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Development of BLIFOSI Learning Media Based on Blitar City Map for Grade XI Function Transformation Material

Desy Trihandayani[1*)], Anita Dewi Utami[2)], Imam Rofiki[3)]

Mathematics Education Study Program, State University of Malang, Indonesia[1,2,3)]

*Corresponding Email: desy.trihandayani.2203116@students.um.ac.id

Abstract. *Understanding concepts is the foundation of learning mathematics. However, in reality, many students still struggle to understand mathematical concepts, including material on function transformation. Practicing structured questions and applying game-based learning models is one way to overcome these challenges. Apart from that, incorporating contextual learning with elements of local culture is important to integrate into learning activities so that students feel connected and happy while learning. This research employs the research & development method using the ADDIE (analyze, design, develop, implement, evaluate) development model. The model aims to describe the process of developing BLIFOSI (Blitar Function Transformation) media, specifically an educational board game based on the Blitar City Map, to facilitate understanding of function transformation materials. This research involved 35 students from Class XI at SMAN 2 Blitar. The validation results of media and material experts show that BLIFOSI is valid and suitable for application in learning activities. In addition, students' responses in the positive response questionnaire show that BLIFOSI is practical to use. Meanwhile, the test results showed that 94.28% of students obtained a score ≥ KKTP. These results demonstrate that BLIFOSI can support students' conceptual understanding of functional transformation material.*

Keywords*: BLIFOSI, Concept Understanding, Function Transformation*

INTRODUCTION

Conceptual understanding is a crucial foundation for developing solid knowledge (Jumaini et al., 2021). Conceptual understanding enables students to grasp a subject matter in depth, allowing them to apply it in various situations (Nurhangesti & Seruni, 2024). A good understanding of concepts enables students to relate one concept to another, understand the meaning of the procedures used, and solve problems more flexibly. One factor that influences students' understanding of concepts is the learning strategy/model used (Liberna & Lestari,

2024). Therefore, educators are required to use learning strategies/models that enable students to understand the concepts of each subject taught.

However, in reality, many students still struggle to understand mathematical concepts in depth. One subject that often poses a challenge is function transformation (Sudiarti et al., 2024). This material requires students to visualize changes in function graphs due to transformations, namely translations, reflections, dilations, and rotations, which are often difficult to understand without the aid of visual and contextual media. In practice, learning about function transformations is still dominated by symbolic and procedural approaches that do not provide sufficient space for students to thoroughly explore and understand the concepts (Koyunkaya & Yaman, 2023).

Based on interviews with one of the mathematics teachers and several students at SMAN 2 Blitar, it was found that most students struggled to understand abstract mathematical concepts such as functions and function transformations. Some students admitted that they were confused when doing math problems because they seemed difficult and irrelevant to everyday life. Students hoped for enjoyable mathematics lessons so that the material could be conveyed and understood, for example, by incorporating games into the learning process. In line with the research (Tama & Sumargiyani, 2022), students hoped for an interesting and non-boring learning atmosphere. Researchers highlight the need to develop innovative, engaging, and contextually relevant learning media, such as games, to convey the material on function transformations.

Game-based learning media can be either digital or manipulative. Manipulative games encourage active engagement, exploration, and collaboration, which can increase students' motivation and confidence in learning mathematics. One manipulative game that can be presented in the Game-Based Learning model to offer a fun and participatory learning experience is a board game. Various studies have developed board games for mathematics learning, such as MONOTIKA (Ramadhani et al., 2022), JUMANJI (Azis, 2024), GESITESKAP (Venkurnia, 2024), MagicShop (Najah & Afifah, 2024), DAKOTA (Aisyah et al., 2025), and

Math Card (Andika M. Faris et al., 2024). However, none of them specifically combine the local context of Blitar with the function transformation material.

Furthermore, a contextual approach based on locality and culture has also begun to be widely adopted in the development of learning media. Lestari & Permana (2024) and Buchori et al. (2023) emphasize the importance of integrating local elements into learning media as an effort to increase the relevance and closeness of the material to students' experiences, their activities, and their ability to understand mathematical concepts. This statement aligns with the concept of contextual learning, which posits that the learning process should be tied to the learner's environment, encompassing their geographical and cultural surroundings. Research by Inayah (2022) reinforces this view, suggesting that learning media should not only focus on content but also utilize local resources as a context for 21st-century mathematics learning. Thus, the development of learning media that can integrate the local context of Blitar, function transformation material, and incorporate the Game-Based Learning model is an urgent need to address the challenges of 21st-century learning.

