Development of Interactive Mathematics E-Module Using Visual Studio

Farida¹, D D Pratiwi¹, S Andriani¹, S I D Pramesti², J Rini², C W Kuswanto³, E Sutrisno¹

¹Mathematics Education Department, Universitas Islam Negeri Raden Intan Lampung, Indonesia.
²Mathematics Education Department, Institut Agama Islam Negeri Pekalongan, Indonesia.
³Early Childhood Education Programs, Universitas Islam Negeri Raden Intan Lampung, Indonesia.

Corresponding author: ekosutrisno801@gmail.com

Abstract. This development research aims to develop an interactive mathematics e-module using Visual Studio in the curvature material for the ninth grade students of junior high school. The study was conducted to find out the attractiveness, convenience, usefulness, and effectiveness of the e-module at MTs Negeri 2 Bandar Lampung. This study aims to produce teaching materials in the form of an e-module that is suitable for the learning objectives. The method refers to the 4D research and development (R & D) design (Define, Design, Develop, and Disseminate). The final product produced obtained an average score of 3.46 in the field trial with very interesting criteria. The effectiveness test results show that the e-module is effectively used as learning media because they get a value of n Gain of 0.38 with moderate criteria and 93% of students have completed the value of mathematics Minimum Completion Criteria (KKM) that has been set, 73.

1. Introduction
Science and technology experienced very significant and rapid development. The development of these technologies also affects all aspects of life, including education [1] The field of study that occupies an important role in education is mathematics [2, 3]. At least it can be seen from the hours of mathematics lessons in schools that get more servings than other subjects [4] To compensate for the rapid development of technology, innovation in the world of education is needed, one of which is by developing technology-based learning media [5] Technological developments are very important in helping to solve various educational problems. Education is a complex activity, its dimensions are broad, and many are influenced by many variables [6].

Media is widely used in the education process. Media is a tool that can be used as an intermediary that is useful to increase effectiveness and efficiency in achieving learning objectives [7]. Learning media are all things that can be used to convey messages from the sender to the recipient so that they can stimulate the thoughts, feelings, concerns and interests and abilities of students in such a way that the learning process occurs to achieve the learning objectives effectively [8]. Based on some of the opinions above, learning media is a tool used in the learning process that aims to make time effective in achieving learning objectives.
The module is interpreted as the smallest unit of a subject which can stand alone and be used independently in the learning process [9]. The module can be printed and electronic (e-module). E-module is a learning tool that contains material, methods, limitations, and ways to evaluate. It is systematically and attractively designed to achieve the expected competencies according to their level of complexity electronically [8]. An electronic module or e-module is a display of information in a book format that is presented electronically using a hard disk, diskette, CD, or flash disk that can be read using a computer or with another electronic book reader [10].

The selection of the right media provides a role in learning. During this learning media used are manuals or teaching aids. But along with the development of technology, learning media is lacking to attract the attention and interest of students. For this reason, a learning media is needed which can attract the attention and interest of students without reducing the function of the media general learning [11]. E-module as learning media have the same characteristics as printed characteristics, according to [12] there are several elements that must be met in order to be an effective learning module, among others, Self Instructional, namely students are able to learn themselves not dependent on other parties, Self-contained, namely all learning material from one competency unit that is learned is contained in one whole module, Standalone that is, the module used are not dependent on other media, Adaptive ie the module should have a high adaptive power to the development of science and technology, User friendly that the module should have a gift familiar to its users and Consistency ie consistency in the use of letters, spaces and layout [13].

In developing module several ways can be done. According to Sungkono, the development of module and e-module can be carried out using three techniques, including self-writing (starting from scratch), that is, the writer can write the module himself to be used in the learning process, repackaging information (repackaging information), ie the writer does not write module itself, but utilizing textbooks and information that are already on the market to be repackaged into module that meet the characteristics of a good module and the last structuring information (Compilation), namely in the arrangement of information no changes are made to the module taken from the textbook, scientific journals, articles, and others. Based on the three ways that can be done in the development of a module that according to Sungkono, researchers use the development of information repacking techniques, which means researchers do not write the module themselves but rather utilize and adapt existing textbooks now.

Based on the results of the needs information is obtained that there are still many students who experience difficulties in learning mathematics, especially the material of the curved shape. Students say that new learning media are still rarely used and tend to only use printed books provided by schools. Based on the results of the analysis given to 59 students on the development of interactive mathematics e-module developed, accumulative obtained from the two schools was obtained as much as 71.87% of students welcomed and gave positive responses to the development of an interactive mathematics e-module using visual studio.

