

Developing Interactive Multimedia Learning for Teaching Integral Calculus in College

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Abstract: This research aims to develop interactive multimedia learning in the form of Compact Disk by using Macromedia Flash Professional for teaching Integral Calculus in College. This research refers to the development model of ADDIE (Analysis, Design, Development, Implementation and Evaluation). The research's subject is students of mathematics department UIN Imam Bonjol Padang, Indonesia. Data were collected through observations, interviews, checklist, videotaping, and analyzing the students' works. The interactive multimedia learning was validated by experts in mathematics education and multimedia to meet the criteria of validity (relevance and consistence). The interactive multimedia learning was implemented and evaluated through one-to-one and small group evaluation before it was tried out in a field test. The results showed that the interactive multimedia learning worked as intended in the classroom. Based on the results obtained, it can be concluded that the interactive multimedia learning is valid, practical and effective.

1 INTRODUCTION

Research suggests that despite the numerous benefits of using technology in mathematics education, the process of embedding technology in classrooms is slow and complex (Cuban et al., 2001)(Duderstadt et al., 2002). It has been suggested that adequate training and collegial support boost teachers' willingness to integrate technology into their teaching and to develop successful technology-assisted teaching practices (Becker et al., 1999). Supported by their teachers and by using different kinds of instructional materials (e.g. 'Traditional' worksheets on paper, interactive applets, quizzes) students were guided towards discovering the concepts of derivative and / or integral. These learning environments were tested in Austrian high schools with several hundred students (Embacher et al., 2006). Computer algebra systems (such as Derive, Mathematica, Maple or MuPAD) and dynamic geometry software (such as Geometer's Sketchpad or Cabri Geometry) are powerful technological tools for teaching mathematics. Numerous research results suggest that these software packages can be used to encourage discovery and experimentation in classrooms and their visualization features can be effectively employed in teaching to generate conjectures (Draaijers et al., 2004)(Lavicza, 2007).

The material in Differential Calculus includes number systems, multiple function operations, function limits, continuous functions, function derivatives and application of derived concepts. The material in integral calculus includes integrals, integral usage, transcendent functions, integration techniques, and unnatural indeterminate and integral forms. The purpose of studying calculus as proposed by Zhang, (Zhang, 2003) is that students understand mathematical ideas and to develop logical, profound and creative thinking skills. Moreover, it has functions to enhance the intellectual and imaginative abilities, so that students will gain skills in arithmetic and obtain useful tools for future needs. The successful of the students in understanding the material of this calculus will make it easier for the students to understand the material in a course that uses mathematics in their discussion.

Calculus consists of abstract concepts and has a lot of prerequisite knowledge. As a lecturer, we must be able to simplify the concept of abstract calculus into things that are easy to understand, innovate and create learning quality for calculus and fun in the classroom. Pleasant learning will certainly have an impact on the results of the studies obtained by students. Based on the observations in the Department of Mathematics, Faculty of Mathematics and Teacher Train-

ing in UIN Imam Bonjol Padang, the effectiveness of calculus learning is low. This is seen from the low of students' learning outcomes. The percentage of students who got A grade for a calculus course in the last 3 years only average 19.4%, and for the value of B only 49.2%, the remaining got the values of C, D and E. The low of effectiveness in learning calculus is also experienced by other students from another college. Several researchers have examined the problem of the low effectiveness of calculus learning, such as (Dhoruri et al., 2007)(Sepriyanti et al., 2017)(Yuan, 2002)(Zhang, 2003).

Based on the interviews with students of Tadris Mathematics class of 2016 with initials HN and DW it was obtained the information that the students realize that Calculus is very important to learn, but they faced the fact that the calculus is abstract and difficult, especially if the given problem is a matter of the story. Calculus is only considered as a collection of numbers and formulas that have nothing to do with their daily lives. Though the problems faced in everyday life cannot be separated from the problems of calculus.

Based on the results of interviews with the lecturer of Calculus, it has obtained information that the students' involvement has not been fully in the learning process, not yet effective in using the media and has not used multimedia-based interactive media for learning calculus yet, has not accepted what is explained by the lecturer either. This resulted in the student's difficulties in understanding the concepts that have been taught by the teacher, it is found that the students are also difficult in transferring the concept of calculus into real life. The learning process that took place has a low result on student learning activities and student's results in studying are also low.

