



Development of Inverse Matrix Module Related to Student's Mathematical Connection Skills

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Article Info	Abstract
Received November 2, 2022	The purpose of this study was to describe the process and results of the development of the matrix Inverse module related to students' mathematical connection skill, as well as to describe the quality of the matrix Inverse module in terms of validity and practicality. The method used was design research with Plomp model, includes the initial research stage, development stage, and assessment stage. The data was obtained from interview, document analysis, and questionnaire. The result of this study showed that developed module was valid based on validation of material experts, media experts, and practitioner. The validation results of this module show that this module was quite feasible to use with a percentage of 80.83% from material experts and 75.93% from media experts, and was quite practical to use with a percentage of 76.90% from the educator's response questionnaire. From the validation results and educator responses, this module can be implemented as a learning resource or teaching material. In conclusion, the Inverse matrix module was declared fit and practical to be used as teaching material and learning resources.
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Development module; Mathematical connection skills; Matrix invers module.	

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INTRODUCTION

Covid-19 pandemic made a lot of changes in various sectors, one of them in the education sector. This pandemic was a special condition that causes different learning lags or learning losses in the achievement of student competencies.

In addition to learning loss, many national and international studies state that Indonesia has also experienced a learning crisis for a long time. These studies found that many children in Indonesia have difficulty understanding simple reading or applying basic mathematical concepts. The findings also show that there was a fairly steep education gap between regions and social groups in the country (Kementrian Pendidikan, Kebudayaan Riset dan Teknologi, 2022).

The Ministry of Education has published an alternative curriculum to overcome this problem. That was a follow up of the learning policy in response to the covid-19 pandemic. Later in February 2022, The Ministry of Education revised the

curriculum to deepen its essence with aim the curriculum was focused on material and development of the student's competencies that according with mental development phase. In other side, with recommendation from Government of Indonesia, the school must develop a simplified curriculum with the principle of diversification in accordance with the conditions of the school, regional potential, and student (Sanjaya & Rastini, 2020).

The curriculum was a competency-based curriculum to support learning recovery by implementing project-based learning. Educational units in school have been able to choose three options for implementing the curriculum. One of those was developing their own various teaching tools in the form of module. The module was a learning plan with the concept of project-based learning. Its aim was to arranged the material according to the phase or stage of student's mental development, to the learning's themes and topics, and to student's long-term development.

Mathematics learning in Indonesia was entering a new paradigm. Curriculum development was directed at achieving all domains in knowledge, not only cognitive domain but also affective and psychomotor domains. It also was to develop students' mathematical power through innovation and implementation of various approaches and methods. The goal was to build confidence in their mathematical abilities through the process of: 1) solving problems; 2) provide inductive and deductive reasons for making, defending, and evaluating mathematical arguments; 3) communicate, convey ideas/ ideas mathematically; 4) appreciating mathematics because of its relevance to other disciplines, its application to the real world (Abidin & Jupri, 2017).

If a topic was given to the student's separately, the learning will lose a moment in an effort to improve student learning outcomes in learning mathematics. Therefore, it was important for students to develop mathematical connection skills in studying mathematics so that they can see the relationship between one topic and another (Romiyansah, Karim, & Mawaddah, 2020). Furthermore, students will lose the moment to improve their learning outcomes if the mathematics topic that given to them were independent. Therefore, it was very important for students to understand the relationship between one topic and other topics that were interconnected in learning mathematics. Understanding or seeing the relationship between one topic and another was one of the mathematical connection skills.

One of the subjects that was closely related to mathematical connection skills was the matrix and vector course. In this course, there are several topics require mathematical connection skills such as connecting a problem to a mathematical model, solving a mathematical model, and reasoning in concluding a solution (Fitriawan, 2020).

