of the concept and applying the concept flexibly, accurately, efficiently and precisely in problem solving, (2)

communicating ideas with symbols, diagrams, tables to explain a situation, (3) use reasoning on patterns or traits to generalize, compile evidence, or explain ideas, (4) show strategic abilities in formulating, interpreting and completing mathematical models, and (5) having an attitude of appreciating the usefulness of mathematics in life.

C. Concept Understanding

According to Soedjadi, concepts are abstract ideas that are used to carry out classifications which are generally expressed in terms or series of words [2]. Meanwhile, according to the [3], the concept is an idea or understanding that is extracted from a concrete event, a mental picture of an object or process or anything that exists outside the language used by the mind to understand other things. Concepts can also be interpreted as abstract ideas that are used to classify a group of objects [4].

According to Skemp & Pollastek [5], there are two types of concept understanding, namely understanding instrumental concepts and rational understanding. Instrumental understanding is the understanding of separate concepts, only formulas are memorized for carrying out simple calculations. Rational understanding is an understanding contained in a scheme that can be used in solving broader problems. An idea, facts and mathematical procedure can be understood if it is associated with a network of a number of connections.

[6] said that in learning mathematical concepts, generalizations and abstractions are needed. At the moment the students' conception of feelings is still weak even some are mistakenly understood. Many students after learning mathematics, are unable to understand even in the simplest parts. Many concepts are misunderstood so that mathematics is considered a difficult, complicated and difficult science. [7]. Even though an important part of learning mathematics is understanding concepts, as stated by [8] that "mathematics emphasizes concepts."

Indicators that can be used to find out students understand a concept are as follows (1) able to explain verbally about what they have achieved, (2) able to present mathematical situations in various ways and find out differences, (3) able to classify objects based on whether or not the requirements that form the concept are met, (3) able to apply the relationship between concepts and procedures, (4) able to provide examples and counter examples of concepts learned, (5) able to apply concepts in an algorithmic way, (6) able to develop concepts that are has been studied.

[9] dated November 11, 2004 on report cards outlined that indicators of students understanding mathematical concepts are able to: (1) restate a concept, (2) classify objects according to certain according to the concept, (3) provide examples and not examples of concepts, (4) present concepts in various forms of mathematical representation, (5) develop necessary or sufficient conditions of a concept, (6) use and utilize and choose certain procedures or operations, (7) apply concepts or algorithms in problem solving.

D. Prospective Teacher

Prospective teacher must have the correct mastery of concepts. Because their task later when already serving as a teacher must be able to instill the concept correctly also to the students. Therefore these prospective teacher students must have 4 main competencies as required [10] concerning teachers and lecturers, the four competencies are professional competence, pedagogical competence, personality competence, and social competence.

In this pedagogical competency, prospective teacher are required to manage mathematics learning well. This management includes understanding students' psychology, designing and implementing learning, evaluating learning outcomes and trying to develop students to actualize the various potentials they have. In the part of implementing learning, prospective teacher students must be able to instill mathematical concepts correctly. The process of instilling this concept means that students must have a surefire way so that the concepts accepted by students are true.

II. METHOD

This research uses R&D approach. According to[11] research and development in education is defined as "a process used to develop and validate educational products". This research only develops an educational product, not finding a new theory. In this research, the development of school mathematics lecture design focuses on strengthening the understanding of concepts for prospective teacher.

The subject of this study is the 2017 mathematics study program students who take school mathematics courses. The number of research subjects was 10 students. The leader of the research team is the school mathematics subject. The object of this study is the design of school mathematics recovery to strengthen the understanding of concepts for prospective teacher. The stages used in this study are the adaptation of the stages developed by [11] as in Figure 1 below.

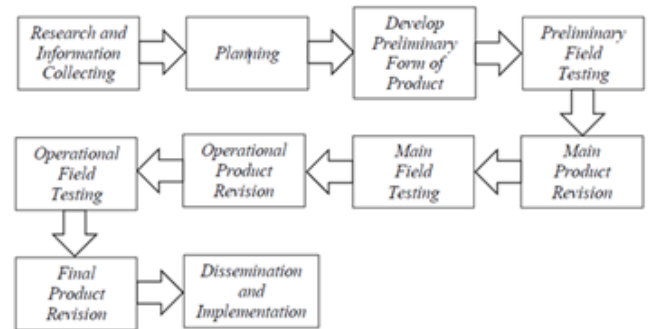


Fig. 1. Stages of Borg and Gall's research and development [11]

Not all of the above stages were carried out in this study, but only at the operational stage of product revision or improvement of the main product trial results, because limited by times and budgeting. Thus the final result of this study is the design of school mathematics lectures that are ready to be validated before being widely tested in other universities that teach school mathematics courses. The following explanation of the stages of research.

A. Research and Information Collection

There are three activities at this stage, namely (a) Analysis of needs related to the characteristics of research subjects is done by direct observation during lectures. Also reinforced by interviews and questionnaires. (b) Study of literature on school mathematics topics and basic mathematical concepts in higher education as further material. In addition, the results of the research subject's internship activities were studied at schools around the campus. (c) Small-scale research to find out the mastery of concepts for prospective teachers through observation, submission of tests and informal interviews.

