

The Development of Mathematics Student Books Using Matlab Software on Numerical Methods Courses

*Nurul Novita Sari¹, Suradi Tahmir², Hamzah Upu³

¹Postgraduate Program UNM, Makassar, Indonesia

² Department of Mathematics, Universitas Negeri Makassar, Makassar, Indonesia

³ Department of Mathematics, Universitas Negeri Makassar, Makassar, Indonesia

* Email : nurulnovitasari96@gmail.com

ABSTRACT

This research aimed to develop valid, practical, and effective mathematics students' books for numerical methods assisted by Matlab software. The type of this study used was *Research and Development* refers to the ADDIE development model, which consisted of 5 steps, namely: (1) Analysis;(2) Design;(3) Development;(4) Implementation, and (5) Evaluation. The study subjects were students of mathematics education classes 3-4 in 2020/2021 at UIN Alauddin Makassar. Products developed in the form of students' books which contain material in numerical method program was equipped with Matlab syntax that can help the students. The instruments used in this research were validation sheets, observation sheets for the implementation of mathematics students' books, questionnaires of students' responses, observation sheets of student activity, and student learning outcomes tests. Based on the results of the trials obtained: (1)Validation results for student books and all research instruments are 4.7, categorized as "very valid." (2) Practically based on the average overall aspect of the mathematics student books implementation sheet in all categories are 1.96. Then the percentage of student response questionnaires for all aspects are 93.35 in the very positive category, (3) Effective based on the result of observations student activities using mathematics student books assisted by Matlab software in the very good category with an average of 85.21% and student learning outcomes showed that of 37 students joined the test there are 89.18% of students who complete the test and 10.81% were failed. It can be concluded that the development of the use mathematics student books by Matlab software of numerical method courses have met the criteria of validity, practicality, and effectivity.

Keywords: *Student books, numerical method, Matlab software.*

1. INTRODUCTION

Technology and science are two interrelated things and influence one another to improve human resources in a nation. One of the efforts made to improve human resources is to increase the quality of education [1]. Education has a very important role in improving the quality of human resources. The law on the National Education System (*Sisdiknas*), for instance, is to show the strategic role of education in the formation of quality human resources. Education functions to develop capabilities and shape the character and civilization of a dignified nation in the context of educating the nation's life, and aims to develop the potential of students to become human beings who believe and fear to God Almighty, have good character, personality, advanced, intelligent, creative, active, skilled, disciplined,

professional, responsible, and productive [2]. The purpose of education is to develop students' self-potential so that they have good morals to be helpful for society, nation, and state.

Mathematics, as one of the subjects, has an essential role in education. Universal science that underlies the development of modern technology is a science that is indispensable for developing logical, systematic, and critical thinking skills in students. In addition, everyone needs mathematics, especially students, to support their learning success in pursuing higher education [3]. Therefore, mathematics subjects need to be given from an early age to college because with mathematics; students can develop logical, rational, critical, and creative and solve problems through mathematical mindset is expected to face the time [4].

The essential ability that students must possess is solving mathematical problems and is characterized by fundamental problems in learning mathematics. Students as prospective educators must learn to increase their creativity in solving a problem encountered in the learning process. However, it should be realized that students' abilities are different. The learning process is so monotonous. The use of teaching materials from year to year has never changed, making students less interested in learning and impacting student achievement. One way that can be conducted by an educator in solving mathematical problems to create an optimal learning process is by developing the student books used where development is defined as a change slowly and gradually as a process of developing towards perfection or is expected to change for the better [4]. The optimal learning process is the use of teaching materials, especially student books.

Teaching materials are all forms of materials used by teachers in the learning process to achieve a learning goal, the teaching materials in question can be written or unwritten teaching materials such as Hand Outs, books, modules, student worksheets (LKS), radio, CD cassettes, student books, etc. [5]. Teaching materials, especially student books, have a very important role in the learning process, which is used to assist lecturers in carrying out teaching and learning activities in the classroom [6]. Everything that supports the success of the learning process needs to be considered in realizing the function of the book, such as the steps for selecting learning materials, considering the concept of material, type, and others [7].