Based on the facts found by researchers from document studies and interview results at the Mathematics Education Study Program, the achievements of students that learning in matrix and vector algebra courses was relatively low. This was evidenced by the results of the mid-semester exams where the class of 2019 has an average score of 81.93, the class of 2020 has an average score of 62.12, and the class of 2021 with an average score of 49.76. The result showed a declining trend every year. In addition, the last class of 2021 showed the lowest score in according to the assessment system in the university. These values were obtained from the Inverce matrix problems in exam which contains one of the mathematical

connection skills, namely the relationship between one topic and another topic. Some of the factors were student's experience distance learning that caused learning loss during Covid-19 pandemic, learning activity that carried out only through Whatsapp Groups, and the unavailability of teaching materials in accordance with the needs of students and curriculum development.

The results of the cognitive diagnostic tests that conducted on students on the Inverse matrix material related to mathematical connection skills shown an average value of 17.67 on a scale of 0-100. In according to Arikunto (2010), this shows that the students' mathematical connection skill in Inverse matrix material was still relatively low.

Based on theoretical studies and problems obtained in the field, the low students' mathematical connections skills were due to the unavailability of teaching materials. Yet according to Andesta, Lestari, & Pratiwi (2021), the availability of teaching materials can improve learning outcomes. Therefore, in this study the researcher wanted to describe the process and results of the development of the Inverse matrix module related to students' mathematical connection abilities, as well as describe the quality of the module in terms of validation and practicality, so that it was hoped that it can be an alternative learning resource that can be used.

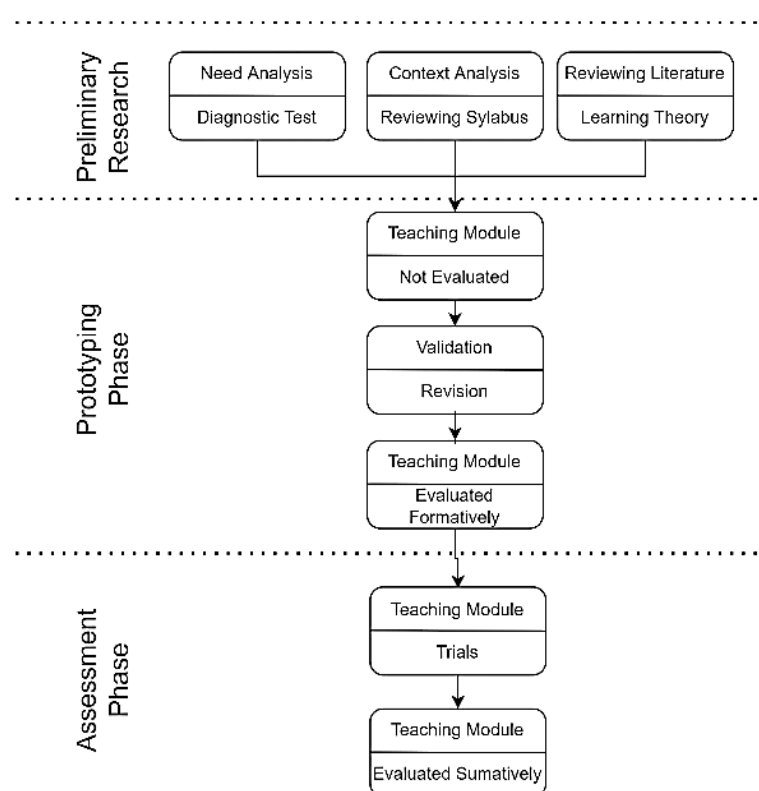


Figure 1. Flowchart of Design Research Steps with Plomp model

RESEARCH METHODS

This study was used Design research methode. Design research can be used for research that has a function to design or to develop an intervention with the aim of solving complex problems in the field of education (Plomp & Nievee, 2013; Plomp,

2007). The development design used in this research is the Plomp model design. The Plomp model was chosen because the model more flexible than other models. The Plomp development model consists of three stages, namely the preliminary research phase, the prototyping phase, and the assessment phase. However, this research has implemented only to the preliminary research phase (initial research phase) and the prototyping phase (development phase). The subjects of this study were high school mathematics teachers and lecturers in mathematics education at the Universitas Islam Nusantara.

