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THE DEVELOPMENT OF ANDROID BASED INSTRUCTIONAL MEDIA TO IMPROVE MATHEMATICAL UNDERSTANDING ON PYTHAGOREAN THEOREM

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ABSTRACT

Mathematical understanding is an essential goal of mathematics learning, particularly for abstract topics such as the Pythagorean Theorem, which require strong conceptual comprehension. However, mathematics instruction at the junior high school level is still largely dominated by conventional methods with limited use of interactive learning media, causing students to experience difficulties in understanding concepts. This study aims to develop an interactive Android-based learning multimedia, Pytha-Go, for the Pythagorean Theorem material for eighth-grade students at SMP Negeri 13 Tibawa. This research employed a Research and Development (R&D) approach using a modified 4D development model consisting of three stages: Define, Design, and Develop. The Define stage identified learning problems and student needs through observations and interviews. The Design stage focused on designing the structure, learning content, and interface of the multimedia. The Develop stage involved media production, expert validation, readability testing, and limited trials. Data were collected using media and material expert validation questionnaires, media readability test instruments, teacher observation sheets, and student response questionnaires. The results showed that the average scores from media and material expert validation were 3.23 and 3.17, categorized as very valid and valid. The media readability test obtained an average score of 3.34, indicating that the multimedia is feasible. Teacher observation and student response scores were 3.35 and 3.58, respectively, categorized as very practical. Based on these findings, it can be concluded that the *Pytha-Go* Android-based learning multimedia is feasible and practical for supporting the learning of the Pythagorean Theorem for eighth-grade students.

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INTRODUCTION

Mathematical understanding is a primary goal of mathematics learning because it enables students not only to memorize formulas but also to comprehend concepts, relationships, and their applications in various contexts. Mathematics plays an important role in developing

logical, analytical, and systematic thinking skills; therefore, conceptual understanding serves as a fundamental foundation in mathematics education (Supriyatno et al., 2020).. Meaningful learning occurs when students actively explore and construct knowledge from various sources and then process it to develop deeper understanding (Paputungan & Mohidin, 2023)

As a systematic and hierarchical discipline, mathematics requires students to understand concepts sequentially and in an interconnected manner. A lack of understanding of a basic concept can hinder the comprehension of subsequent concepts (Pauweni et al., 2022). One topic that demands strong conceptual understanding is the Pythagorean Theorem. This topic requires not only procedural skills but also an understanding of geometric concepts as well as square and root operations. However, various studies indicate that students still experience difficulties in understanding the Pythagorean Theorem and tend to rely on formula memorization (Dewi et al., 2022). In addition, mathematics is often perceived as a difficult and abstract subject, which negatively affects students' motivation and engagement in learning (Hanifah et al., 2023).

In the Indonesian context, mathematics instruction is still dominated by procedural approaches and textbook-based learning. Similar conditions were found at SMP Negeri 13 Tibawa, where learning is still dominated by conventional methods and the use of textbooks, with limited interactive instructional media. This situation causes learning to be less engaging and leads students to experience difficulties in understanding concepts, particularly in identifying the sides of right triangles and performing square and root operations.

One effort that can be undertaken to address these problems is the use of technology-based instructional media, particularly Android-based learning multimedia. Bito & Masaong, (2023) state that the use of innovative instructional media can help concretize abstract mathematical concepts. Usman et al., (2022) add that learning multimedia are able to integrate text, images, animations, audio, and video, thereby making the learning process more effective and engaging. Specifically, (Rahayu et al., 2022) demonstrate that the use of Android-based instructional media can improve the quality of mathematics learning. These findings are strengthened by (Ali et al., 2023), who show that Android-based mathematics applications have a positive effect on students' mathematical understanding and attitudes toward mathematics.

Furthermore, interactive multimedia encourage two-way interaction between students and learning materials. Caesariani et al., (2018) explain that interactive multimedia enable students to actively engage in the learning process, thereby making learning more meaningful. In modern learning environments, teachers no longer serve as the sole source of information but act as facilitators who support students' learning exploration (Layco, 2022).