The use of specific *software* in the developed book will make the teaching and learning process more efficient and accessible for students to solve existing problems[8]. However, in reality, in the numerical method course, a particular course for mathematical problems that cannot be solved precisely, many lecturers are only fixated on existing books. They do not take advantage of current technology. In addition, the observation results say that one of the difficult subjects to understand is numerical methods because it requires techniques in formulating mathematical problems to be solved by calculation operations. Solving the questions also requires a long explanation with a very long time if done manually. Many materials will be studied, and students must have accuracy, thoroughness, and problem-solving skills. For example, in the interpolation material, in determining the value of the interpolated polynomial, algebraic manipulation is carried out to find out the new point of a function whose calculations require accuracy with a long time depending on the given point.

Furthermore, in the numerical derivative material, in finding the approximate value of the derivative function, accuracy and accuracy are also required in completing calculations and other materials. To solve the problem on the material, only using Microsoft Office Excel software to make it easier for students, but its use is limited to certain materials such as systems of linear equations and non-linear equations, so solving other material problems will be challenging. This is also because the student books for numerical method courses assisted by the software are still lacking and challenging to find in the campus area.

One solution to improve the learning outcomes of numerical methods courses is to utilize existing technology. The presence of computer technology today has made it easier for various parties to use it in life, including education, to support education. This is because using a computer can increase the efficiency of a job due to its advantages. These advantages include doing work quickly and precisely, especially in the learning process[9]. The use of technology in mathematics is very broad, both as a medium of learning in schools in calculating and as a medium for independent learning. Learning mathematics, such as linear algebra, numerical methods, linear programming, and other courses using *software* such as Maple, Matlab, SPSS, and others, is very useful and good to use[5]. One of the computer software that can be used in learning numerical methods is *Matlab software*.

Matlab software is a high-level programming language where students implement a range of numerical methods and optimization techniques through group-based projects (teamwork) to gain hands-on experience in solving numerical problems with modern scientific computing[10]. Matlab software can increase speed and accuracy in various calculations in numerical method material so that the time needed to work is more efficient [9]. And can solve mathematical concepts that can be described using Matlab, such as matrices, vectors, linear algebra, interpolation, integrals, and ordinary differentials [11]. Some researchers experienced that the development of Matlab-based teaching materials based on analysis results and student responses has reached a step close to needs. Matlab software is proven to be practical for students to use [12]. And Zuhendri's research concludes that using the Matlab program is very effective for linear algebra lecture activities and can be used to increase the speed and accuracy in various calculations in linear algebra material so that the time required to solve problems is more efficient and the results obtained are more accurate than calculations which are done manually [5].

Given the importance of using computer-assisted students books in the learning process, this article describes the results of developing *Matlab software-assisted* student books to measure student learning outcomes and see the quality of valid, practical, and effective teaching materials.

2. RESEARCH METHODS

This article is Research and Development (R & D) using the ADDIE development model. The 5 steps of this model are Analysis, Design, Development, Implementation, and Evaluation. The product developed in this research is a student book for students' numerical methods course using Matlab software. This study's subjects and test sites were students of the Mathematics Education Department for Mathematics class 3-4 for the 2020/2021 academic year, conducted at UIN Alauddin Makassar. The data collection instruments used are: (a) Validation sheets are used to measure the validity of student books and all research instruments used, (b) Implementation sheets of student books using Semester Learning Plans by applying the STAD (Student Team Assisted Divison) type cooperative learning model and student response questionnaires to measure the practicality of the teaching materials, (c) learning outcomes tests, namely 5 number essay tests and student activity observation sheets used to measure the effectiveness of the teaching materials developed. The data that has been collected is then analyzed quantitatively to explain the validity, practicality, and effectiveness of the *Matlab software-assisted* teaching materials that have been developed. The data from the trials conducted in classes 3-4 for the 2020/2021 academic year were used to explain the effectiveness and practicality of the teaching materials.

3. RESULT AND DISCUSSION

The development process of student books assisted by *Matlab software* is in the numerical method course for students of the Mathematics Education Department for class 3-4 the academic year 2020/2021 UIN Alauddin Makassar. The development of student books assisted by *Matlab software* in the numerical method course is carried out by applying the ADDIE development model. Here is a brief discussion.

3.1 Analysis.

The analysis is carried out to determine the fundamental problems needed before developing student books or teaching material. At this step, student needs, student analysis, and analysis of the materials are carried out by collecting and analyzing supporting information to plan activities that will be carried out in the next step.