The difficulty in understanding the abstract of calculus material and being far from everyday life has always been the pretext of students in studying calculus. The cause of such difficulties can be sourced from within the student as well as from outside, for example the way of presenting the calculus material or the learning atmosphere that being carried out. The difficulties experienced by learners are also encountered by Khambari, Luan, & Ayub (Khambari et al., 2010). They say to overcome these difficulties; Information and Communication Technology (ICT) can be an alternative solution. Information and Communication Technology such as computers, props, or other media are expected to improve the effectiveness of learning. Many countries consider ICT as a vehicle for upgrading the education system to a better degree and interpret ICT as an improvement and development of e-generation-based learning that will make efficiency

in classroom activities.

By the 21st century is now Indonesia's educational experience a paradigm shift from behaviorists to constructivist. Responding to these changes, (Priyanto, 2009)(Rusman and berbasis Komputer, 2013) states that teachers / lecturers are not just teaching (transfer of knowledge) but must be a learning manager. It means that every lecturer is expected to be able to integrate the information and communication of technology (ICT) into learning activities, create learning conditions that challenge, creativity toward student activities, motivate students, use multimedia, multi methods, and various learning resources in order to achieve the expected learning objectives.

The rapid development of computer technology has been felt in various sectors of life, so that in learning the development of technology is needed. This is in line with the opinion expressed by (Akşan and Eryılmaz, 2011) in the education sector, for example the use of computers has been developed not only as a tool that is only used for administrative affairs, but also it is very possible to be used as a means of operating the learning media. For example, the existence of a multimedia computer is capable of displaying images and writings that are still and moving and vocal. This kind of thing should be responded positively by the teachers / lecturers so that computers can be one tool that helps in developing learning.

NCTM (1973) states that the use of computers as learning media actually has long been developed in many countries such as America and Britain. As a medium, the computer is useful for teachers as a tool in preparing teaching materials and organizing learning activities. Currently the use of computers as a medium of learning mathematics is rarely applied in schools because not many manufacturers offer special software of mathematics learning, so it takes expertise and tenacity of teachers to take advantage of software potluck. Therefore, the use of computers is dependent on the teacher as a facilitator in designing computers as a medium of learning mathematics.

(Arsyaz, 1997)(Muhson, 2010)(Sudjana and Rivai, 2010) revealed that various studies have been conducted on the use of instructional media in teaching and learning process to the conclusion that the process and result of student learning showed significant difference between learning without media and learning by using the media. Therefore, the use of learning media in teaching and learning process is highly recommended to enhance the quality of learning, including computer media. Based on these factors felt the importance of developing multimedia-based calculus learning media in the form of Macro-media Flash Professional.

Research development in learning mathematics at the level of Higher Education is relatively new and not much studied, including research on the development of Interactive Multimedia-based learning by using Macromedia Flash Professional. Though problems in college, especially in mathematics education cannot be solved by only composing experimental research on strategies or learning methods.

Some researchers have observed this problem, such as (Khairani and Febrinal, 2016)(Sepriyanti et al., 2018) with the results of research indicates that the learning media developed valid, practical and effective because it can improve students' concept understanding and improve students' positive responses in learning. Fahmi (Fahmi, 2014), the results showed that the learning media developed had an impact on students' mathematics learning behavior. Sinurat (Sinurat et al., 2015), the results showed that the media used in the mathematics learning can improve students' mathematical skills and the last is (Safitri et al., 2013), with the results of research media Macromedia Flash learning developed effectively to improve students' conceptual understanding.

Based on researches that have been done by previous researchers, it gives an evidence that the use of Macromedia flash in learning is to give a potential impact on the process, attitudes, abilities and student learning outcomes. Therefore, the development of learning media Macromedia flash professional is in college is also very necessary.

