The Development of Teaching Materials of Numerical Methods by Using Matlab Software

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Abstract: This study is based on the lack of teaching materials of numerical methods that use software on learning. This study aims to develop the teaching materials of numerical method by using MATLAB (Matrix Laboratory) program that can be used to help students on calculations and to determine whether the problems of Numerical Methods having the solution or not. The use of MATLAB programs can also save the processing time and solving the problem effectively. This study used Research and Development methods through 7 steps, namely (1) Potential and problem, (2) Collecting the information, (3) Designing the product, (4) Validation of design, (5) Repairing the design, (6) Trial the product, and (7) Revision of product. The data were collected through literature review and analyzed qualitatively, then the data were validated by two validator to perfect the teaching materials and the developed programs. The products of this study is a set of teaching materials of Numerical Methods incorporating with MATLAB software that can be used on Numerical Methods subject in the Department of Mathematics Education and Teaching of Science Faculty Tarbiyah UIN Syarif Hidayatullah Jakarta.

Keywords: Research and Development, Teaching Materials of Numerical Methods, MATLAB software

1. Introduction

Mathematics is very important in human life because it can train the intellect of human in order to be able to think logically, systematically, critically, and analytically. Numerical Methods subject is a compulsory subject that is presented in the sixth semester in the Department of Mathematics Education and Teaching Faculty Tarbiyah Syarif Hidayatullah State Islamic University Jakarta. This subject is an introduction to understanding the concepts of numerical calculation, which is provided to students who have mastered the calculus of one variable functions and understand one of computer programs. This subject aims to help students to gain the intuitive understanding about some numerical methods for basic problems in mathematics; mastering the concepts of error, analyzing and estimate it; developing the experience on implementing the numerical methods by using computer. The achievements of learning are (1) Applying the concepts and principles of mathematics calculations numerically in mathematical problems in daily life, (2) Mastering the concepts and principles of mathematical calculations numerically and science technology to implement the learning in financial mathematics, physics and engineering, (3) Making the strategic decisions based on the relevant information and data.

Murni (2012 : 1) stated that numerical method is a technique used in the formulation of mathematical problems that can be solved with arithmetic operations plus, minus, times, and division. The type of counting is divided into direct counting and indirect counting/iterative. The direct counting is the obtained solution through the series of counting, while the indirect counting is the direct counting which carried out repeatedly. The results of indirect counting formed a line leading to an expected value, but it does not rule out the possibility that the results of the iteration does not exist.
or in other words not having a solution, and the solution can also be obtained after doing a lot of iterations. Therefore, the calculation manually is very drab especially if miscalculations in the first iteration, then the others will be wrong. Therefore, the indirect counting should have the initial guesses, the iteration scheme (formula) and the iteration stopping criterion. The calculation must be done carefully and thoroughly.

The syllabus of numerical methods subject in UIN Syarif Hidayatullah Jakarta presented material of error, iteration, the roots of nonlinear equations, interpolation, system of linear equations and integration. The emphasizing is given on understanding the numerical method. Each topic is started with the underlying theory. The detailed examples guiding students in the calculations for algorithm understanding. On the application of computer programming, presenting of algorithms used pseudo code that can easily be translated into a programming language.

Based on the above explanation, we need a software application to handle it. One of the software applications that can be used to solve the problem of numerical methods is MATLAB. MATLAB (Matrix Laboratory) is a program for analysis and numerical computation and an advanced mathematical programming language which is formed by using the premise of characteristic and form of matrix. The role of numerical methods on solving problems is also increasing with the fast development of digital computers especially software, so that the numerical methods are able to handle the system of linear equations, non linear and complex geometry which is often impossible to solve analytically.

The prerequisite subject before taking this subject is Computer I that uses MATLAB software, so that its application in study of Numerical Methods can be directly applied. Students can also create the curves correctly (not only painted sketch) by using MATLAB software, so it can be seen whether the numerical methods have solution or not. Therefore, MATLAB software is suitable for use on subject of Numerical Methods.

Based on the above description, the researchers want to develop the teaching materials of Numerical Methods by using MATLAB software, so this study entitled “The Development of Teaching Materials of Numerical Methods by Using MATLAB Software”. This study aims to produce a product in the form of teaching materials of Numerical Methods by using Matlab software.

2. Literature Review

2.1. Research and Development

Sukmadinata (in Haryati, 2012) stated that research and development is a research approach to produce the new products or enhance the existing products. The form of product can be software or hardware such as books, modules, packages, learning programs or study aids. Research and development is different with the usual research that only generates suggestions for improvement, research and development produces the products that are used directly. Additionally, Sugiyono (2015) said that Research and Development is a research method that is used to produce a particular product, and to test the effectiveness of product. To produce the certain products, the research must have the requirement analysis. To test the effectiveness of product in order to have function in society at large, it is needed the research to test the effectiveness of that product. So the research and development is longitudinal (multi years).