In the 21st century, everyone must possess at least four essential skills: critical thinking, creative thinking, communication, and collaboration (Putri et al., 2022). A learning strategy that includes structured exercises can help students gradually hone their conceptual understanding and problem-solving skills (Ke et al., 2024). According to Apriani & Sudiansyah (2024), a lack of structured practice or exercises leads to a low level of conceptual understanding of a subject. Unfortunately, to date, there has been no mathematical board game that effectively highlights the locality of Blitar City while supporting conceptual understanding and integrating material on function transformation. This gap serves as the basis for the creation of BLIFOSI, an educational board game based on the Blitar City Map, designed to facilitate an understanding of function transformation through visual and spatial game strategies. The uniqueness of BLIFOSI lies in the modification of strategic elements from the Santorini board game, combined with mathematical concepts and the geographical context of Blitar, making it not only enjoyable but also contextual and relevant to the participants' experiences.

This study focuses on the development process of BLIFOSI media. It aims to describe the development of BLIFOSI (Blitar Function Transformation) board game media as a contextual and interactive learning medium that supports the understanding of grade XI students' concepts in function transformation material.

METHOD

The research method used is Research and Development (R&D) with the ADDIE model. The R&D method aims to produce products and test their effectiveness in an educational context, and is often used in the development of learning media (Okpatrioka, 2023). The ADDIE model is a systematic and flexible development model for creating learning media (Rosmiati & Siregar, 2021). Therefore, the R&D method, combined with the ADDIE model, is highly suitable for developing manipulative mathematics learning media. The ADDIE development model consists of five stages: Analysis, Design, Development, Implementation, and Evaluation.

Analyze

Analysis is the first stage in the ADDIE development model. Researchers analyzed the curriculum and materials used in high school mathematics learning activities. Additionally, an analysis of students' learning media needs was conducted through surveys and observations of 108 11th-grade students at SMAN 2 Blitar from 4 different classes. This stage was conducted to determine whether the media developed was aligned with the students' objectives, learning objectives, learning materials, learning environment, student needs, and delivery strategies in learning (Winarni, 2018).

Design

The second stage carried out by the researchers was the design stage. The researchers designed the media concept, starting from the name, philosophy, media design, and media application flow. At this stage, the media design was still contextual and formed the basis for the next development process (Winarni, 2018).

Development

During the development stage, the media design was realized (Winarni, 2018). BLIFOSI media was developed by selecting materials, namely the type of paper used and wooden blocks, as items for BLIFOSI media. After that, the researcher created instruments to measure media performance, namely: media validation sheets, student response questionnaires, and test questions. After the media was developed, the media validation stage was carried out by media and material experts. The results of media validation will be analyzed as follows:

The media validation results are presented by dividing the total score by the maximum score of the assessment, then multiplying by 100% as follows:

$$P = \frac{\sum x}{\sum x_1} \times 100\%$$

Explanation:

P = Percentage of score obtained

x = Total score obtained

x_1 = The maximum total score that can be obtained

After obtaining the validity percentage results, the researchers then adjusted them to the media validity indicators shown in Table 1. The media was considered practical to use if the Percentage achieved was more than 60% with a good qualification.

Table 1. Media Validity Indicators

Achievement	Qualification
$80\% < P \leq 100\%$	Very good/Very valid
$60\% < P \leq 80\%$	Good/Valid
$40\% < P \leq 60\%$	Fairly good/Fairly valid
$20\% < P \leq 40\%$	Not very good/Not very valid
$0\% < P \leq 20\%$	Not good/Not valid

Source: (Siregar dkk., 2024)

Implementation

The implementation stage involved testing the developed media in a real-world setting, specifically in the classroom (Winarni, 2018). A total of 35 grade XI students at SMAN Blitar became subjects in this stage. After the implementation activities, the practicality of the media was evaluated using a student response questionnaire, and the effectiveness of the media was assessed using test questions.

The results of the student response questionnaire and test scores were then analyzed as follows:

The results of the student response questionnaire were presented by dividing the total score by the maximum score of the assessment, then multiplying by 100% as follows:

$$P = \frac{\sum x}{\sum x_1} \times 100\%$$

Explanation:

P = Percentage of score obtained

x = Total score obtained

x_1 = The maximum total score that can be obtained

After obtaining the practicality percentage, the researcher then adjusted it to the practicality indicators shown in Table 2. The media was considered practical to use if the Percentage achieved was more than 60% with a good qualification.

