

Development of Teaching Materials on Sine and Cosine Rules based on Flipbook for Mathematics Education Students

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ABSTRACT

The purpose of this research is to produce a product in the form of a teaching material as a medium in studying the sine and cosine rule material. This study was development research that was designed using the ADDIE (Analysis, Design, Development, Implementation, Evaluation) model. To obtain valid and effective teaching materials, the validity of the research instrument was tested and the validity of the developed teaching materials was tested. The teaching materials that have been implemented are then assessed by the research subjects to determine their effectiveness. The results obtained are: flipbook-based teaching materials on the sine and cosine rule materials are declared to meet the validity and effectiveness. These results were obtained after being tested for validity by experts which consisted of validating teaching materials in the form of teaching materials and problem-solving questions, all of which were in the very valid category, namely 3.76. Meanwhile, for display validation, it is in the very valid category with the average validator value of 3.56. Teaching materials are declared practical based on the results of the analysis, there are 97.1% of respondents who rate the attractiveness of teaching materials, 88.6% of respondents who assess interest/motivation, 89.4% of respondents who rate ease of use, and 95.7% respondents who assess the functioning of teaching materials. Teaching materials are declared effective based on the results of the analysis, there are 96.3% of respondents who rate the material, 87.6% of respondents who rate problem solving, and 90.9% of respondents who rate visual communication.

Keywords: Cosine Rule, Flipbook, Sine Rule, Teaching Materials

ABSTRAK

Tujuan dari penelitian ini, yaitu untuk menghasilkan suatu produk berupa sebuah bahan ajar sebagai media dalam mempelajari materi aturan sinus dan cosinus pada mahasiswa Tadris Matematika di IAI Muhammadiyah Sinjai. Penelitian merupakan penelitian pengembangan yang dirancang dengan menggunakan model ADDIE (Analysis, Design, Development, Implementation, Evaluation). Untuk mendapatkan bahan ajar yang valid dan efektif, maka dilakukan pengujian validitas terhadap instrumen penelitian berupa soal-soal pemecahan masalah serta pengujian validitas terhadap bahan ajar yang dikembangkan. Bahan ajar yang telah diimplementasikan kemudian dinilai oleh subjek penelitian untuk menentukan keefektifannya. Hasil penelitian yang diperoleh yaitu: bahan ajar berbasis flipbook pada materi aturan sinus dan cosinus dinyatakan memenuhi kevalidan dan keefektifan. Hasil ini diperoleh setelah dilakukan uji validitas oleh para ahli yang terdiri dari validasi materi bahan ajar berupa materi ajar dan soal-soal pemecahan masalah yang keseluruhan aspek berada pada kategori sangat valid yakni 3,76. Sementara untuk validasi tampilan berada pada kategori sangat valid dengan nilai rata-rata validator adalah 3,56. Bahan ajar dinyatakan praktis berdasarkan hasil analisis, ada 97,1% responden yang menilai tentang daya tarik bahan ajar, 88,6% responden yang menilai tentang minat/motivasi, 89,4% responden yang menilai tentang kemudahan penggunaan, dan 95,7% responden yang menilai tentang keberfungsian bahan ajar. Bahan ajar dinyatakan efektif berdasarkan hasil analisis, ada 96,3% responden yang menilai tentang materi, 87,6% responden yang menilai tentang soal pemecahan masalah, dan 90,9% responden yang menilai tentang komunikasi visual

Kata kunci: Aturan Cosinue, Flipbook, Aturan Sinus, Bahan Ajar.

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Introduction

Improving the quality of learning is a crucial thing that can be considered in the learning process; it aims to improve the quality of education (Mutahharah et al., 2022; Zaki & Yusri, 2020). However, in their articles, several researchers stated that the education quality in

Indonesia is still very low. Therefore, the low quality of education is one of the key strategic problems of Indonesian national education (Priatna, 2018). The success of education management can be seen in the achievement of academic and non-academic achievements, as well as the effectiveness and efficiency of the educational process. In other words, the quality of education can be seen from the results, effectiveness, and efficiency of the educational process carried out by educational institutions. Some influencing factors include subjects, existing educators and education staff, student abilities, teaching materials prepared for learning, teaching aids used, technology, availability of educational facilities and infrastructure to management and quality control of education (Fadhli, 2017; Priatna, 2018).