2 METHODOLOGY

This research used the ADDIE model to develop the product. Expert validation is conducted to keep the quality of the product that consist of two contents/material experts and two media experts. The standard of the product is achieved if the experts gave at least valid for each criterion. The quality of instructional media (practicality) is carried out to 8 (eight) students of Tadris Mathematics Department UIN Imam Bonjol Padang who have taken Integral Calculus courses selected randomly from three classes, they are class A, B, and C. Time and place of this research were conducted on June 1, 2017 until September 20, 2017 at UIN Imam Bonjol Padang. In this study there are five procedures performed 1) Analytical phase (Analysis), 2) Design stage, 3) Development stage, 4) Implementation stage, 5) Evaluation stage. Data collection was obtained from several techniques, namely: observation, interview, and literature.

3 RESULTS & DISCUSSION

The initial design/prototype of interactive multimedia as follows:

- Opening page view

The opening page that appears on the learning media when it is run. This page has one button, the start button to go to the main page. It is shown in Figure 1.



Figure 1: Preview of opening page.

- Main page view

This main page consists of Pendahuluan (introduction), Materi (contents), Latihan (exercises), Evaluasi (evaluations), Referensi (references), and Profil (profiles). This page comes with a back sound once the view is opened. Each page on the main menu will be linked to the main page using the menu button.



Figure 2: This caption has one line so it is centered.

- The introduction main menu

If the introduction button on the main page is clicked, then it will show learning matrix as shown in Figure 3. This learning matrix contains the learning outcomes and contents that must be mastered by students on a

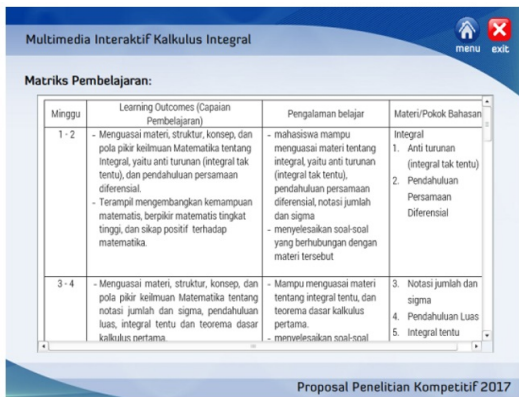


Figure 3: This caption has one line so it is centered.

weekly basis or meeting. It will help the student to adjust the time for each content.

- The contents main menu

Main menu of the contents consists of four main topics as shown in Figure 4. These topics were built by using a learning matrix that provided in introduction menu. The student must learn the topics sequentially from Integral (the definite integral), Penerapan Integral (applications of the integral), Fungsi Transenden (transcendental functions), and Teknik Integrasi (techniques of integration).

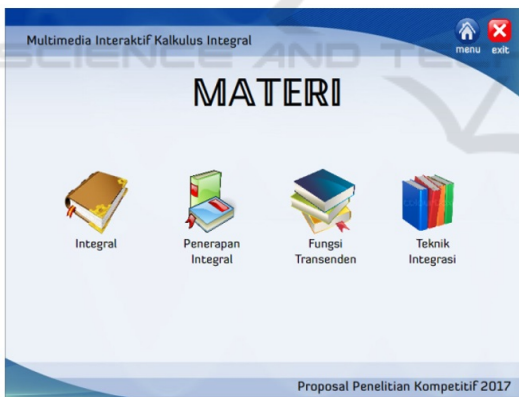


Figure 4: This caption has one line so it is centered.

- The exercise main menu

Exercise can be accessed by clicking Latihan on the main page. There are four exercise packages based on the topics of study. The student can answer each exercise by inputting the answer in the box that has provided. They also can check whether correct or wrong the answer by clicking periksa button. Every correct answer will be marked by a green checklist next to the answer, while the wrong answer will be marked with a red cross as shown in Figure 5. Students can repeat

typing the answer again by pressing cobalagi button so that the answer box will be blank.

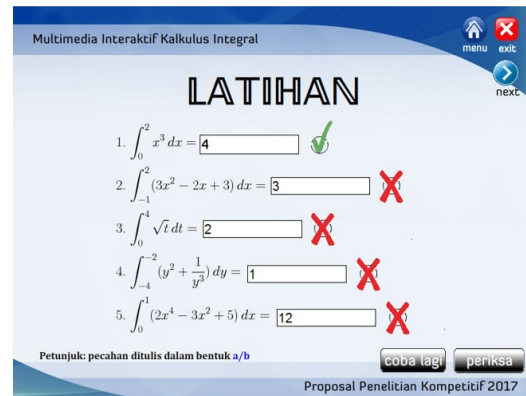


Figure 5: This caption has one line so it is centered.