Table 2. Media Practicality Indicators

Achievement	Qualification
$80\% < P \leq 100\%$	Very good/Very practical
$60\% < P \leq 80\%$	Good/Practical
$40\% < P \leq 60\%$	Fairly good/Fairly practical
$20\% < P \leq 40\%$	Poor/Less Practical
$0\% < P \leq 20\%$	Not Good/Not Practical

Source: (Siregar et al., 2024)

Test scores were analyzed based on the Learning Objective Achievement Criteria (KKTP) as follows:

$$KKTP = \frac{\sum x_2}{n}$$

Explanation:

x_2 = Student test scores

n = Number of students participating in the study

The media will be considered effective if more than 80% of the students obtain a KKTP score above 75. The KKTP threshold is set at 75, considering that this score indicates that students have mastered 75% of the expected competencies, which indicates a fairly good understanding of the learning material. This determination also takes into account the national minimum passing score of 75

(Juhairiah, 2023), student characteristics, and the complexity of the learning material. A score of 75 is considered realistic and achievable by the majority of students with optimal effort, while still being challenging enough to encourage students to strive for maximum competency.

Evaluation

In the evaluation stage, researchers critically evaluate the impact of media use in learning, measure the achievement of product development objectives, measure what students have achieved, and what has enabled students to achieve this (Winarni, 2018). Researchers carry out this stage through several things, namely: (1) Summarizing the results of personal reflection as a teacher from the analyze to implementation stages, (2) Analyzing the results of media validation, student response questionnaire results, and test scores obtained during the implementation stage, (3) Direct observation during the learning process to see student participation and responses.

RESULTS AND DISCUSSION

This research follows the ADDIE development model procedure, namely (1) analyze, (2) design, (3) development, (4) implement, and (5) evaluation. The following is a description of the results of the BLIFOSI media development.

Analyze

The researcher analyzed the material, curriculum, and student needs through observation, written surveys, and literature studies. The results obtained were that the material studied in the even semester was composition & inverse functions and function transformations. The curriculum applied was the Merdeka Curriculum, utilizing the Student Centered Learning (SCL) approach. The SCL approach emphasizes students as the center of the learning process, focusing on their needs, talents, and interests (Putra et al., 2024). From the results of a written survey regarding the learning expected by students, it was found that students wanted to have interesting learning interspersed with games. Based on observations, students began to become unruly during mathematics lessons because they were held close to break time or the end of the school day.

Based on the analysis conducted, the researchers chose to develop a mathematics learning medium, namely a gameboard. Board games help make it easier for students to accept the material because they feel like playing (Thirafi & Akbarsyah, 2024). The material chosen was a function transformation. The researchers observed that learning function transformation was important and that understanding the material required practicing questions.

Design

At this stage, the researcher designed the concept of the media, encompassing the name, philosophy, design, and flow of the media application. Then the researcher found a name, BLIFOSI, which stands for Blitar Function Transformation. Through this media, grade XI high school students are expected to be able to solve function transformation problems correctly with a touch of Blitar City's locality. In addition, students are also expected to think actively and creatively in devising strategies to win the game.

The first step taken by the researchers was to determine the specifications of the product being developed. The next step in product design was to create a storyboard. A storyboard is an alternative method for sketching images of a product based on an idea (Khulsum et al., 2018). Storyboards are used to help design learning media by creating rough sketches before creating the actual learning media. The researchers then designed the BLIFOSI media using Canva software. They began by designing the media packaging, the media itself, and all its components, then created a flowchart for its application. The media developed can be seen as follows:

Figure 1. BLIFOSI Game Board

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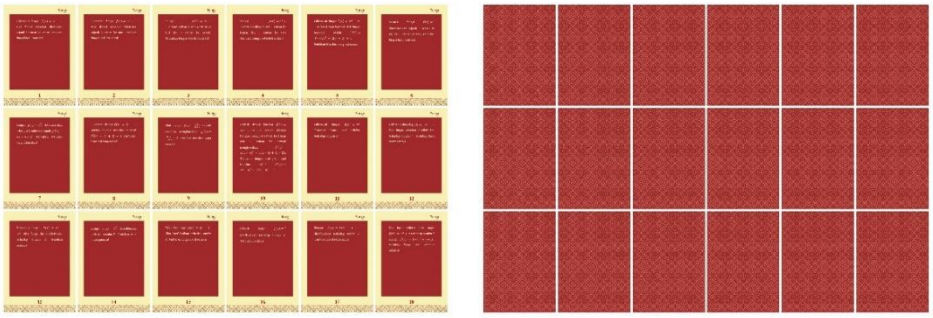

Figure 2. BLIFOSI Question Cards (Front and Back)

BLIFOSI question cards contain different function transformation questions on each card. The question cards included a card number at the bottom, making it easier for players to determine whether their answers were correct or incorrect.

