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The Development of Probing Prompting-Based Module on Calculus 2 Course for Mathematics Education Study Program

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Abstract. This study aimed at developing the teaching materials in the form of probing prompting-based module on Calculus 2 as well as revealing its quality. This research used the procedural development model of Instructional Development Institute (IDI) consisting of three stages, namely define, development and evaluation. The development procedure design involved front-end analysis, prototype, and assessment phase. The product assessment was through descriptive design. Two validators performed the product assessment, they were the lecturers of mathematics education for Calculus 2 course and the learning media lecturers. The research object was the quality of teaching materials based on the established criteria. The data were the preparation and development process of the teaching materials as well as the quality of developed materials. The research instrument was a validation sheet in the form of checklist about the quality of the teaching materials. The product quality data were descriptive and converted into scores of 1, 2, 3 and 4 for the criteria of “very bad”, “bad”, “good”, and “very good”. The developed material was in the form of calculus 2 module covering four subjects. The result of the material validator assessment was in the percentage of 83.33% that can be categorized as “good” and from the media validator was 94.44% with “very good” category. It means that the developed material has met the established quality standards and it is feasible for the learning process.

Keywords: *calculus 2, teaching materials, probing prompting*

1. INTRODUCTION

Calculus is a branch of mathematics discussing limits, derivatives, integrals, and infinite series. It focuses on the science of change, as geometry is the science of form while algebra refers to the science of solving equations and their applications [1]. Calculus offers a wide range of materials, thus, Mathematics Education Study Program of Riau Kepulauan University splits its learning process into Calculus 1, Calculus 2 and Advanced Calculus.

Based on the observations among the students of Mathematics Education Study Program of Riau Kepulauan University, especially on Calculus 2 course, it seems that students find it difficult to understand the material from the textbook. Also, they are not facilitated with a practical material as their learning guidance. The teaching material is only the books from the library with a very limited number. It has affected the low learning outcomes among the student. Based on the data of the students learning results for Calculus 2 courses in the last two years, there were still many students who obtained the scores below 68 (C category).

The results of informal interview with the students who calculus 2 course, it can be concluded that students only comprehend the basic concept of the material and they are not able to relate the concepts to the materials. The students attitude during the learning

process also worsen this circumstances when the lecturer asks a critical question which is different with the example, they get confused. It indicates that the students have not mastered the material well and just give an answer based on the previous instance.

The course of Calculus 2 earns 3 credits unit. It requires the students to study independently beyond the class hours without any guidance from their lecturers. However, with the varied ability of the students, the suitable teaching materials is needed to facilitate the students' autonomous learning even as a consideration material to support the reference books [2]

One of strategies to improve students' material understanding is by providing a problem as a stimulus in order to explore students' answers and to train them in communicating their ideas [3]. The urgency of the learning resources can be solved by developing the materials in the form of a module which is designed to provide the problems to stimulate critical thinking on the basic concepts. This idea is in line with the learning concept of probing prompting method that emphasizes on the students' involvement so that the students can experience their own knowledge as the results of their problem solving process [4]. Unfortunately, probing prompting is a method which is performed in a class with the teacher instruction, therefore, the researcher tries to make the probing prompting method to be applied in independent learning context by using modules as the learning resources.

This study aimed at: 1) developing probing prompting-based module for Calculus 2 course; 2) knowing the validity of the developed teaching materials through expert judgment (validator). The benefits of this module is to assist the students to have better understanding on the Calculus 2 material and to enhance the reference of the learning source instead of textbooks that are rarely obtained. It is also to provide a module which is in accordance with the curriculum requirements by considering the students' needs or the module that is based on the students' characteristics, as well as to present the learning media that can be used optimally in universities level, especially in Riau Kepulauan University.

2. RESEARCH METHOD

A. Research type and procedure

This study can be categorized as development research in order to create modules-based learning. The research based on probing prompting that can be used for the lecture process among the 2nd semester students of Department Of Mathematics Education UNRIKA. The module development was using the Instructional Development Institute (IDI) procedural model consisting of the define phase with needs analysis, the develop stage until the evaluation stage. These three stages were revised according to the feedbacks. In this study, the implementation of development was limited to the define and develop stages of the validation step and, from those two stages, the design development procedure is developed as follows:

1. Front-End Analysis

This stage was done to obtain a clear overview of the real conditions in the field. This stage can be called the needs analysis phase. The following steps were taken in this stage:

- a. Analyzing the Calculus 2 course syllabus to find out the appropriateness of the material with the expected competencies.
- b. Analyzing and reviewing the reference books of Calculus 2 courses on the contents, the presentation, the tasks and the exercises to know its appropriateness with the applicable course syllabus.
- c. Conducting interviews with peers to gain the encountered problems related to their Calculus 2 teaching.
- d. Observing the students' characteristics before the arrangement of language content and difficulties level of the modules

2. Prototype stage

Referring to the front-end analysis results, a learning device prototype was designed as Calculus 2 module. The prototype was made through two stages, the validation and practicality stage but this study had a limitation which was only on the validation stage. The validation phase was to find out whether the developed materials had met the validity criteria and the qualified teaching materials in the feasibility aspects of the content or material, presentation, language, probing prompting assessment and media.