The research and development trial design was carried out in three stages, that is: 1) the validation of material and media expert that intended to obtain product validity, 2) product practicality tests given to educators, and 3) the effectiveness of the module that would be given to students in the form of evaluation questions. The product trial in this research and development was carried out on a small group of students of mathematical education at the Universitas Islam Nusantara. The overall research and development stages of the module can be seen in Figure 1.

The score guide for validation was using Likert scale with four alternative score that displayed on Table 1 (Source: Mukholifa, Tisngati, & Ardhyantama, 2020).

Table 1. Scoring Guide Validation

No	Score Scale	Score
1	Very Good	4
2	Good	3
3	Not Good	2
4	Very Not Good	1

Validation Analysis

The analysis of validation was determined by:

- a. Evaluate the score of validation using formula (Rohmaini et.al, 2020).

$$\text{Validity} = \frac{\text{Total score obtained}}{\text{Total score maximum}} \times 100\%$$

- b. The result then categorized to validation criteria which is displayed on Table 2 (Source: Fatmawati, 2016).

Table 2. Validation criteria

No	Score (%)	Validation criteria
1	85,01 - 100,00	Very Valid
2	70,01 - 85,00	Quite Valid
3	50,01 - 70,00	Not Valid
4	01,00 - 50,00	Invalid

Practicality Analysis

The result of practicality analysis of module obtained from mathematics teacher and mathematics lecturer in the form of questionnaire. The analysis of practicality was determined by:

- a. Evaluate the score of practicality using formula that adopted from by Sudjono (in Rahma, Laila, & Saidah, 2022):

$$\text{Practicality} = \frac{\text{Total score obtained}}{\text{Total score maximum}} \times 100\%$$

- b. The result then categorized to practicality criteria that shown on Table 3 (Source: Rahma et al., 2022).

Table 3. Practicality criteria

No	Score (%)	Practicality Criteria
1	85,01 - 100,00	Very Practical
2	70,01 - 85,00	Quite Practical
3	50,01 - 70,00	Not Practical
4	01,00 - 50,00	Impractical

RESULT AND DISCUSSION

The result of the initial research indicates that the student's score on the Inverse matrix material related to mathematical connection skill was not good. The learning resources used are also only books written by Howard Anton in 1997 and Dr. Ruminta and lessons are given via Whatsapp Group. Thus, it was relatively easy to understand by students and according to the demands of curriculum development.

The learning resource developed was in the form of an Inverse matrix module related to the students' mathematical connection skill. The process was carried out through the plomp model. Students' mathematical connection skills were discussed further in the third phase. The following are two stages of research and development of the plomp model.

Preliminary Research Phase

At the preliminary research phase, there are two steps of analysis, namely needs analysis and context analysis. At the needs analysis step, it was carried out through document analysis, questionnaires, and cognitive diagnostic tests to students regarding the mathematical connection skills in Inverse matrix material and conducting interviews with lecturers of matrix and vector algebra courses related to the learning process and student achievement on Inverse matrix material. Meanwhile, at context analysis step, it was done by analyzing the Inverse matrix material syllabus, learning outcomes, mathematical connection skill indicators, and learning model syntax that was adapted to the material.

Prototyping Phase

At the prototyping phase, the researcher collects information that supports the development of the Inverse matrix module. The collected data has been integrated to the module. The initial product written in the form of a temporary module draft. Then, the module will be designed iteratively as perfect as possible by carefully matching the components of the module for suitability to the curriculum. The following was display of the cover page and its component of the module that was developed as shown in Figure 2.