3.2.1 Analysis of Student Needs

This step is the first step carried out in this research. The activity carried out is to analyze the problems that occur in the teaching and learning process, such as the learning process, which is not only centered on the lecturer but is expected to be able to involve students so that they are always active in the learning process and the lecturer only as a facilitator in delivering material. This statement is in line with the behavioristic view where learning activities prioritize changes in student behavior as a result of the stimulus and response, and also learning is the transmission of knowledge where the lecturer is the provider and distributor of information to their students which has an impact on student learning outcomes obtained later[13]. In addition, the use of student books in this course is still not provided by supporting lecturers; the available teaching materials are still lacking. Moreover, student books and teaching materials that utilize computer technology can significantly assist in solving problems given by lecturers so that student achievement increases. Researchers get a solution for what students need, namely the need for a numerical method student book using Matlab software that is in accordance with the characteristics of current students, which can improve student learning outcomes.

3.2.2 Instructional Analysis

After analyzing student needs, the next step of analysis is to conduct instructional analysis. Instructional analysis or analysis of the materials is carried out by analyzing the subject matter in the numerical methods course taught to the fifth-semester students, which consists of systems of linear equations, non-linear equations, interpolation, numerical derivatives, and numerical integrals. At this step, an analysis is carried out where whether these materials have a relationship between one material and another or not and which material will be discussed first.

3.2.3 Analysis of Student

Students who are the subject of this research are students majoring in mathematics education class 3-4 in 2020/2021 semester V. In student analysis, the researcher examines students' background knowledge, and the activities carried out during the learning process. Based on the researcher's observations, it was found that in the learning process in the numerical method course, students were less active and even tended to be passive when the lecturer gave material and still needed tools to solve complex numerical method problems.

3.2 Design.

The next step is the planning step. The design of teaching materials begins with designing student books assisted by Matlab software, namely selecting the title of

the book to be developed, designing student books, and determining what numerical method materials will be included which will be equipped with Matlab syntax and designing RPS (semester learning plans) and learning outcomes tests.

3.2.1 The title selection of the student books to be developed.

3.2.2 Design of student books

At this step, the student books compiled consist of titles, introductions, table of contents, concept maps, introductions, introduction to Matlab, material descriptions, general Matlab syntax, sample questions, evaluations, and bibliography.

3.2.3 Design of RPS ((Semester Learning Plans) and THB (study result test).

In addition to designing teaching materials, researchers also developed RPS (Semester Learning Plans) and learning outcomes tests. At this step, the researchers compiled lesson plans and learning outcomes tests. The preparation of the RPS contains the steps that will be taken during the learning process. In contrast, the preparation of the learning outcomes test is an evaluation tool used by lecturers to measure the success of the learning process. Learning planning is very important for educators to do before teaching. This aligns with Hamid Darmadi asserting that learning planning aims to encourage educators to be better prepared to carry out learning activities with careful planning. Every time they carry out compulsory learning, educators prepare everything that supports learning activities in the classroom because, without planning and preparation, it will only damage mentally and morally[14].

3.3 Development.

At this step, the aim is to produce mathematics student books assisted by Matlab software. Books are arranged in such a way with specifications in the form of print media, displayed with an attractive appearance in accordance with the student book display design that has been determined in the previous step, namely the design step. This student book is compiled by applying Matlab syntaxes, which can perform mathematical computations easily and quickly without requiring a complex computer programming language. The preparation of student books in the form of print media consists of 6 chapters. Chapter 1 explains the introduction of Matlab software, a guide to using Matlab and basic operations that are often used in mathematics, while Chapter 2-6 contains material taught in numerical methods courses including systems of linear equations, non-linear equations, interpolation, numerical and integral derivatives numeric which are equipped with Matlab syntax according to the material being taught. The materials presented are provided with evaluation

questions at the end of the chapter to hone students' abilities based on their understanding. In addition to developing student books, the preparation of lesson plans, learning outcomes tests, and other research instruments include implementation sheets of teaching materials, student response questionnaires, and student activity sheets. Student books and other instruments that have been developed and met the lecturers' requirements before being used in the teaching and learning process are first validated by the two validators. The validation process was carried out 2 times by taking into account the suggestions and comments of the two validators with an interval of $4.3 \leq M \leq 5$. The validation results carried out for the entire instrument are 4.7, which are in the very valid category based on a predetermined interval range.