As explained above, teaching materials are one of the determining factors that significantly influence the quality of learning. Therefore, it takes the ability to make teaching materials, which must be effective and efficient when used (Salma, 2020). The development of teaching materials can make learning more interesting but still does not deviate from the learning objectives. In addition, teaching materials must be designed as unique as possible, which means that teaching materials are only used for certain purposes and learning (Magdalena et al., 2020). The teaching materials must follow technological developments (Buchari et al., 2019; Kaswar & Nurjannah, 2021; Miftah, 2014). Based on the technology used to make them, teaching materials are categorized into four groups, namely printed teaching materials, audio, audio-visual teaching materials, and multimedia teaching materials. Examples of published teaching materials are books, modules, worksheets, photos, etc. At the same time, examples of audio teaching materials are radio and CD. For audio-visual teaching materials, for example, VCDs and films (can be regular films or documentaries). For the multimedia teaching materials, for example, interactive multimedia such as CAI (Computer Assisted Instruction) and websites (Sholeh et al., 2018).

Multimedia teaching materials are among the many types of teaching materials that students favor because of their more attractive nature and accessible content (Ilyas & Mursid, 2015). One example of the use of applications that are suitable to be used as interactive teaching materials is Flipbook (Rahmawati et al., 2017). A flip book is a collection of combined images that create the illusion as if the image is moving where there is an animation in the form of a small book that moves without a machine (Wibowo & Purnamasari, 2019).

A flipbook is a collection of composite images intended to be flipped to give the illusion of movement and create animated sequences from simple booklets without machines (Wibowo & Purnamasari, 2019). Making flip book-based learning media is done using software like Kvisoft Flipbook Marker, which displays partially open books or other materials into a computerized electronic book. This program converts PDFs to lined flipbooks with advanced page-folding effects. This page creates text and images in advanced information in SWF, exe, Html format, email design, or used as a screen saver (Wibowo & Purnamasari, 2019).

One material that is suitable for flipbooks is the material on Sine and Cosine in Trigonometry. Because to convey this material, interesting pictures are needed to explain the teaching material in detail (Nurhayati et al., 2017). In addition, in this case, the sine and cosine rules, trigonometry is a material that all students must understand because this material is prerequisite material for other courses, such as calculus, algebra, and differential equations (Iskandar & Andriyani, 2019).

Based on initial observations, it was found that most Mathematics Education students found it a little difficult to understand Trigonometry material. It is because the Trigonometry material contains elements of Sin, Cosine, and Tangent, which students have considered difficult from the beginning. Hence, it reduces the enthusiasm to learn the material.

Therefore, the researcher intends to conduct research in the form of developing flip book-based teaching materials on the sine and cosine rule material for Mathematics education students at IAI Muhammadiyah Sinjai.

Research Methods

This research was executed using the ADDIE (Analysis, Design, Development and Implementation, Evaluation) model. The subjects of this study were mathematics education students, totaling 26 people. To carry out development with the ADDIE model, the flow used can be seen as follows:

Analysis

In the early stages, researchers analyze needs and identify problems (conditions) using the observation method.

Design

At this stage, the researcher made a design (blueprint) for Flipbook-based teaching materials at IAI Muhammadiyah Sinjai. At this stage, the researcher designs any procedures that the researchers will use in developing Flip book teaching materials.

Development

At this stage, researchers began to develop teaching materials based on Flipbook on sine and cosine rule material at IAI Muhammadiyah Sinjai, namely:

Expert Validation Assessment (Validity Test)

To get an effective instrument, the verification process is first carried out by an education expert (material expert) (Mattoliang et al., 2022; Nurjannah et al., 2022). In addition, the initial product design (product prototype) contained in the designed interactive textbook is then submitted to the expert (verifier) for content evaluation or verification (Rahman et al., 2019). Next, evaluate the verifier to test the effectiveness of the previously designed teaching materials. The verifier conducts inspections and provides suggestions/input for improving teaching materials (Sembiring & Napitupulu, 2022). The verifier's input and suggestions are then used as material for revising flipbook-based teaching materials. There are two experts each who become validators in this study. The research instrument was in the form of problem-solving questions and blueprints for the developed teaching material designs.

Product Revision Stage

After getting suggestions/input from the validator, the next step is to make revisions to the suggestions/inputs.