Figure 3. BLIFOSI Power Card (Front and Back)

The BLIFOSI power card is a card that players can obtain by answering three questions correctly in a row. This card contains game advantages that players can utilize.

Figure 4. BLIFOSI Game Guide

The BLIFOSI game guide provides instructions to help players easily navigate the game, including explanations of the game components and rules.

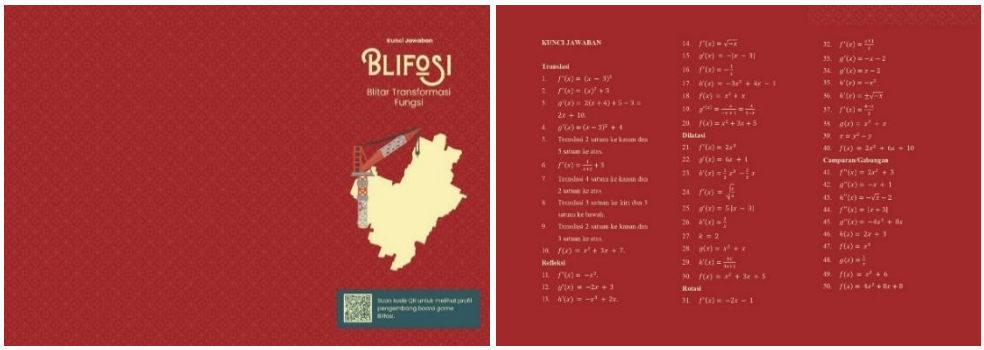

Figure 5. BLIFOSI Answer Key

The BLIFOSI answer key contains the answers to each question on the question cards. The numbers used in the answer key correspond to the numbers on the question cards.

Development

At this stage, the researchers developed the BLIFOSI media through a process of physical design and material selection. The researchers also compiled research instruments in the form of media validation sheets, response questionnaires, and test questions, which were then validated by media and material experts. The material selected for the BLIFOSI building components and pawns was wood.

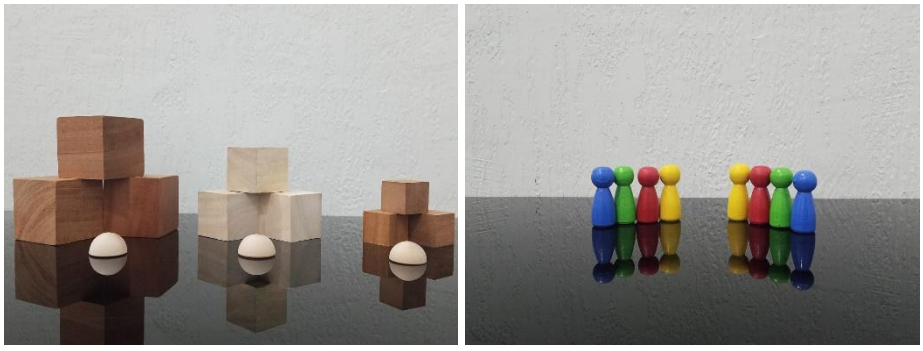

Figure 6. BLIFOSI Building Components and Pawns

The material for the game board, question cards, power cards, game guide, and answer key is art paper with varying thicknesses.

Figure 7. Top View of BLIFOSI Media

At this stage, the developed learning media is validated by validators. Validation is crucial in determining whether the learning media are suitable for use. Based on the validation results, it can be determined whether the media still needs improvement or is ready for implementation (Winarni, 2018). Three validators validated the BLIFOSI media, namely one mathematics lecturer from Malang State University and two high school mathematics teachers.