B. Planning

Formulate specific objectives at each stage of the study. In addition it will conduct an analysis of capabilities related to the estimated funds, manpower and time needed during research and development.

C. Develop Preliminary Form of Product

These activities include (1) determining the design of school mathematics lectures. (2) determine the infrastructure that supports the implementation of the design such as developing the format of teaching materials (textbooks, worksheets, evaluation sheets, and media). (3) determine the plan for the pilot phase (4) conduct the design feasibility test.

D. Preliminary Field Testing

The developed design was tested on a limited basis for students in 2017. The data collection process at this stage used a qualitative approach. Data analysis was then performed.

E. Main Product Revision

Improvements were made based on the results of previous trials. This process can be more than once, as needed. Analysis using a qualitative approach.

F. Main Field Testing

The results of the revision of the limited field test are then implemented into the school mathematics classroom class. To see its effectiveness, qualitative and quantitative approaches are used.

G. Operational Product Revision

The results of the trial design of lectures for school mathematics courses were further improved thoroughly. At this stage, an analysis is carried out to improve understanding of concepts, achievement of lectures and student responses to lectures.

III. RESULT

The initial part of this research is a preliminary study of needs analysis. This analysis is related to the characteristics of the research subjects. Students of STKIP Al Hikmah as math teacher candidates come from various types of secondary schools, namely high schools, vocational schools and MA (religious schools). Because of these different backgrounds, the ability to understand concepts is also different.

Direct observation during previous lectures shows that some students have difficulty solving problems because they have not mastered the concept correctly. As a result, the final settlement is wrong. This was confirmed by interviews with a number of students who claimed they had not received certain material during their studies in high school. Another part of this preliminary study is the study of literature. The researcher examines school material topics that contain basic concepts. There are 5 basic concepts chosen by researchers. The five basic concepts are (1) the root of a number (2) comparison (3) function (4) the height of a triangle and (5) the tangents of a circle.

In this first stage, a small-scale study was also conducted on students taking school mathematics courses in the academic year 2018 - 2019. Two prospective student teachers were selected from the ten planned subjects. This little research is to capture how far mastery of the concepts they have. The form of activities is observation during the lecture, submission of tests and informal interviews. During the lecture the two students were asked to explain the topic of tangents to the circle on the whiteboard. Other students were asked to comment.

The researcher presents a concept understanding test consisting of 2 questions for each concept. From 10 test questions tested on these two subjects, the following data were obtained. S1 subjects were able to correctly correct 6 questions, while subject S2 was correct 7 questions. Thus the average is 6.5. This is still far from expectations as prospective mathematics teachers who should have an average of more than 9, because this is a basic concept. Informal interviews are conducted after the test results are obtained. This interview serves to strengthen the suspicion whether the workmanship is derived from understanding the wrong concept or just counting wrong.

The second stage in this development research is Planning. At this stage the researcher calculates the time needed to complete this research. From the initial process to the final report takes four months. In conducting the research, the two researchers were assisted by two students for the data collection and processing process. Specific objectives for each stage of the study are also formulated at this stage, as presented in table 1 below.

TABLE I. SPECIFIC OBJECTIVES OF EACH STAGE

Stage	Activities	Objectives
1	Research and Information Collection	Know the characteristics of the subject and determine topics that contain basic concepts
2	Planning	Determine the cost, time and research assistant
3	Develop Preliminary Form of Product	Design lectures
4	Preliminary Field Testing	Test the results of lecture design
5	Main Product Revision	Improve lecture design
6	Main Field Testing	Test designs on more diverse and diverse subjects
7	Operational Product Revision	Improve the design of lecture results of field trials

The third step in this research is the Develop Preliminary Form of Product. At this stage the researchers designed the design of school mathematics lectures. The design in question is like the following picture 2.

Each topic is summarized in 1-2 sheets of A4 paper from 3 different sources. It was chosen that the summary written by hand is not typed to improve writing because they are prospective teachers who require that the writing on the board be read by all students. The presentation is carried out for 10 minutes for each topic with presenters chosen randomly. The written test consists of 10 questions, a maximum of 20 minutes. Test topics verbally for each student, with a span of 20-30 minutes to be sure to master the concept well. Finally microteaching, 15 minutes each for each topic. Who gets what topics are chosen randomly.

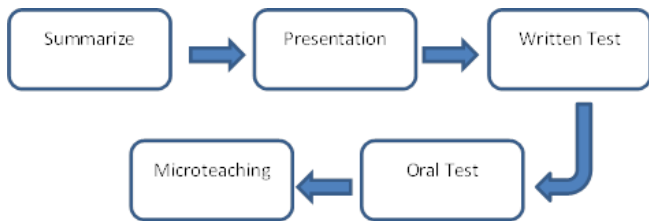


Fig. 2. Design Lecture of School Mathematics

At this stage, the researcher also compiled an evaluation sheet, namely 10 written test questions and guidelines during the oral test, and an observation rubric during the presentation and microteaching. Then, the trial phase plan is determined. Design feasibility trials were conducted on two subjects, S1 and S2 as in the first stage, for one topic, namely comparison.