B. Research Instruments and Analysis Techniques

The research instrument was a validation sheet in the form of checklist. It was used by the validators to assess the developed products whether it had met the aspects of qualified content or material feasibility, presentation feasibility, language feasibility, probing prompting assessment aspects and media feasibility. The validation data from the validator on all aspects were analyzed quantitatively by giving a score according to the specified scale ranging from 1-4 with the category of "very bad" into "very good". The results of the scores were presented in the tables and converted into the percentage score with the following formula [5]:

$$P = \frac{\text{the number of score per item}}{\text{the number of maximum score}} \times 100\% \quad \text{with, } P: \text{Percentage}$$

The obtained percentage results were interpreted as the feasibility or validity level of the module. This result was confirmed by the certain criteria as shown in table 1 below.

Table 1. Criteria of module validity

Score range	Category
$M_i + 1,8S_{bi} < \bar{X}$	Very Good
$M_i + 0,6S_{bi} < \bar{X} \leq M_i + 1,8 S_{bi}$	Good
$M_i - 0,6S_{bi} < \bar{X} \leq M_i + 0,6S_{bi}$	Moderate
$M_i - 1,8S_{bi} < \bar{X} \leq M_i - 0,6S_{bi}$	Bad
$\bar{X} \leq M_i - 1,8S_{bi}$	Very Bad

Source : Adapted from Widoyoko [6]

Explanation :

\bar{X} = Mean score

Ideal maximum score = Number of indicators x highest score

Ideal minimum score = Number of indicators x lowest score

$$Mi \text{ (ideal mean)} = \frac{1}{2} (\text{Ideal maximum score} + \text{Ideal minimum score})$$

$$Sbi \text{ (ideal standard deviation)} = \frac{1}{6} (\text{maximum score} - \text{minimum score})$$

Below is the calculation of validity criteria of the module:

1. Material experts

The number of question items = 33

$$\text{Ideal max score} = 4 \times 33 = 132$$

$$\text{Ideal min score} = 1 \times 33 = 33$$

$$Mi = \frac{1}{2}(132 + 33) = 82,5$$

$$Sbi = \frac{1}{6}(132 - 33) = 16,5$$

Table 2. Criteria of Module Validity from the Material experts

Score range	Catagory
$112,2 < \bar{X}$	Very Good
$92,4 < \bar{X} \leq 112,2$	Good
$72,6 < \bar{X} \leq 92,4$	Moderate
$52,8 < \bar{X} \leq 72,6$	Bad
$\bar{X} \leq 52,8$	Very Bad

2. Media experts

The number of question items= 27

$$\text{Ideal max score} = 4 \times 27 = 108$$

$$\text{Ideal min score} = 1 \times 27 = 27$$

$$Mi = \frac{1}{2}(108 + 27) = 67,5$$

$$Sbi = \frac{1}{6}(108 - 27) = 13,5$$

Table 3. Criteria of module validity fromthe Media experts

Score range	Catagory
$91,8 < \bar{X}$	Very Good
$75,6 < \bar{X} \leq 91,8$	Good
$59,4 < \bar{X} \leq 75,6$	Moderate
$43,2 < \bar{X} \leq 59,4$	Bad
$\bar{X} \leq 43,2$	Very Bad

In this study, the module can be declared valid if the results of the validator assessment at least in the good category.

3. RESULT AND DISCUSSION

This research is trying to develop teaching materials in the form of probing prompting-based module for calculus2 course. To produce a valid module, the development stages is through the define and develop stages and the development procedures includes the front-end analysis and prototype stages. The results of the development are described as follows.