The objectives in this study are: (1) to produce products in the form of interactive mathematics e-module on the material of the curved shape; (2) describe the attractiveness, usefulness, and convenience of interactive mathematics e-module on the material of the curved shape; (3) describe the effectiveness of interactive e-module mathematics on the material of the curved shape.

2. Method
Development research procedures used were the 4D model proposed by Sivasailam Thiagarajan, Dorothy S. Semmel, and Melyn I Semmel. The 4D development model was chosen because it is a development model suggested in the development of learning tools. The main stages of the 4D development stage are defined, design, develop and disseminate or be adapted into a 4P model that is defining, designing, developing and distributing [14]. The application of the main steps in research is not only according to the original version but is adjusted to the characteristics of the subject and the study environment. The main stages of the 4D development model are shown in Figure 1.
The 4D research flowchart in Figure 1 includes: 1) the defining stage, the purpose of this stage is to define and determine the conditions for developing an interactive mathematics e-module using Microsoft Visual Studio. In determining the terms of the development of interactive e-module mathematics using Microsoft Visual Studio based on an analysis of the objectives of the material constraints; 2) the planning stage (design), at this stage, the aim is to design interactive mathematics e-module using Microsoft Visual Studio. The process at this design stage is the collection of data on the development of e-module or other electronic teaching materials that are relevant to this research as a source of reference in the product development process, the preparation of an e-module structure outline based on competencies compiled, this framework describes the whole the contents of the material included in the product development, the development stage (develop), the purpose of this stage is to produce a product in the form of an interactive mathematics e-module. The application program used as a product development tool at this stage is Microsoft Visual Studio. At this stage, the researcher also conducted a feasibility test/validation of the e-module product that was developed to the validator, with three expert validators namely media expert and material expert. Besides, after obtaining validation from experts, the next step is to revise the results of input and suggestions from experts. At this stage of development, a product trial process is also carried out, namely the testing of attractiveness and effectiveness testing.

The object of this research is an interactive mathematics e-module using visual studio. The subject of evaluation of the development of this interactive mathematics e-module consists of material experts, media/design experts, small group trials, large group trials, and effectiveness trials. The validity test of the material and design experts was carried out by a team of experts, two mathematic lecturers, and one education practitioner teacher.

Data in this developmental study were obtained through interview instruments, questionnaires, and tests. The questionnaire method is used to analyze students’ needs and responses to the development of interactive e-module mathematics in class IX. The questionnaire instrument uses a Likert scale with four choices of answers. The expert validator questionnaire instrument is used to collect data about product worthiness based on content suitability, appropriateness of design, linguistic, appearance and use of interactive e-module on the material of the curved shape on the product that has been developed.

The questionnaire instrument to obtain data on the attractiveness, convenience, and usefulness of the product for product users has four answer choices according to the content of the question. Each answer choice has a different score which means the level of suitability of the product. Total instrument assessment is done from the total score obtained then divided by the total number of scores, then the results are multiplied by the number of answer choices. The assessment scores for each of these answer choices can be seen in Table 1. The results of the assessment scores are then averaged from several trial samples and converted to an assessment statement to determine the quality and level of validity, ease, the attractiveness of the product produced based on the validator and user opinion. The conversion of scores to this valuation statement can be seen in Table 2.

Analysis of test result data to measure the level of effectiveness of the e-module, the minimum completeness criteria (KKM) value of mathematics subjects in schools as a comparison is 73 after using learning media in the form of interactive e-module on the material of the curved shape. According to[15], if 75% of students who learn to use this e-module have completed KKM, then the
learning media in the form of interactive mathematics e-module using the visual studio on the material of the curved shape can be said to be effective and feasible to be used as learning media.

3. Results And Discussion

The results of the development research that have been carried out at MTS Negeri 2 Bandar Lampung is an interactive mathematics e-module on the material of the curved shape. This research was carried out through several stages in accordance with the development procedures that researchers used. The detailed results of each stage of the development research procedure are carried out as follows:

3.1 Defining Stage.
The stages in a study that was first conducted and very important were to carry out preliminary analysis, this was done by observers, giving questionnaires and conducting interviews with educators at SMP Negeri 4 Bandar Lampung and MTS Negeri 2 Bandar Lampung. It aims to determine the needs and formulate problems that will be sought for a solution in this study.