The results of the feasibility trial showed that the two subjects were able to summarize as required, is not to exceed 2 A4 pages. S1 complete writing 3 references, whereas S2 only writes 2 reference sources. During the presentation the two subjects were able to present the material well. S1 explains it in a structured but less convincing way, whereas S2 explains it in an incoherent manner. When the written test both of them were able to solve 10 questions in less than 20 minutes and the score was the same at 8. During the oral test, the guidelines compiled were able to help the two subjects understand the concept of comparison. Based on the summarizing experience, the presentation and oral test caused the appearance of the two subjects when microteaching became better, more acceptable

TABLE II. RESULT OF PRELIMINARY FIELD TESTING

Stage of Design	S3	S4	S5
Summarize	Structured, with own language, 3 references	Poorly structured, partially duplicating, 2 references	Not structured, only 1 reference
Presentation	Good	Enough	Less
Written test	Score 9/10	Score 8/10	Score 6/10
Oral test	Answering correctly without help	Correct answer a little help	Answering correctly with lots of help
Microteaching	Satisfying	Less exploratory	Difficulty giving arguments

In the fourth stage is Preliminary Field Testing. At this stage the designs that have been made are tested on senior students. Three prospective teacher students were selected namely S3, S4 and S5. Sequentially represent teacher candidates who have high, medium and low pedagogical competencies. School material is summarized the same for each subject at this stage, namely the topic of comparison. At the time of presentation, the appearance of the subject is in accordance with his pedagogical abilities. The written test results for S3, S4, and S5 respectively were 9, 8, and 6. Oral test results, showed that S3 was able to answer correctly and less than 10 minutes. S2 answered correctly a little help with 14 minutes, whereas S5 answered correctly for 19 minutes. S5 needs more help to answer the concept properly. At the time of S3 S3 microteaching is able to explain well, as well as answer 'students' questions satisfactorily. S4 is able to explain well but is less exploratory. While S5 can explain, but it is difficult to give an argument when there are questions from students. The complete results in step 4 are presented in the following table 2.

The fifth stage in this research is Main Product Revision. Improvements made at this stage, namely (1) reference to summarize the material that was originally 3 books into 5 books, (2) Presentation, originally allowed to bring a summary to not be able to bring a summary, (3) Written test, there is one problem that was revised because has not sharply measured concept mastery, (4) no improvement, (5) microteaching is allowed to use media.

The sixth stage is Main Field Testing. At this stage the lecture design was tested on a larger group, namely 5 prospective mathematics teacher students who took mathematics school courses in the academic year 2018 - 2019. The time required for this stage was five weeks. Research subjects were given the initials S6, S7, S8, S9, and S10 which represented high competencies (S6), moderate (S7, S8, S9) and low (S10). The results of applying the lecture design are presented in table 3.

Each design stage uses 3 types of indicators. Indicators summarize there are 3 namely T = Structured, CT = Fairly Structured, KT = Less Structured. nR shows the many references used. Presentation indicators consist of SB = Very Good, CB = Good Enough, and KB = Not Good. Oral Test Indicators consist of TB = Without Assistance, SB = Little Assistance, and BB = Much Assistance. While the Microteaching indicator consists of M = Satisfactory, CM = Quite Satisfactory, and KM = Not Satisfactory.

TABLE III. RESULT OF APPLYING THE LECTURE DESIGN

Stage of Design	S6	S7	S8	S9	S10
Summarize	T, 5R	CT, 4R	T, 4R	CT, 3R	KT, 2R
Presentation	SB	SB	CB	CB	KB
Written Test	10/10	9/10	10/10	9/10	8/10
Oral Test	TB	TB	SB	SB	BB
Microteaching	M	CM	CM	CM	KM

The seventh stage is Operational Product Revision. At this stage there are some improvements to the design of school mathematics courses to strengthen understanding of concepts. The following is a list of improvements that are presented in table 4 below.

TABLE IV. REVISION OF LECTURE DESIGN

Stage of Design	Main Field Testing	Operational Product Revision
Summarize	5 local references	5 local references + 2 foreign references
Presentation	There is an introduction to the material	Jump to the main topic
Written Test	Maximum 20 minutes	Maximum 15 minutes
Oral Test	Assisted by explanation on paper	Assisted explanation on the board
Microteaching	There are 2 examples of concepts	there are at least 3 examples of concepts

IV. CONCLUSION

This development research resulted in the design of school mathematics lectures for prospective mathematics teachers. In developing the design, a research and development (R&D) model is used which refers to the stages developed by [11] that were adapted. Of the 10 stages, researchers only used the seventh stage. The resulting design can improve understanding

of concepts for prospective teacher students. This is indicated by the improved understanding of the concept test results, before applying the lecture design with after applying the new lecture design. The intended design includes the following flow (1) Summarizing the subject matter, (2) Presentation, (3) Written Test, (4) Oral Test, and (5) Microteaching.

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