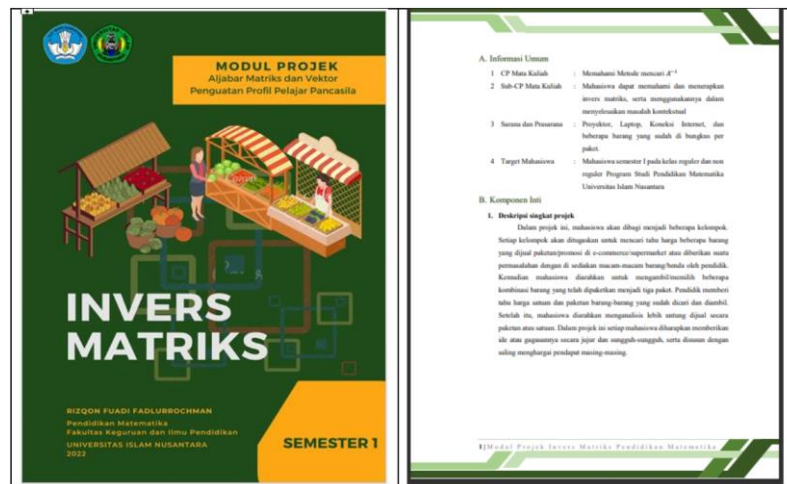


Figure 2. Cover and Component's Module

Validation of the Development of Inverse Matrix Module Related to Student's Mathematical Connection Skill

After the module was designed, the researcher validates the initial product to material experts and media experts. The validators of material experts and material experts are mathematics education lecturers and high school mathematics teachers. Expert validation results are used as initial product suggestions or improvements. The module validation steps are as follows.

a. Material Expert Validation

The validation consist: (1) aspects of content or material feasibility, (2) presentation feasibility, and (3) language feasibility. Mathematical connection skills are integrated into examples and evaluation test questions. The material expert validator checks whether or not mathematical connection capabilities are integrated into the module. Validation data was obtained by using a questionnaire. The results of material expert validation can be seen in Table 4.

Table 4. The Result of Material Expert Validation

No	Aspect	Mean Score (%)	Criteria
1	Content Feasibility	79.58	Quite Valid
2	Presentation Feasibility	83.88	Quite Valid
3	Language Feasibility	77.56	Quite Valid
Total		80.83	Quite Valid

Based on Table 4, the result has an average score of 80.83% with quite valid criteria. That mean the developed module was declared feasible to be used as teaching materials and learning resources.

b. Media Expert Validation.

The Validation was carried out after the product was finished. That was carried out to determine the feasibility of the media listed in the Inverse matrix module. The assessment that was carried out by media experts consist of; aspects of module size, module cover design, and module content design. The experts filled out the

validation sheet that had been provided by the researcher. The results of media expert validation can be seen in Table 5.

Table 5. The Result of Media Expert Validation

No	Aspect	Mean Score (%)	Criteria
1	Module Size	75	Quite Valid
2	Cover Design	75	Quite Valid
3	Design Module	76.38	Quite Valid
Total		75.93	Quite Valid

Based on Table 5, the result has an average score of 75.93% with quite valid criteria. That mean the developed module was declared quite feasible to be used as teaching materials and learning resources.

Based on the description of several validations as a whole, both material expert and media expert validation, the results of the Inverse matrix module validation related to mathematical connection capabilities can be seen in Figure 3.