Based on these considerations, this study aims to develop an Android-based learning multimedia called Pytha-Go for the topic of the Pythagorean theorem. The study focuses on producing a learning media that is valid, practical, and effective in supporting Grade VIII students of SMP Negeri 13 Tibawa in developing a conceptual understanding of the Pythagorean theorem. It is expected that the developed media will enhance students' mathematical understanding and support more effective mathematics learning.

METHOD

This study employs a Research and Development (R&D) approach with the aim of producing an interactive learning multimedia product. The research subjects consisted of 28 eighth-grade students from SMP Negeri 13 Tibawa. The development model adopted in this study is the Four-D (4-D) Model proposed by Sivasailam Thiagarajan, Dorothy S. Semmel, and Melyn I. Semmel which comprises four stages, namely Define, Design, Develop, and Disseminate (Slamet, 2022).

This model was chosen because it provides systematic steps and is relevant for developing instructional materials in a structured manner. However, in this study, a modification was made by limiting the process only to the Develop stage, considering that the research focuses on producing high-quality learning multimedia.

The data collection techniques employed several instruments, namely expert validation sheets to assess the feasibility of the media, readability test sheets to evaluate the level of clarity and comprehensibility of the learning media when implemented in the learning process, as wellasteacher observation sheets and student response questionnaires to determine the practicality and acceptance of the developed multimedia. The modified flowchart of the multimedia development model (Bito, 2009) based on the 4D model was used as a reference in this study :