Students can re-try to answer the questions in the fields provided and re-examine the answers. However, students can also directly see the correct answer by pressing the (?) button so that the solution will appear as shown in Figure 6. The solution can be closed by clicking (X) button.

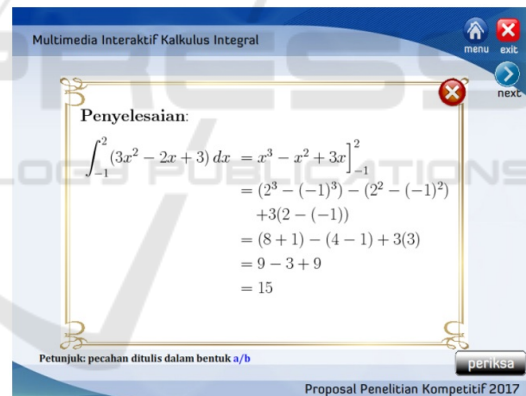


Figure 6: This caption has one line so it is centered.

- The evaluation main menu

Evaluation can be accessed by clicking evaluasi button on the main page. Evaluation-1 is an evaluation aimed at measuring learning outcomes for integral review materials and application, while Evaluation-2 for transcendent functions and integration techniques. Evaluation can be selected by clicking on one of the buttons available on the page. Before starting the evaluation, it will be given an instruction at first page as shown in Figure 7. In each evaluation there were 10 questions to be answered with a duration of 60 minutes.

Problems will appear randomly, so that among students who one with another small will get the same

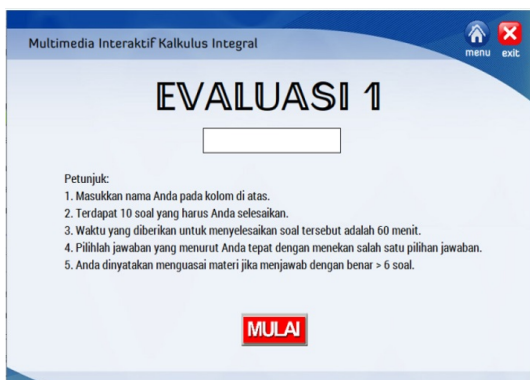


Figure 7: This caption has one line so it is centered.

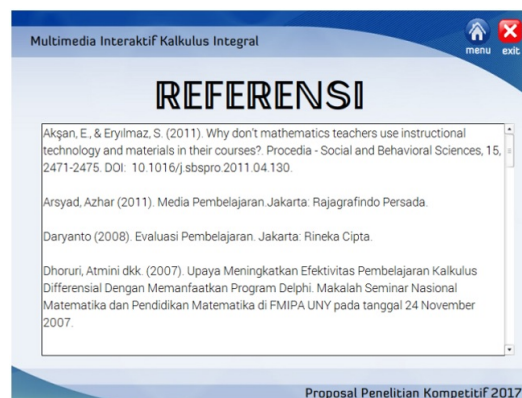


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problem even though done simultaneously. Evaluation can be started by clicking MULAI (start) button on the page. On the top right there is a time indicating the remaining time available to answer the question. The problems will be answered by clicking on one of the available answer options. After the whole question is answered, then the value of the evaluation results can be known and included part of the material that has not been mastered by students as shown in Figure 8. Student who have not mastered the material can re-understand the material or try to answer the problem back by clicking cobalagi button once again.

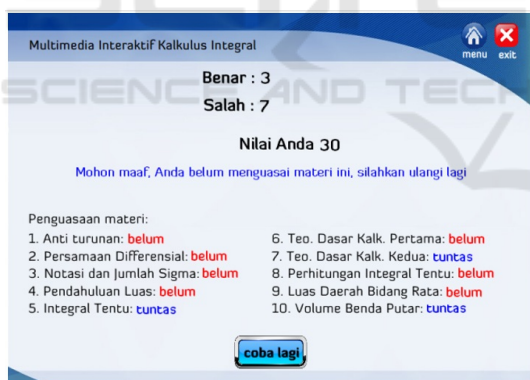


Figure 8: This caption has one line so it is centered.