The steps of research and development by Sugiyono (2015) are as follows:

a. Potential and problems. Data about potential and problems do not have to look for by yourself, it can based on the other people's research reports, reports or documentation of activity individuals or institutions that are still up to date.

b. Collecting the information. After the above steps done, the collected information can be used as material for planning the expected specific products to solve the problem.

c. Designing the product. The product design should be formed in the image or chart, so it can be used as a handle to assess and create it.

d. Validation of design. The design validation is a process to assess whether the layout of product rationally will be more effective than the old ones or not.

e. Repairing the design. After validation, it will be known its weaknesses. The weakness was attempted to be reduced by improving the design.
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f. Trial Product. Test can be done by using experiment, comparing the effectiveness and efficiency of the working system with the new one.

g. Revision of product. If the test results are less satisfactory, the product design need to be revised again. After revised, it needs to be tested again in real work.

h. The trial usage. After testing of the product is success, and there may be a revision that is not too important, then the next product in the form of new work systems are implemented in real conditions for a broad scope. In the operating system, the new work must be assessed deficiencies or obstacles that arise in order for further improvements.

i. Revision of product. This product revision is done when there is deficiency or weakness on using on the real conditions.

j. Making a mass product. it is done when the product has been tried declared effective and feasible for mass produced.

In this study, the steps of research and development which is done are from step-a to step-g. Step-h to step-j will be made on the next phase of research.

Wulandari, et al. (2014: 9) studied about the development research with title The Development of Learning Media Based Learning Realistic Mathematics Education Topics Cube and Block. The result showed that the Learning Media Based Learning Realistic Mathematics Education Topics Cube and Block which consist of Lesson Plan, Student’s book, Worksheet and Learning Outcomes on the good category because it has completed three criteria feasibility learning device, such as valid, practice, and effective. The method of development research is also done by Putri (2016: 51) with entitled “The Development of Teaching Materials of Elementary Mathematics Service Non Exact Programs”. The results of this study is the product of the teaching materials Elementary Mathematics Service which is appropriate to apply to the Department Non exact, namely the teaching materials in accordance with the request of students by multiplying the sample questions, so that students can do the similar exercises and if given the questions which need the higher thinking, it is expected can improve the understanding of mathematical concepts of student.

2.2. Software MATLAB

MATLAB (Matrix Laboratory) is a program for analysis and numerical computation and an advanced mathematical programming language which is formed by using the premise of characteristic and form of matrix. MATLAB was first adopted by control design engineers (who also specializes Little), but then spread rapidly to other areas. Matlab is also used in education, especially in teaching linear algebra and numerical analysis, as well as popular among scientists who pursue the field of image processing (Wikipedia).

3. Methodology of Research

This research use Research and Development method, namely the research methods which is used to produce a particular product. From this study, the product generates a set of teaching materials of Numerical Methods by using Matlab software. The design of development of teaching materials of Numerical Methods using matlab software is presented below:

![Figure 1. The steps of used R & D method in this study](image-url)
The data was collected through a literature review and analyzed qualitatively validated by two validators to perfect the teaching materials which have been developed.

4. Results and Discussion

4.1. Result

This study product the set of teaching materials incorporating Numerical Methods Software of Matlab with outline is as follows:

a. Systems of Linear Equations, including Linear Systems Triangle Top, Gaussian Elimination and Pivoting, Triangle Decomposition (Doolittle, Crout, and Cholesky), Jacobi Iteration Method and Gauss Seidel.

b. Interpolation, includes linear and quadratic interpolation, Newton divided difference interpolation, interpolation at a point equidistant (forward and backward depending interpolation Newton), and Lagrange interpolation.

c. Integral numeric, includes composition Trapezoid Rule, Rule Composition Simpson and Gauss quadrature rule Legendre.

4.2 Discussion

The results of the program on Systems of Linear Equations with Linear Systems sub Triangle Top, sub Gaussian Elimination and Pivoting and sub Decomposition Triangle are going well and in accordance with the concept. It means that the product is valid. However, the program for the sub Methods Jacobi Iteration and Gauss Seidel is not valid because the program runs well but not in accordance with the concept of matter. The algorithm as the absolute requirement for this iteration must be dominant diagonal is nothing. Thus, the algorithm for this sub has been revised. The results of the interpolation and integration program are valid.

At trial the product, there are constraints on Numerical Integration, as the results obtained in contrast to the results manually. Therefore, the algorithm Numerical Integration has been revised. In this trial, the students also stated that solving numerical methods using MATLAB software is faster than the manually calculation.

5. Conclusion

This research produce the product in the form of teaching materials of Numerical Methods by using MATLAB software that can help students on calculations and to determine whether the problems of Numerical Methods having the solution or not, so that the processing time is more efficient and solving problem is more effective.

Through this research, it is suggested to the next researchers to be more careful in making algorithm because the algorithm is the determinant to the successful of program.

References