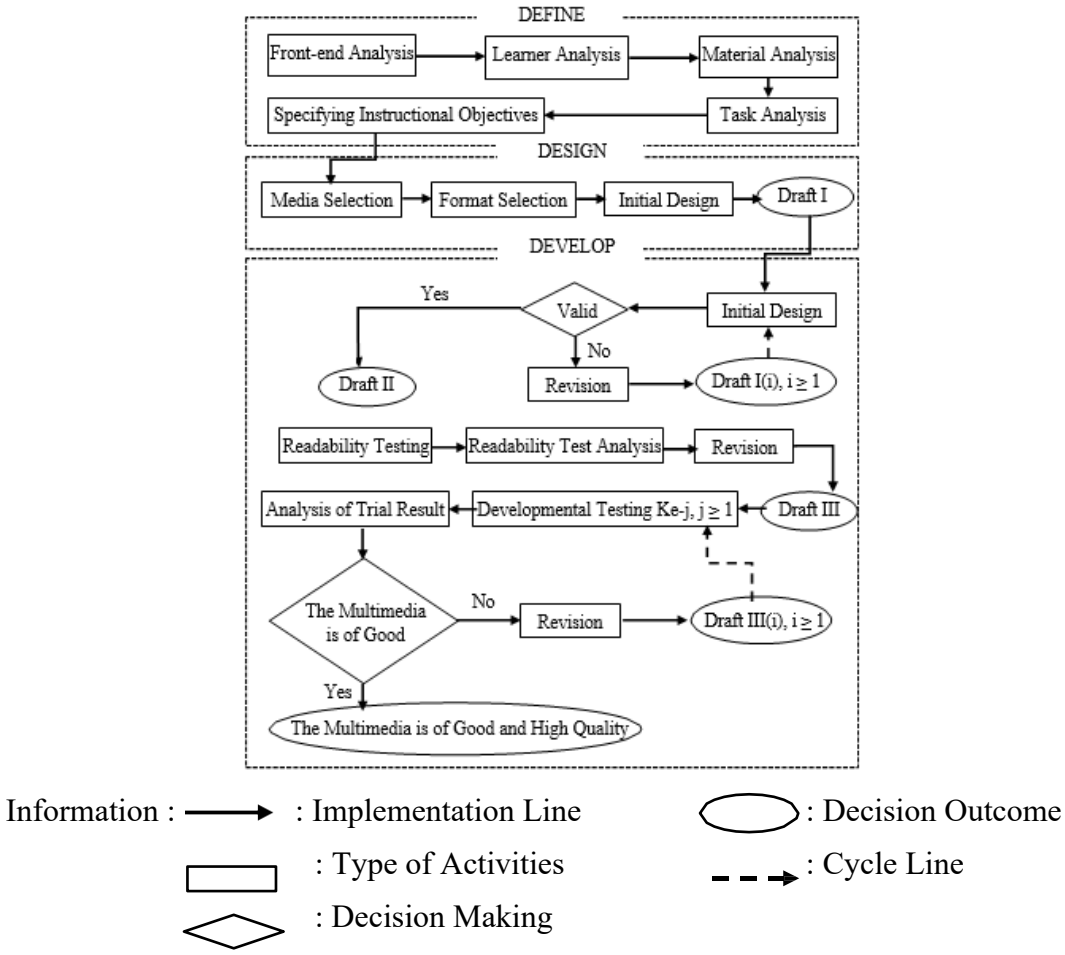

Figure 1 Flowchart of the 4D Model

The collected response data were analyzed using a Likert scale. According to (Sugiyono, 2019), the Likert scale is used as a measurement tool to assess the attitudes, views, and perceptions of individuals or communities toward a social phenomenon.

RESULTS AND DISCUSSION

Result

The study and development process followed the 4D model, which consists of four phases: define, design, develop, and disseminate. However, since this development was limited to producing a well-developed multimedia product, the dissemination phase was not carried out. The following are the research findings obtained based on the stages of the 4D model:

1. Define

a. Front-end Analysis

Based on the observations conducted at SMP Negeri 13 Tibawa, several problems were identified, including the limited use of media in the learning process. This became the main reason for the researcher to develop the Pytha-Go learning multimedia. The lack of media integration was found to negatively affect the quality of learning, particularly in terms of conceptual understanding, learning motivation, and student engagement. In addition, the Pythagorean theorem material is also considered difficult. One of the students' difficulties lies in distinguishing the sides of a right triangle. Other challenges include performing operations involving squares and square roots, which are integral components of calculations in the Pythagorean theorem

b. Learner Analysis

The research findings indicate that a significant number of students still show low interest in learning mathematics. They often feel bored and unmotivated when learning relies solely on textbooks as the primary source, compounded by teacher-centered instruction.

c. Material Analysis

The material analysis in this study focuses on the Pythagorean Theorem, which is one of the core topics taught to eighth-grade students at SMP Negeri 13 Tibawa. Several subtopics within the Pythagorean Theorem were selected by the researcher, including the basic concept of the theorem, Pythagorean triples, the ratio of sides in an isosceles right triangle, and the ratio of sides in a right triangle with angles of 30°, 60°, 90°.

d. Task Analysis

The task analysis for the Pythagorean Theorem was conducted to identify the skills required by students in accordance with the learning outcomes and objectives to be achieved.

e. Specifying Instructutional Objectives

The learning objectives for developing the Android-based multimedia learning application Pytha-Go are outlined as follows:

- After learning using the Pytha-Go application on the Pythagorean Theorem, students are able to determine the validity of the theorem correctly.
- After learning using the Pytha-Go application on the Pythagorean Theorem, students are able to identify Pythagorean triples accurately.
- After learning using the Pytha-Go application on the Pythagorean Theorem, students are able to solve problems involving side ratios in isosceles right triangles and right triangles with angles of 30°, 60°, and 90°.