- Display Reference Menu

The reference menu contains reference-related information used in the development of learning media in the form of contents/study materials, practice and evaluation questions and some theories used in developing an interactive learning media. Reference can be accessed by clicking Referensi in the main page.

Expert validation is conducted to assess the designed product so that it can know its strengths and weaknesses. Validation is done by showing the design of the design and then the experts are asked to judge it. Expert validation consists of expert in media and in

content. Validation from the expert in media side was done by the lecturer of mathematics education study program at the State University of Padang and lecturer of tadrir mathematics at State Islamic University Imam Bonjol Padang. The experts see and listen to the learning media, then they judge by using closed and open questionnaire instruments. The result of validity as a whole is categorized as valid. However, if viewed from each aspect. Expert media validation results are shown in the Table 1.

Table 1: The Expert Media Validation Result.

No.	Aspect of assessment	Percentage	Description
1	Coloring	75.00	Valid
2	The use of words and language	80.00	Valid
3	The screen display	83.30	Very Valid
4	Animation	75.00	Valid
5	Menu command	90.00	Very Valid
6	Design display	100	Very Valid
Total (overall)		83.85	Very Valid

Validation from the expert in contents side was done by two lecturers of calculus of tadrir mathematics at State Islamic University Imam Bonjol Padang. The result of contents/materials validation results are shown in Table 2:

Table 2: The Validation Result of The Content Experts.

No.	Aspect of assessment	Percentage	Description
1	Instruction	75.00	Valid
2	Curriculum	85.30	Very Valid
3	Material	83.30	Very Valid
Total (overall)		81.80	Very Valid

The results of validity are categorized as valid,

both in terms of learning, curriculum, and material content.

- Implementation Phase

Once the learning media is validated and declared eligible for trial, then it will continue to the implementation stage. At this stage, the product is carried out in a small group that consist of 8 students of mathematics Tadris UIN Imam Bonjol Padang who took the integral calculus courses. Furthermore, each student was given a questionnaire to assess the learning media in terms of practicality.

- Evaluation Phase

An evaluation is conducted to know the results of the implementation of instructional media in terms of practicality by students. The results can be seen in Table 3, seen as a whole learning media is categorized very practical.

Table 3: The Result Of Practicality Test.

No.	Aspect of assessment	Percentage	Description
1	Operation	95.00	Very practical
2	User reaction	95.00	Very practical
3	The safety of the program	92.50	Very practical
4	Additional support facilities	92.50	Very practical
Total (overall)		94.25	Very practical

Based on the result of student's calculus integral test step shows that the obtain effectivity percentage value with effective category with an average score of 71.39 %. The percentage of students who got A grade for Calculus Integral course average 25 %, for the value of B is 46.43 %, for the value of C is 25 % and for the value of D is only 3.57 %.

Table 4: The Result Of Effectivity Test.

No	Grade	Percentage
1	A	25.00%
2	B	46.43%
3	C	25.00%
4	D	3.57%

4 CONCLUSIONS

CD interactive multimedia-based learning as the output of this research is a good learning media and it can be used independently by the student self. In order to save costs and use of the CD, these learning media can be copied and installed to the smartphone

directly. Based on the results of the study, the CD interactive multimedia-based learning of Integral Calculus has validity assessment in very valid criterion with an average score of 82.83 %. This validity is assessed from two criteria, namely: 1) Media expert validation criteria show that the qualitative media obtained is very valid with the percentage of 83.85%. So that the learning media is suitable for learning. 2) Contents/material expert validation criteria showing the qualitative which is the category is very valid, with percentage 81.80 %. So that learning media can be used for learning.

The quality of instructional media is based on the aspect of practicality. Practicality is assessed from one criterion that is the quality of technical criteria (technical quality). Multimedia-based interactive multimedia learning media developed according to user trial subjects that has met the practical criteria that can be used with the percentage of practicality 94.25% and was produced in accordance with aspects of effectivity assessment so that the developed CD Interactive multimedia-based learning is included in effective criterion with an average score of 71.39 %. So, it is concluded that the learning media is suitable for the use as an interactive learning media.

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