The results obtained from the three validators can be seen in the following table:

Table 3. Analysis of Media Validation Results

Statement	Validator 1	Validator 2	Validator 3
Clarity of BLIFOSI media usage guidelines	5	5	4
Ease of use of BLIFOSI media	5	4	4
Attractiveness of BLIFOSI media for use by students	5	5	4
Suitability of BLIFOSI media with basic competencies of Function Transformation material	5	4	4
Suitability of BLIFOSI media to support the achievement of learning objectives	5	4	4
Accuracy of BLIFOSI media to increase student learning motivation	5	5	4
Accuracy of BLIFOSI media image design	5	5	5
Total Validity Score	35	32	29
Average Validity Score	5	4,57	4,14
Average Validity Score Percentage	100%	91,42%	82,85%
Validity Criteria	Very Good	Very Good	Very Good

Based on Table 3, it can be seen that the average Percentage of validator 1's validity score is 100%, which is classified as very good/highly valid. The average validity score percentage for validator 2 is 91.42%, which falls into the very good/highly valid category. Moreover, the average validity score percentage for validator 3 is 82.85%. Thus, the average Percentage for the three validators is 91.42% and falls into the very good/highly valid category.

Table 4. Analysis of Material Validation Results

Statement	Validator 1	Validator 2	Validator 3
The suitability of the material on the BLIFOSI media with basic competencies and indicators	5	4	4
Alignment of material on BLIFOSI media with learning objectives	5	4	4
Material on BLIFOSI media is easy for students to understand	5	5	4
Material on BLIFOSI media is appropriate for students' abilities	5	5	4
Material on BLIFOSI media trains students to think critically and creatively	5	5	4
The material on the BLIFOSI media is clear and presented in a simple manner	5	5	5
Total Validity Score	30	28	25
Average Validity Score	5	4,66	4,16
Average Validity Score Percentage	100%	93,33%	83,33%
Validity Criteria	Very Good	Very Good	Very Good

Based on Table 4, it can be seen that the average validity score percentage of validator 1 is 100%, which falls into the very good/very valid category. The average validity score percentage for validator 2 is 93.33%, which falls into the very good/highly valid category. Moreover, the average validity score percentage for validator 3 is 83.33%. Thus, the average Percentage for the three validators is 92.22% and falls into the very good/highly valid category.

Table 5. Analysis of Language Validity Validation Results

Statement	Validator 1	Validator 2	Validator 3
The language used in BLIFOSI media is easy for students to understand	5	5	4
The sentences used in BLIFOSI media are simple	5	5	5
The spelling of sentences in the BLIFOSI media is correct	5	5	4
The use of words in the BLIFOSI media usage guide is clear and not confusing	5	5	4
The language used is not ambiguous	5	5	5
Total Validity Score	25	25	22
Average Validity Score	5	5	4,4
Average Validity Score Percentage	100%	100%	88%
Validity Criteria	Very Good	Very Good	Very Good

Based on Table 5, it can be seen that the average validity score percentage of validator 1 is 100%, which falls into the very good/very valid category. The average validity score percentage for validator 2 is 100%, which falls into the very good/highly valid category. The average validity score percentage for validator 3 is 88%. Therefore, the average Percentage for the three validators is 96%, which falls into the very good/highly valid category.

After further analysis of the three tables above, the average Percentage of validity scores for all aspects was found to be 93.21%. This result indicates that BLIFOSI media falls into the very good/highly valid category. Therefore, BLIFOSI media is suitable for use and implementation in schools. This conclusion aligns with the research by Rohmah and Bukhori (2020), which suggests that media that meet validity criteria are suitable for use in mathematics learning. However, the validators provided several suggestions, including enlarging the game map from Blitar City to East Java and developing BLIFOSI media into digital learning media, which cannot be developed at this time.

Implementation

The implementation of BLIFOSI media was carried out for 35 students in class XI E of SMAN 2 Blitar. The implementation took place on Tuesday, May 28, 2025, during mathematics class. At the beginning of the implementation activity, the teacher explained the rules and components of the BLIFOSI game.

Figure 8. Implementation of BLIFOSI Media (1)

Next, the students were divided into four large groups consisting of 8-9 people. Then each group elected a group leader, devised a game strategy, determined the order of play, and chose a group pawn.

Figure 9. Implementation of BLIFOSI Media (2)

The next step was for each group to take turns picking up 1 question card to work on. A group representative then presented the answer to the teacher for verification against the answer key to determine if it was correct or incorrect. If the answer was correct, the group could move their pawn up, down, right, or left by one step and build one building, with the stipulation that they had to start with the largest building. If the answer was incorrect, the pawn remained in place and waited for the next turn to take another question card. If a group successfully answers three questions correctly in a row, they will receive one power card that can be used in the next round of the game. The power card is used to increase the competitive spirit of the students in the game. The game ends with the determination of the BLIFOSI game winner, namely the one who has built the most buildings.