Socialization Stage (Simulation)

After the revision, the next step is to conduct socialization or simulation for the research subject.

Implementation and Evaluation

At this stage, experiments were conducted to determine the practicality and effectiveness of the interactive teaching materials that had been developed. After the research subjects answered all the questions related to the interactive textbook, they could immediately see the experiment's results.

Result and Discussions

The results of this study can be seen from several aspects, which include; the level of validity, practicality, and effectiveness of the teaching materials developed.

Validity of Instruments and Teaching Materials

In accordance with the stages of this research, the validity of the application is carried out at the development stage. The validation process is carried out by submitting an instrument containing indicators and validating the developed application. The instruments prepared include; an expert validator instrument used as a validator assessment format and a field instrument used as a field data collection tool.

Each validator was asked to assess the relevance of the statement items to the aspects and indicators as well as the theoretical basis used to develop the instrument. Furthermore, the validator is asked to provide a value on the available validator format as well as provide suggestions and comments on the instrument script that has been specially provided.

The process of testing the validity by the validator, as described in the development stage, obtained the results that the questions were in accordance with the indicators in each aspect of the material. Although the results of teaching materials, supporting tools, and instruments are valid, input from the validators is still used as input and is considered the basis for revising teaching materials. Improvements to instruments and teaching materials are related to aspects of the validation format and aspects of the instructions for using the instrument. Revisions for the material and practice questions include shortening the material without losing the meaning contained and replacing the questions by adjusting the problem-solving indicators. As for the revision of the display of teaching materials, it is recommended to pay attention to the appearance of the interface, especially on the display of colors and backgrounds.

The result of the revision based on input and suggestions from the validator is referred to as the second model revision. At the same time, the first model is a model designed at the design stage. After the second model was established, it was then socialized and simulated to lecturers within the Faculty of Tarbiyah and Teacher Training at the Islamic Institute of Religion (IAI) Muhammadiyah Sinjai. This socialization and simulation is an empirical validation activity for the developed teaching materials.

The results of the socialization and simulation within the Faculty of Tarbiyah and Teacher Training Institute of Islamic Religion Muhammadiyah Sinjai will implement the model in the form of input and suggestions from participants. Inputs and suggestions from participants include reducing questions on teaching materials. The results of the input on the socialization and simulation activities are referred to as the third model that is ready to be implemented.

The criteria used to decide that flipbook-based teaching materials are in the category of validity as described before that three are distribution (t table) for $\alpha = 0,05$ and degree of freedom

($df = n - 2$). Conclusion rule: If $t_{count} > t_{table}$ it means valid, but otherwise $t_{count} < t_{table}$ means invalid.

Table 1 shows the results of the validity of teaching materials. The validation of teaching materials consists of material validation and display validation.

Table 1. Summary of Material Validation Results

No.	Aspects Assessed	Average Score (\bar{X})	Information
1	Material	3,87	Valid
2	Problem-Solving Questions	3,65	Valid
	Total Average Value	3,76	Valid

The results of the analysis from Table 1 can be clearly shown as follows:

The average value for the material aspect is 3.87 and it is value included in the valid category. The average value for the problem-solving questions is 3.65 and it is value is included in the valid category. So, the total average value is 3.76 and it is valid category.

Table 2. Summary of Display Validation Results

No.	Aspects assessed	Average Score (\bar{X})	Information
1	Design/Display Quality	3,26	Valid
2	Button Quality	3,55	Very Valid
3	Efficiency	3,53	Very Valid
	Total Average Value	3,56	Very Valid

The results of the analysis from Table 2 can be clearly shown as follows:

The average value for the aspect of design/display quality is 3.26 and it is value included in the valid category. The average value for the quality aspect of the button is =3.55 and it is value included in the very valid category. The average value for the application efficiency aspect is 3.53 and it is value included in the very valid category. So, the total average value is 3.56 and it is included in the very valid category.

From the results of the validity test, it can be concluded that the research instruments and applications developed in this study are valid.