2. Design

a. Media Selection

At this stage, the researcher selected the appropriate media format, namely an Android-based application that can be accessed both online and offline. The Pytha-Go application was chosen because it allows the material to be presented in accordance with the research objectives. Several supporting tools were used during the development process, including Canva, I Spring Suite 11, Microsoft PowerPoint, and Web2APK Builder.

b. Format Selection

The format selection process involved dividing the learning material into several structured subtopics. This included detailed descriptions of the content, example problems, practice exercises presented in the form of simple games, and the chosen development format.

c. Initial Design

The initial design of the Pytha-Go application consisted of three main stages. First, Canva was used to create visual elements such as backgrounds, buttons, icons, and videos. Second, Microsoft PowerPoint was utilized to structure the layout and learning materials. Finally, the draft was converted into an Android application using iSpring Suite and Web2APK Builder, resulting in the first draft of the Pytha-Go application. The following presents the design output:

- Initial Display

  The initial display of the Pytha-Go application was created to be simple yet appealing, with the application title centered on the screen to match the characteristics of junior high school students. This page contains two main buttons: Start, which leads to the main menu, and Music On/Off, which allows users to control background audio.

Figure 2 Initial Display

- Main Menu Page

  The main menu page of Pytha-Go displays four main buttons, namely the application developer profile, user instructions, learning materials, and practice questions/games.

Figure 3 Main Menu Page

- Developer Profile Page

  This page displays information about the application developer, such as name and university affiliation, allowing users to identify the creator of Pytha-Go.

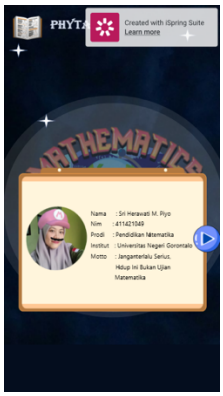

Figure 4 Developer Profile Page

- User Instructions Page

  This page contains guidelines and information on the subtopics of the Pythagorean Theorem, enabling users to understand the content as well as how to use the features of the application.

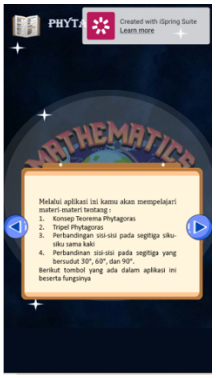

Figure 5 User Instructions Page

- Materials Page

  This page contains the learning materials on the Pythagorean Theorem, covering topics from the basic concepts to the ratios of the sides in right triangles. In addition to textual explanations, illustrative videos and problem discussions are also provided.

Figure 6 Materials Page

- Quiz/Games Page

  This page contains multiple-choice questions presented in the form of a simple game to make the learning experience more enjoyable.

Figure 7 Quiz/Games Page

3. Develop

a. Expert Validation Test for Material and Media

The validation test was conducted by three expert validators for the material and three for the media. The evaluation was carried out to determine the validity of the application design. The aspects evaluated in the material included content suitability and the accuracy of language usage. The following presents the results of the expert material validation

Table 1. Result of the Material Expert Validation Analysis

No	Assessed Aspects	Assessment Criteria			
		1	**2**	**3**	**4**
1	Content Appropriateness	0	0	2	1
		0	0	3	0
		0	0	3	0
		0	0	2	1
		0	0	2	1
		0	0	2	1
		0	0	3	0
		0	0	2	1
2	Leanguage Appropriateness	0	0	3	0
		0	1	1	1
Overall Assessment : Suitable for use with minor revisions					

Furthermore, the aspects evaluated in the media included display design, audio, video, animation, and user-friendliness. The results of the media expert validation can be seen in the following table:

Table 2. Result of the Media Expert Validation Analysis

No	Assessed Aspects	Assessment Criteria			
		1	**2**	**3**	**4**
1	Display Design	0	0	3	0
		0	0	2	1
		0	0	1	2
		0	0	3	0
		0	0	3	0
		0	0	1	2
		0	0	1	2
		0	0	3	0

		0	0	3	0
2	Audio	0	0	2	1
		0	0	3	0
		0	0	3	0
3	Video	0	0	1	2
		0	0	2	1
		0	0	3	0
4	Animation	0	0	3	0
		0	1	2	0
		0	0	1	2
5	User Friendly	0	0	2	1
		0	0	2	1
Overall Assessment : Suitable for use with minor revisions					

Based on the data obtained from Tables 1 and 2, it can be seen that each validator, both material and media experts, provided ratings ranging from 2 to 4. This indicates that the Pytha-Go multimedia is valid and can be trialed, although minor improvements or revisions are required. The comments and suggestions provided by the validators were used as a basis for consideration.