Figure 10. Implementation of BLIFOSI Media (3)

At the end of the media implementation activity, students were asked to complete a response questionnaire and a test. The test questions were also used as a daily test on function transformation. The test consisted of 10 questions, with each set of 2 questions representing one sub-topic that students had to complete.

Figure 11. Implementation of BLIFOSI Media (4)

The results of the student response questionnaire were used to measure the practicality of using BLIFOSI media. In line with the opinion (Toma & Reinita, 2023), the practicality of the media is determined by the results of user assessments. The results obtained from the student response questionnaire can be seen in the following table:

Table 6: Analysis of Student Response Questionnaire Results

Aspect	Average Score
I find it easy to understand the Function Transformation material using BLIFOSI media	3,21
I do not feel bored using BLIFOSI media in learning the Function Transformation material	4,06
I am more motivated to discuss with friends after using BLIFOSI media	4,18

Aspect	Average Score
I find it easy to understand the rules for using BLIFOSI media	3,25
I can use BLIFOSI media easily	3,18
I am more motivated to learn after using BLIFOSI media	3,53
Using BLIFOSI media is a new experience for me	4,68
Total Practicality Score	26,09
Average Practicality Score	3,72
Percentage of Practicality Score	74,5%
Practicality Criteria	Good/Practical

Based on Table 6, it can be seen that the average Percentage of the student response questionnaire score for assessing the practicality of the media is 74.5%, which is in the good/practical category. This result shows that BLIFOSI media is practical for use in learning activities.

Additionally, researchers assessed the effectiveness of media use by measuring student test results. The test results are shown in the following table:

Table 7 Test Result Analysis

Aspect	Average Score
Number of Students	35
Average Test Score	85,28
Lowest Score	32
Highest Score	100
Number of Students Who Scored Above KKTP	33
Number of Students Who Scored Below KKTP	2
Percentage of Students Achieving a Score ≥ KKTP	94,28%

Based on Table 7, it can be seen that 33 out of 35 students, or 94.28% achieved a score greater than or equal to KKTP, with a classical average of 85.28. The range of scores obtained by students was 32 to 100. These results indicate that the BLIFOSI learning media are effective for use in teaching and learning activities. Additionally, a correlation exists between conceptual understanding and test results (Susanto & Anggresta, 2024). Conceptual understanding is directly proportional to student test results/learning outcomes. Thus, good test results indicate that students also have a good understanding of the concepts.

Evaluation

After the implementation stage was completed, the researchers conducted an evaluation. The results showed that the BLIFOSI media was highly valid, practical, and effective. The BLIFOSI game mechanism, which requires students to solve function transformation problems to advance in the game, has been proven to increase engagement and conceptual understanding, as evidenced by the test results and student responses. The situation was evident during the implementation of BLIFOSI media in the classroom, where students were actively engaged in interacting with their teachers and peers while learning (Wirjana & Sumandya, 2023). Researchers assess that the BLIFOSI media still requires revision regarding the guidelines for using the media, so that it can be used individually or in groups (Nurfadhillah, 2021), as well as the Blitar ethnomathematics questions. Revision is necessary to enable researchers to develop the optimal BLIFOSI media (Fareza & Zuhdi, 2023). Additionally, it is necessary to re-examine the suggestions provided by the validators regarding the BLIFOSI media.

CONCLUSION

This study successfully developed and described the process of developing BLIFOSI (Blitar Function Transformation) media, providing valid, practical, and effective Function Transformation material for grade XI. The BLIFOSI media met the criteria of being highly valid with a score of 93.21%, practical with a score of 74.5%, and effective, with 94.28% of students achieving KKTP. Therefore, it can be said that the BLIFOSI media is suitable for use in learning activities after the media has been revised.

Although the BLIFOSI media has been proven to be feasible, this study is still limited to one school with a certain number of respondents and preliminary trials, so the results cannot be generalized. Nevertheless, BLIFOSI can be an alternative interactive medium for teachers to teach Function Transformation in a more concrete and enjoyable way, as well as a school innovation to support game-based learning that encourages student activity and motivation.

The suggestion for further research is to apply the revised BLIFOSI media to grade XI high school students on a small scale, specifically with 3-5 participants, and on a larger scale, involving an entire class. If the BLIFOSI media is already optimal, it can be further developed into digital learning media after a review.

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