The Practicality of Teaching Materials

Table 3. Practical Analysis of Teaching Materials

No.	Aspects assessed	Average Score (\bar{X})	Percentage	Information
1	Attractiveness	3,71	97,1%	Very Practical
2	Interests/Motivation	3,68	88,6%	Very Practical
3	Ease of Use	3,66	89,4%	Very Practical
4	Functionality	3,77	95,7%	Very Practical
	Total Average Value	3,70	92,7%	Very Practical

The determination is that flipbook-based teaching materials are practical if the overall student assessment percentage is above 60%. The practicality of teaching materials in terms of student assessments at the evaluation stage showed the majority of students responded positively. A total of 92.7% said that this application is practical. Thus, if viewed from the student's assessment, the teaching materials have met the practicality criteria in the "very practical" category.

If the practicality is seen from the results of the student assessment questionnaire, the score is very high. Of a total of 13 (thirteen) respondents (students) who were assessed, none of them showed a low category. There are four practical aspects of teaching materials assessed by students in flipbook-based teaching materials on the sine and cosine rule material. Based on the results of the analysis, there are 97.1% of respondents rate the attractiveness of teaching materials, 88.6% of respondents rate interest/motivation, 89.4% of respondents rate the ease of use, and 95.7% of respondents rate the functioning of teaching materials. Thus, this flipbook-based teaching material is very practical.

Effectiveness of Teaching Materials

The determination that flipbook-based teaching materials are effective if the overall student assessment percentage is above 70%. The effectiveness of teaching materials in terms of student assessments at the evaluation stage showed the majority of students responded positively. A total of 91.6% said that this application was effective. Thus, if viewed from the student's assessment, the teaching materials have met the effectiveness criteria in the "very effective" category.

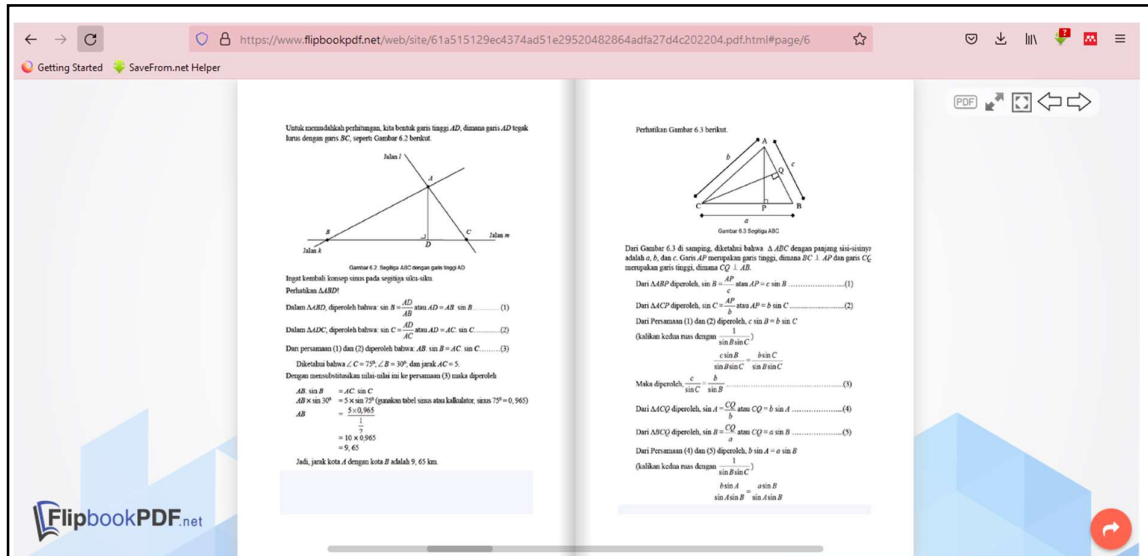
Table 4. Analysis of the Effectiveness of Teaching Materials

No.	Aspects assessed	Average Score (\bar{X})	Percentage	Information
1	Material	3,74	96,3%	Very Effective
2	Problem Solving	3,58	87,6%	Very Effective
3	Visual Communication	3,69	90,9%	Very Effective
	Total Average Value	3,67	91,6%	Very Effective

If the effectiveness is seen from the results of the student assessment questionnaire, the score is very high. Of a total of 13 (thirteen) respondents (students) who were assessed, none of them showed a low category. Table 4 shown there are three practical aspects of teaching materials assessed by students in flipbook-based teaching materials on the sine and cosine rule material. Based on the results of the analysis, there are 96.3% of respondents rate the material, 87.6% of respondents rate problem-solving, and 90.9% of respondents rate visual communication. Thus, this flipbook-based teaching material is very effective.