At this stage, defining and establishing development requirements or in other development models is often called a needs analysis. At this stage, there are four main steps, namely the Front-end analysis, Front-end analysis, Concept Analysis, Task Analysis and the formulation of learning objectives (Specifying Instructional Objectives).

3.2 Design Stage.
The second stage is planning design, at this stage the researcher collects information related to the product that the researcher develops, starting from the form of the product, material, color and letter combinations, and the purpose of development. The process at this planning stage is very important because as a reference in making products at a later stage.

At this design stage, the process of designing and designing learning media that will be developed is also carried out so that the initial concept of product development is obtained. The media to be developed is an interactive mathematics e-module using a visual studio that aims to provide a variety of instructional media that can be used by teachers to attract students’ interest in learning mathematics with new media, in this case specifically the material of the curved shape. In this design stage, there are four steps, namely the preparation of tests, media selection, format selection, and initial design or prototype.
3.3 Development Stage.
The third stage is the stage of product development or manufacturing. The development stage is the longest research stage and many processes are carried out including 1) the results of making e-module, at this stage the researchers conducted an interactive mathematics e-module that was designed using Microsoft visual studio software such as designing interfaces or displays, making the blue/print media script, typing the material, making and looking for examples of UN questions, then started making e-module by writing computer programming code to run the e-module. The first appearance of the e-module when students open it is called a flatscreen, which is a temporary screen that opens a few seconds which contains the general identity of the e-module, the subject matter discussed, and the name of the application developer. After the flash screen is closed it will open the main page of the interactive mathematics e-module homepage. 2) product feasibility assessment, Product feasibility for developing interactive mathematics e-module using visual studio was assessed by 6 experts consisting of 3 material experts and 3 media experts with a portion of 4 lecturer validators and 2 educational practitioner validators. The validation instrument used is a validation instrument compiled by reference to the BNSP assessment standard and using a four-Likert scale. The criteria for evaluating the test using the questionnaire instrument can be seen in Table 1.

Table 1. Internal and External Test Assessment Criteria, the answer choices and criteria in this table are the references that will be used in the validation and attractiveness testing process

| Answer Choice | Criteria         | Answer Choice         | Score |
|---------------|------------------|-----------------------|-------|
| Strongly agree| Valid            | Very interesting      | 4     |
| Agree         | Valid enough     | Interesting          | 3     |
| Not agree     | Less valid       | Less attractive       | 2     |
| Disagree      | Invalid          | Not attractive        | 1     |

Source:[16] dan[17]

Table 1 explains the choice of answers and assessment criteria in the product validation process to the experts and the attractiveness testing process in schools during large-scale trials.
### Table 2. Conversion of Material Expert and Media Expert Validation Assessment

| Score | Average Score      | Classification |
|-------|--------------------|----------------|
| 4     | $3.26 < \bar{x} \leq 4.00$ | Valid          |
| 3     | $2.51 < \bar{x} \leq 3.26$ | Valid enough   |
| 2     | $1.76 < \bar{x} \leq 2.51$ | Less valid     |
| 1     | $1.00 < \bar{x} \leq 1.76$ | Invalid        |

The total assessment score on the questionnaire is calculated using the following formula

$$\bar{x} = \frac{\sum_{i=1}^{n} x_i}{n}$$

With

$$x_i = \frac{\text{total score}}{\text{maximum score}} \times 4$$

Information:

- $\bar{x}$ = average score
- $x_i$ = questionnaire operational test scores for each student
- $N$ = number of students

#### 3.4 Product Validation

The next step is to validate the validator that has been determined, aims to determine the feasibility of the product being developed. In the validation stage both material and media validation are carried out in two stages, namely, stage 1 and stage 2. This is done to ensure there are improvements to the product being developed. The results of material validation in stage 1 can be seen in Table 3.

### Table 3. Validation of Stage 1 Material, this data is the first data obtained in the material validation process.

| Aspect   | $\sum x_i$ | Criteria       |
|----------|------------|----------------|
| Content  | 2.96       | Valid enough   |
| Presentation | 3.00     | Valid enough   |
| Language | 2.77       | Valid enough   |
| Average  | 2.91       | Valid enough   |

Based on the first stage of the material validation table, it is known that the average assessment of getting the criteria is quite valid, this requires the need for improvement so that the product developed gets a valid criterion.