Table1. The Validation Results Summary

| Resource | Mean | Criteria |
|------------------------------------|-------------|-------------------|
| Student Book | 4,7 | very valid |
| Semester Learning Plans | 4,7 | very valid |
| Student Books Implementation Sheet | 4,5 | very valid |
| Student Response Questionnaire | 4,7 | very valid |
| Student Activities | 4,7 | very valid |
| Test Results | 4,7 | very valid |
| Total Average | 4,7 | very valid |

The results above show that student books, RPS (semester learning plans), learning outcomes tests, student response questionnaires, student activity observation sheets, and student book implementation sheets are feasible to test.

3.4 Implementation.

Student books and instruments that have been previously declared valid are then tested on students of the Mathematics Education Department for math class 3-4 for the 2020/2021 academic year as many as 37 students to meet the criteria for practicality and effectiveness student books. The trial activity was carried out for 2 meetings, including the provision of THB. The practicality of student books can be seen from the results of observations of the implementation of student books observed by two observers and student response questionnaires. While the effectiveness of teaching materials can be seen from the student activity observation sheet, which consists of 7

aspects of the assessment and learning outcomes test, consisting of 5 essay questions.

Table 2. Practical Test Results of student books

| The Assessment Sheet | Average Rating | Category |
|---|----------------|------------------------|
| Implementation of student books with the STAD model | 1.96 | Completely implemented |

The table above shows the average result of observing the implementation of Matlab software-assisted student books in the numerical method course, including the syntax component of the STAD (Student Team Assisted Division) cooperative learning model, social interaction, and reaction principle are 1.96. interval ($1.5 \leq M \leq 2$), which means it is in the category of being carried out thoroughly.

In addition to the implementation sheet of student books, student response questionnaires also support the practicality of teaching materials given to 37 students after being tested by following the whole series of numerical method learning using student books assisted by *Matlab software*. The analysis results show that the percentage of student responses is 93.35%, meaning that the student books are in the practical category to use. In contrast to the research conducted by Rikayanti, which showed that when conducting the test, the student's response had reached a step that was close to the need, meaning that it did not meet the practical requirements for future use, while the results of the research I did had met the criteria for practicality and were feasible to use. The advantages of the student books that I have developed are in the book's made content. The explanation of the examples given is done manually then compared with the results done with the help of Matlab to provide more understanding for students. Another advantage of this book is the introduction of the software used, namely the *Matlab software*, a guide to the use of the software and simple arithmetic operations in the first chapter of this book so that readers who are not familiar with *Matlab software* have an initial picture before being associated with numerical method materials.

Table 3. Test the Effectiveness of Teaching Materials

| Numb. | The assessment sheet | Evaluation | Category |
|-------|-----------------------|---|-----------|
| 1. | Learning Outcome Test | 89.81% of students are in the complete category | Effective |

| | | | |
|----|--------------------|---|-----------|
| 2. | Student activities | The average student activity from 7 aspects of the assessment is 85.21% | Effective |
|----|--------------------|---|-----------|

Based on the table above, information is obtained that from 37 students who took part in the trial of the student books developed, there were 33 students or 89.81% of students meeting the criteria for completeness and 4 people or 10.18% of students not completing learning mastery, seen from student learning outcomes test scores have met the requirements for student effectiveness. The analysis of student activities from 7 aspects of the assessment carried out during the learning process through observations by 2 observers amounted to 85.21 in the very good category with a range of $80 \leq P \leq 100$.

3.5 Evaluation

This step is the last step of this research. At the evaluation step, revisions are made based on suggestions and criticisms from users of teaching materials to complement the student books that have been developed. The revisions made were minor revisions or no significant changes in the student books developed. An important evaluation is carried out to determine the development's effectiveness and provide value to what was set [15].

4. CONCLUSION

The development process of student books using the ADDIE model consists of 5 steps: analysis, design, development, implementation, and Evaluation. A valid, practical, and effective student book was obtained based on the test results of the numerical method student book using the Matlab software. Books and research instruments that were validated were in the very valid category with an average of 4.7. This valid student book is then applied in the learning process using semester learning plans with the STAD Type Cooperative learning model syntax to see the practicality and effectiveness of student books. The developed student book is stated to be practical by looking at the student response questionnaire analysis results, which is 93.35%, and the student book implementation sheet for the three aspects is in the fully implemented category. The effectiveness of the student's book is seen from the results of the analysis of the learning outcomes test of 5 essay questions shows that the percentage of student learning completeness is 89.18%, and the percentage of incompleteness is 10.81%. In addition, the percentage of student activity is 85.21%.