1. Define stage

The define phase was done with front-end analysis activities. This stage was a need analysis activity through:

a. Curriculum analysis

Curriculum analysis is useful to determine the competencies from material development. In this stage, the researcher analyzed the semester learning plan of calculus 2 courses in Riau Kepulauan University and determined the four topics to be developed including indefinite integrals, integration techniques, definite integral and integral applications.

b. Reference analysis

In this part, the calculus textbook were collected, which were relevant to the developed topics materials.

c. Students' characteristic analysis

Based on the analysis result, it can be seen that the second semester students in the academic year of 2017/2018 on Mathematics Education Study Program in Riau Kepulauan University coming from different senior high backgrounds. Some students came from senior high school with science or social concentration and others were from vocational high school majors. It certainly affected the students' initial ability and their learning strategies during Calculus 2 course. Moreover, the reference books which was used, so far, had not been able to facilitate the students for their calculus2 learning because the library collection was very limited comparing to the student number. Moreover, the available reference was also the old version books. In terms of economic condition, most students can be classified as middle to lower class, even many students took part time jobs to fulfill their living needs and to pay tuition fees so that many of them were not able to purchase qualified reference books. The results of informal interviews also indicated that the students expected some learning materials that were easy to understand with familiar language so that it can facilitate them to have independent learning.

d. Peer interview

The peer interviews were done to find out the encountered problems or obstacles during their lecturing process. The results this interview with one of the calculus 2 peer lecturer showed that students did not understand the concept of calculus 2 material well and they did not have a practical handbook. In addition, students did not make extra efforts to find out other references about the material being studied. They tended to just wait and follow the lecturer's explanation from the lecturer, it indicated the learning process run with the lecturer as the center of learning.

2. Prototype phase

This stage contained the activities of designing probing prompting-based module on calculus 2 course based on the results of the defining phase which was appropriate to the students' characteristics of. The module layout consisted of (1) Cover; (2) Foreword; (3) General Review of the course; (4) Instructions; (5) Table of Contents;

(6) Material; (7) Glossary and (8) Bibliography. The material for each chapter included introduction, material description, sample of questions, assignments and final chapter exercises. After the prototype was finished, the next step was to obtain the feasibility assessment of the product. Two validators were Ms. Putri Yulia, M.Pd from IAIN Kerinci and Ms. Yesi Gusmania, M.Pd from UNRIKA.

The evaluation results from the validator showed that the module was feasible to be used, and another validator stated that the module was appropriate to be used with some revision. The feedback or suggestions obtained from both validators are presented below:

- a. There is no cover/ backcover
- b. Margin in the table of contents was not proportional
- c. It should be completed with Preface
- d. Page number was needed in the integral chapter, and the content should be added with the sub-chapter type
- e. Sample questions need to be added

After having discussion with the validators, the researcher revised several parts of the module according to the validators' input, such as adding the back cover, foreword, and more examples of questions for the sake of better students' understanding towards the material concept as an attempt to apply the probing prompting method.

Module validation sheet consisted of two aspects, i.e. the material and the media validation. The material validation sheet contained 33 items with the details of 12 items for the content feasibility, 10 items for presentation feasibility, 9 items for language feasibility and 2 items for probing prompting assessment. Table 4 presented the results of the validity module based on the assessment from the material experts.

Table 4. The assessment results from the material experts

No.	The feasibility aspects	Validators' score	Percentage	Category
1.	Content	39	81,25%	Good
2.	Presentation	34	85%	Good
3.	Language	30	83,33%	Good
4.	Probing Prompting	7	87,5%	Good
	Total Score	110	83,33%	Good

Meanwhile the Media validation sheet comprised 27 items of feasibility aspects. Table 5 presented the validity results of the module based on the media expert assessment.

Table 5. The assessment results from the media experts

The aspects	Validators' score	Percentage	Category
Feasibility	102	94,44%	Very Good
Total Score	102	94,44%	Very Good

Based on the validation results, Table 4 obtained a total score of 110 that can be categorized as "good" for the module feasibility based on the materials aspect with the percentage of 83.33% aspect achievement percentage. Mean while, table 5 obtained a total score of 102 which can be declared as "very good" category for the media

feasibility module with the percentage of 94,44%. According to the established validity criteria, the modules that have been developed can be declared as valid and feasible to be used.

4. CONCLUSION

Based on the analysis, it can be concluded that:

1. The development of probing prompting-based module for Calculus 2 was done through 2 phases from 3 phases of IDI development method, namely the define and develop stages. The module development results included four topics such as indefinite integrals, integration techniques, definite integral and integral applications.
2. The module quality testing from two validators included the feasibility aspects of content or material, presentation, language, probing prompting assessment and media feasibility were obtained the percentage of 81.25%, 85%, 83.33 %, 87.5% and 94.44% respectively. Overall, the feasibility percentage from the material validator was 83.33% that can be categorized as “good” while the media validator was 94.44% that can be categorized as “very good”. Thus, the module that has been produced can be declared as valid and feasible to be used.

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