### Table 4. Summary of Content Expert Test Results, in this table written various input points and improvements made to the material expert validation process.

| Assessment Aspects | Suggestions for improvement | Improvements made                              |
|--------------------|------------------------------|------------------------------------------------|
| Language           | Writing terms is consistent, formulas are improved, editorial questions are adjusted to the type of question. | The use of the term has been improved, improved formula writing, and improved the writing of question editors as well as adding UN questions as students' training materials. |
| Feasibility        |                              |                                                |

Based on Table 3, it can be seen that all aspects have sufficiently valid criteria, with an accumulative average of all three aspects of 2.91 with a "sufficiently valid" criteria, this means that improvements
still need to be done. Improvements were made according to advice and input from experts. After the revision, the validation stage 2 is continued to assess the results of the revision and product eligibility. The results of material validation in stage 1 can be seen in Table 4.

| Table 5. Validation of Stage 2 Material |
|----------------------------------------|
| **Aspect** | Score | Criteria |
|-------------|-------|----------|
| Content     | 3.56  | Valid    |
| Presentation| 3.67  | Valid    |
| Language    | 3.74  | Valid    |
| **Average** | 3.65  | Valid    |

Based on Table 4, it can be seen that there are significant improvements to the results of the validation of the previous stage. In stage 1, the average rating of material experts was 2.91 with the criteria of "quite valid" and in the second stage of validation an average of 3.65 was obtained with the criteria of "valid". Thus the product has been said to be valid in the material aspect. After completing the material expert validation stage, then the media expert validation is carried out. The results of media validation in stage 1 can be seen in Table 6.

| Table 6. Media Validation Stage 1, this data is the first data obtained in the media validation process |
|---------------------------------------------------------------|
| **Aspect** | Score | Criteria         |
|-------------|-------|------------------|
| Display     | 2.87  | Valid enough     |
| Use         | 2.80  | Valid enough     |
| **Average** | 2.83  | Valid enough     |

Based on Table 5, it can be seen that all aspects have sufficiently valid criteria, with an accumulative average of all three aspects of 2.83, this means that improvements still need to be done. Improvements were made according to advice and input from experts. After the revision, the validation stage 2 is continued to assess the results of the revision and product eligibility. The results of material validation in stage 1 can be seen in Table 4.

| Table 7. Media Validation Stage 2 |
|-----------------------------------|
| **Aspect** | Score | Criteria |
|-------------|-------|----------|
| Display     | 3.62  | Valid    |
| Use         | 3.78  | Valid    |
| **Average** | 3.70  | Valid    |

Based on Table 4, it can be seen that there are significant improvements to the results of the validation of the previous stage. In stage 1 the average rating of media experts was 2.83 with the criteria of "quite valid" and in the second stage of validation an average of 3.70 was obtained with the criteria of "valid". Thus the product has also been said to be valid in the media aspect. Based on the validation criteria obtained, it can be concluded that the e-module of interactive mathematics on the material of the curved shape has been valid and can be used in field trials.
3.5 Field Trial

After validation has been done and has been declared valid, the next step is to test the product. Trial use of small groups is carried out in small groups of one class of students with 25 students of MTS Negeri 2 Bandar Lampung class IX E and large group trials are conducted on 40 students of class IX D MTS Negeri 2 Bandar Lampung, aiming to find out the attractiveness, ease, and e-module benefits. The response of students’ assessment in the field test according to the questionnaire of attractiveness, ease and usefulness of the e-module can be seen in Table 4. The small group trial consisted of 25 students of Class IX E MTS Negeri 2 Bandar Lampung. In a small group trial, the researcher conducted two meetings, the first meeting was a presentation to students about the interactive e-mathematics module that was developed, how to use it, and the advantages and disadvantages. The second meeting of students was divided into several groups consisting of 4-6 students, then each group of researchers gave a questionnaire that was applied. Next, each group uses an interactive e-module for 10 minutes alternately. After completing the e-module students are allowed to fill in the questionnaire that they have received in accordance with their respective evaluators. Based on the results of the questionnaire analysis, an average score of 3.45 was obtained with a very interesting category. In the large group test, the researcher conducted four meetings, the first meeting was a presentation to students about the interactive e-module mathematics developed, how to use it, and the advantages and disadvantages. The second and third meetings of researchers conducted learning using e-module by way of students divided into groups consisting of 4-6 students, then each group got a laptop that had an interactive mathematics e-module application installed. Next, each group uses an interactive e-module during learning. The fourth meeting, after completing learning to use e-module students is allowed to fill in the questionnaire that researchers have given in accordance with their respective evaluators. Based on the results of the questionnaire analysis, it was found that the average score of a large group test was 3.65 with a very interesting category. Based on the results of the analysis of small group trials and large group trials obtained an average of 3.46 and get a very interesting predicate.