Based on the results of the three effectiveness indicators above, it can be concluded that flipbook-based teaching is effective. This conclusion is in line with the theory put forward by Akker (Nurjannah et al., 2022) that: (1) experts and practitioners, based on their experiences, state that the product is effective; (2) operationally, the product provides the expected results.

Figure 1 shows some screenshots of the teaching materials that have been developed which contain the sine and cosine rule material and problem-solving.



Translate

In English
To facilitate calculations, we form the AD height line, where the AD line is perpendicular to the BD line, as shown in Figure 6.2 below.

Figure 6.2. Triangle ABC with altitude AD

Recall the concept of sine in a right triangle.
Pay attention to ABD!
In $\triangle ABD$, it is obtained that:
 $\sin B = \frac{AD}{AB}$ or $AD = AB \cdot \sin B \dots(1)$

In $\triangle ADC$, it is obtained that:
 $\sin C = \frac{AD}{AC}$ or $AD = AC \cdot \sin C \dots\dots\dots(2)$

From equations (1) and (2) it is obtained that:
 $AB \cdot \sin B = AC \cdot \sin C \dots\dots\dots(3)$

It is known that $\angle C = 75^\circ$, $\angle B = 30^\circ$, and distance $AC = 5$
By substituting these values into equation (3) we get
 $AB \cdot \sin 30^\circ = 5 \cdot \sin 75^\circ$ (use a sine table or calculator, $\sin 75^\circ = 0.965$)
 $AB = \frac{5 \times 0.965}{\frac{1}{2}}$
 $AB = 10 \times 0.965$
 $AB = 9,65$
So, the distance between city A and city B is 9.65 km.

Look at Figure 6.3 below

Figure 6.3. Triangle ABC

From Figure 6.3 above, it is known that $\triangle ABC$ with the lengths of the sides are a, b, and c. The AP line is the high line, where $BC \perp AP$ and the CQ line is the high line, where $CQ \perp AB$.

From $\triangle ABP$ it is obtained, $\sin B = \frac{AP}{c}$ or $AP = c \sin B \dots(1)$

From $\triangle ACP$, $\sin C = \frac{AP}{b}$ or $AP = b \sin C \dots\dots\dots(2)$

From equations (1) and (2) it is obtained, $c \sin B = b \sin C$
(multiply both sides by $\frac{1}{\sin B \sin C}$)
 $\frac{c \sin B}{\sin B \sin C} = \frac{b \sin C}{\sin B \sin C}$

then obtained, $\frac{c}{\sin C} = \frac{b}{\sin B} \dots\dots\dots(3)$

From $\triangle ACQ$, $\sin a = \frac{CQ}{b}$ or $CQ = b \sin A \dots\dots\dots(4)$

From $\triangle BCQ$, $\sin B = \frac{CQ}{a}$ or $CQ = a \sin B \dots\dots\dots(5)$

From equations (4) and (5) it is obtained, $b \sin A = a \sin B$
(multiply both sides by $\frac{1}{\sin A \sin B}$)
 $\frac{b \sin A}{\sin A \sin B} = \frac{a \sin B}{\sin A \sin B}$

Figure 1. Display of flipbook-based teaching materials

Conclusion

Based on the research objectives and the description of the research results, the conclusions of this study are: Flipbook-based textbooks on sine and cosine rules are declared valid. These results were obtained after being tested for validity by experts, including validating teaching materials in the form of teaching materials and problem-solving questions, where all aspects were in the very effective category, namely 3.76, where the material aspect was 3.87 and the question aspect was 3.87. The problem that solves the problem is 3.65. As for Display Verification, the design/display quality aspect is 3.26, the button quality aspect is 3.55, and the efficiency aspect is 3.53, 3.56. Flipbook-based teaching materials on sine and cosine rules are stated to be practical. Based on the results of the analysis, there are 97.1% of respondents rate the attractiveness of teaching materials, 88.6% of respondents rate interest/motivation, 89.4% of respondents rate the ease of use, and 95.7% of respondents rate the functioning of teaching materials. Flipbook-based teaching materials on sine and cosine rules are declared effective. Based on the results of the analysis, there are 96.3% of respondents rate the material, 87.6% of respondents rate problem-solving, and 90.9% of respondents rate visual communication.

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