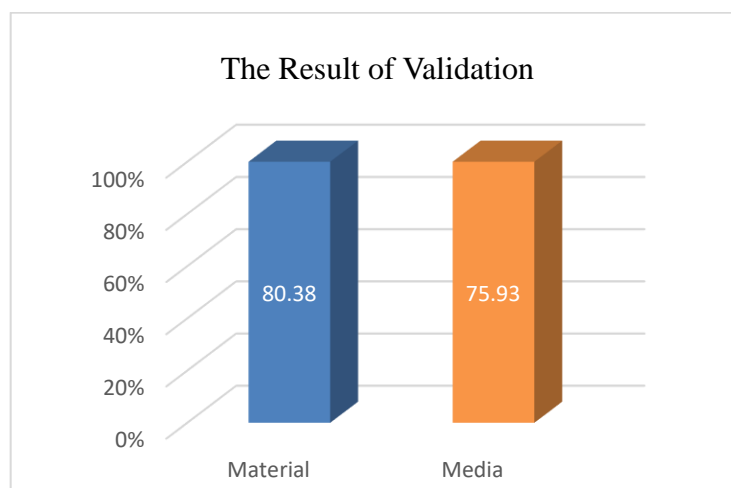


Figure 3. The Result of Validation of Material and Media Expert Overall

Practicality of Inverse matrix Module Related to Student's Mathematical Connection Skills

The practicality test was used to determine the practicality of the Inverse matrix module that developed. That was carried out by high school mathematics teachers and mathematics education lecturers at the Universitas Islam Nusantara in the form of questionnaire. The result of practicality test was shown as follows.

Based on Table 6. The result has an average score of 76.90% with quite practical criteria. That mean the developed module was declared quite practical to be used as teaching materials and learning resources.

The product produced in this research was a Inverse matrix module related to students' mathematical connection skills. The modules used as teaching materials in studying matrix Inverse material were developed by reviewing the conditions of curriculum development and learning conditions. Conditions were analyzed through preliminary studies which included field studies and literature studies. Field studies were carried out through interviews, distributing questionnaires, and formative tests to students to find out how learning was being carried out, whether

or not products were being developed, and the level of student and educator needs for the products being developed.

Table 6. The Result of Practicality Test

No	Indicator	Mean Score (%)	Criteria
1	Cover Page	75	Quite Practical
2	Clarity of Tables/Illustrations/Pictures	75	Quite Practical
3	Language and Sentence	75	Quite Practical
4	Writing Clarity	80	Quite Practical
5	Color Composition	75	Quite Practical
6	Module Content	80.33	Quite Practical
7	Motivate to respond to learning	70.80	Quite Practical
Total		76.90	Quite Practical

The development of the Inverse matrix module related to the student's mathematical connection skills that have met valid and practical criteria was due to the following factors. First, the developed module was designed according to the characteristics of project-based learning and mathematical connection skills so that it can see the interrelationships between topics and understand topic relationships in the real world. Second, the problems presented were problems that are known to be close to everyday life. Presentation of material that connects students to provide an overview of the benefits of the material so as to make learning mathematics more meaningful in students' memory and thinking power. This was in accordance with what was stated by Triyanto (in Widyaningrum, Sarwanto, & Karyanto, 2013), that meaningful learning will not be realized if students only listen to lectures from the teacher. Third, the developed modules were arranged in a unified whole and are interconnected. In addition, the feasibility of the content, the feasibility of presentation, and the eligibility of language that was easy to understand, as well as the module design make the module practical for use in learning. The findings of this study were in line with previous studies (e.g. Fitriawan, 2020). The matrix Inverse module produced in this study was expected to enrich teaching materials for educators, especially in order to increase students' active participation in learning mathematics.

The advantages of this Inverse matrix module were that it was easy to share for anyone to access at any time, it was easy for developing further learning resources, the flexibility of this learning resource because it can be used and changed based on the needs of educators and students, the examples of questions presented in real contexts, and can be used independently by students. The drawback of this module was that it can be accessed only via devices such as laptops and cell phones.

CONCLUSION

Based on the results of the study, it was found that the Inverse matrix module related to the student's mathematical connection skill was declared quite feasible to be used as teaching materials and learning resources in mathematics learning by overall average score of 80.38% from material experts and 75.93% of media experts. The results of the practicality test of the module from the validator has an average score of 76.90% and the criteria is quite practical. It was hoped that the developed module

can contribute to developing student knowledge and used in learning activities to improve student's insight.

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