| No. | Test Type  | Average Score | Criteria         |
|-----|------------|---------------|------------------|
| 1.  | Small group| 3.34          | Very interesting |
| 2.  | Large group| 3.58          | Very interesting |
|     | Average    | 3.46          | Very interesting |
3.6 Effectiveness Test

Effectiveness test aims to determine the level of effectiveness of the product that researchers develop. This effectiveness test stage uses a pre-experimental research design with a one-group pretest and posttest design pattern, which means only using one class of trials. In the implementation of the study begins with the introduction of interactive e-module mathematics on the material of the curved shape that researchers developed. After the product introduction stage is completed the researcher gives the students the initial or pretest questions on the material of the curved shape, then collects and analyzes the results obtained by the students. The next step the researcher conducted the study at the next meeting were two meetings with the assisted interactive e-module mathematics that the researcher had prepared. At the fourth meeting the researchers gave a closing question or post-test to students with similar but different types of questions, the aim is to determine the level of understanding of students during learning by using interactive e-module that the researchers developed. Based on Table 9 it can be seen that the pretest stage of students gets an average value of x gain of 0.73 and in the posttest gets a value of 0.83 x gain means that there is an increase between the acquisition of pretest and posttest values. After obtaining the pretest and posttest values, the n values are calculated using the following formula [18].

\[
g = \frac{\text{Posttest score} - \text{pretest score}}{\text{max score} - \text{pretest score}} \times 100\%
\]

Note: g = n gain value

| Table 9. N-Gain Test Criteria |
|-----------------------------|
| Gain value (g) | Criteria |
| \( g \geq 0.7 \) | High |
| \( 0.3 < g < 0.7 \) | Medium |
| \( g < 0.3 \) | Low |

| Table 10. Product Effectiveness Test Results |
|-----------------------------|
| No | Test Questions | Many students | Analysis Results |
|----|----------------|--------------|-----------------|
| 1  | Pre Test       | 40           | 0.73            |
| 2  | Post Test      | 40           | 0.83            |

Average n gain = 0.38
Category = Medium

Based on the acquisition of the average value of n gain in Table 9 of 0.38 lies in the range of 0.3 <0.38 <0.7 and can be concluded that the level of effectiveness of interactive mathematics e-module products is in the medium criteria, this makes e interactive mathematics module using visual studio on the subject matter of the physical construction can be used as a medium for learning mathematics. The results of this study are in line with similar research results, namely the Development of Visual Studio High School Biology Dictionary Based on Plant Classification Subjects by Aji Purnomo [19] and Development of Interactive E-module as Basic Electronic Learning Resources by Helna Satria Wati [20] both of which received positive responses with very interesting criteria.

3.7 Dissemination Stage

The results of the revision are the final product of an interactive e-module using the visual studio in the form of an installer in the form of a .exe file which only needs to be pressed to enter or double-click the window to install the e-module application. This e-module is rendered with two versions, namely for the architecture of the Microsoft Windows 32 bit (x86) version and the architecture of the Microsoft Windows 64 Bit version which can be adapted to the architecture of the laptop or computer.
school/user. The distribution of the e-module is done in two ways, offline and online. The offline way is done by giving and sharing the .exe file via CDs, flash disk, and other storage devices. The online way is done by providing a Google Drive researcher link, which can later be downloaded by anyone with a relatively small size of 60 Mb.

4. Conclusions and Suggestions

The conclusions of this development research are: (1) an interactive mathematics e-module is produced using visual studio on the material of the curved shape for the ninth grade students of junior high school through 4D development procedures (define, design, develop, disseminate) [20]; (2) interactive mathematics e-module using visual studio on the material of the curved shape is very interesting with an attractiveness score of 3.46; (3) interactive mathematics e-module using visual studio on the curved shapes material developed that has been effectively used as a learning medium because 94% of students have completed the KKM score that has been set at 73 with an average value of 83; (4) interactive mathematics e-module using visual studio on the curved shapes material get an average value of n Gain of 0.38 with moderate criteria so that the product can be used as a learning medium in teaching and learning.

In addition there are advantages of products developed and have been declared suitable for use in the learning process, but there are also still some shortcomings and suggestions that can be used to perfect this research, the results of products that are developed can not be used on smartphones or Android and the material is limited to only one subject.

Suggestions on these shortcomings, it is hoped that in future relevant research can be carried out so that these problems can be resolved and making interactive mathematics e-module using visual studio become better and more reliable products.

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