REFERENCES

[1] A. Dhoruri and dkk, "Upaya Peningkatan Kualitas Pembelajaran Kalkulus Diferensial

- Dengan Menggunakan Program Maple Pada Mahasiswa Prodi Matematika Fmipa Uny,” *Pythagoras J. Pendidik. Mat.*, vol. 3, no. 1, 2007.
- [2] H. tatang, “Pembelajaran Berbasis Masalah Untuk Meningkatkan Kemampuan Berpikir Matematis Tingkat Tinggi Siswa Sekolah Menengah Pertama,” vol. 1, no. 1, pp. 47–56, 2017.
- [3] Y. P. Kusumaningtyas and dkk, “Eksperimentasi Model Pembelajaran Think Talk Write (Ttw) Dan Numbered Head Together (Nht) Terhadap Prestasi Belajar Matematika Ditinjau Dari Konsep Diri Belajar Matematika Siswa Di Smp Negeri E-Kabupaten Blera,” *J. Elektron. Pembelajaran Mat.*, vol. 2, no. 2, p. 106, 2014.
- [4] R. Amalia, “Pengembangan Bahan ajar Matematika Berbasis Penemuan Terbimbing pada Pokok Bahasan Bangun Ruang Sisi Lengkung Kelas IX SMP/MTS,” UIN Alauddin Makassar, 2017.
- [5] Zuhendri, “Pengembangan Bahan Ajar Mata Kuliah Aljabar Linear Berbantuan Matlab,” *J. Cendekia J. Pendidik. Mat.*, vol. 1, no. 1, pp. 122–134, 2017.
- [6] S. Amri and I. Khoiru, *Konstruksi Pengembangan Pembelajaran Pengaruhnya Terhadap Mekanisme dan Praktik Kurikulum*, 1st ed. Jakarta: Prestasi Pustaka, 2010.
- [7] Y. Muhammad, *Prinsip-Prinsip Desain Pembelajaran*. Jakarta: Kencana, 2013.
- [8] N. D. Rosalina, “Pengaruh Software Matlab Terhadap Minat Belajar siswa pada Materi Matriks di Kelas X SMKN 2 Karang Baru Aceh Tamiang TA 2013/2014,” Sekolah Tinggi Agama Islam Negeri (STAIN) Zawiyah Cot Kala Langsa, 2014.
- [9] B. Cahyono, “Penggunaan Software Matrix Laboratory (Matlab) Dalam Pembelajaran Aljabar Linier,” *J. Phenom.*, vol. 1, no. 1, pp. 45–62, 2013.
- [10] P. Z. Lappas and M. N. Kritikos, “Teaching and Learning Numerical Analysis and Optimization : A Didactic Framework and Applications of Inquiry-based Learning,” vol. 8, no. 1, 2018.
- [11] D. Nasution, Mara Doli, “Pengembangan Bahan Ajar Metode Numerik Dengan Pendekatan Metakognitif Berbantuan Matlab,” *J. Mosharafa*, vol. 6, no. 1, pp. 68–80, 2017.
- [12] Rikayanti, “Pengembangan Bahan Ajar Berbasis Software Matlab Pada Mata Kuliah Metode Numerik,” *J. Res. Math. Learn. Educ.*, vol. 2, no. 2, pp. 95–108, 2017.
- [13] N. I. Nahar, “Penerapan Teori Belajar Behavioristik Dalam Proses Pembelajaran,” *Ilmu Pengetah. Sos.*, vol. 1, p. 64, 2016.
- [14] M. J. Dolong, “Sudut pandang perencanaan dalam pengembangan pembelajaran,” vol. V, p. 76, 2016.
- [15] A. R. Putra and J. Manoy, “Pengembangan Media Pembelajaran Berbasis Information and Communication Technology dengan Software Macromedia Flash 8 pada Materi Segiempat,” *Ilm. Pendidik. Mat.*, vol. 3, no. 5, 2016.