After revising Draft I by taking into account the feedback and suggestions from the media experts, Draft II was produced, which will be used in the media readability test.

b. Media Readability Test

Following the validation by the experts, the application was trialed with 5 students as a sample to test the readability of the Pytha-Go application. The distributed trial questionnaire yielded the following results:

Table 3. Readability Test Analysis Results of the Media

No	**Assessed Aspects**	**Assessment Criteria**			
		1	**2**	**3**	**4**
1	Display Design	0	0	2	3
		0	0	1	4
		0	1	1	3
2	Content and Language Suitability	0	0	3	2
		0	2	2	1
		0	0	3	2
		0	0	4	1
3	Student Interest	0	1	1	3
		0	0	4	1
4	User Friendly	0	0	4	1
Overall Assessment : Suitable for use with minor revisions					

Based on the obtained data, it can be seen that the respondents provided ratings ranging from 2 to 4. This indicates that the Pytha-Go multimedia is feasible and can be trialed, although minor improvements or revisions are required. From the readability test, several suggestions and feedback were received from the students. Based on this input, the researcher revised the Pytha-Go application, resulting in Draft III from the revision of Draft II.

c. Limited Trial

In this development trial, the application and observation questionnaires were distributed to mathematics teachers and eighth-grade students of SMP Negeri 13 Tibawa to assess the practicality of the developed application. The teacher observation sheets and student response questionnaires included several variables used as evaluation aspects.

Table 4. Result of Teacher Observation Analysis

No.	Assessed Aspects	Teacher Observations Result
1	Display Design	3
		3
2	Content Appropriateness	3
		4
		3
		3
		3
		4
		3
3	User Friendly	3
		4
		4
		3
		3
4	User Interest	3
		4
		4
		3
		3
		4
Average		3,35

From the calculation, an average score of 3.35 was obtained. Therefore, the Pytha-Go Android-based learning multimedia is considered practical with the criterion of 'Very Practical'. The results of the student response questionnaire can be seen in the following table:

Table 5. Result of Student Response Score Analysis

No	Assessed Aspects	Assessment Criteria			
		1	2	3	4
1	Display Design	0	0	10	18
		0	0	19	9
		0	0	17	11
		0	0	2	26
2	User Friendly	0	0	11	17
		0	0	12	16
3	User Interest	0	0	9	19
		0	0	23	5
		0	0	17	11
		0	0	13	15
4		0	0	12	16

Learning Materials and Practice Exercises/Games	0	0	17	11
	0	0	12	16
	0	0	12	16
	0	0	8	20
Average	3,58			
Criteria	Very Practical			

After conducting the trial of Draft III, it was found that the students' average ratings ranged from 3 to 4. This indicates that the Pytha-Go Android-based learning multimedia on the Pythagorean Theorem is feasible and practical for use in learning activities. Thus, it can be concluded that the Pytha-Go learning multimedia is well-developed.

Based on the research results, the Pytha-Go Android-based learning multimedia developed for eighth-grade students at SMP Negeri 13 Tibawa has proven to be highly practical and can be effectively utilized in the learning process for the Pythagorean Theorem.

Discussions

The results of this study indicate that the Android-based learning multimedia Pytha-Go is valid, practical, and effective in supporting students' understanding of the Pythagorean Theorem. These findings strengthen previous research on the effectiveness of technology-based instructional media in mathematics learning.

At the Define stage, it was found that mathematics instruction remained teacher-centered and monotonous, which contributed to students' difficulties in understanding the Pythagorean Theorem. This result is consistent with the findings of Hanifah et al., (2023) and Rahayu et al., (2022), who reported that limited use of interactive media negatively affects students' conceptual understanding. Students' difficulties in identifying the sides of right triangles and performing square and root operations support the findings of Dewi et al., (2022) and Saputri, et al. (2023), which indicate that the abstract nature of the Pythagorean Theorem often leads students to rely on formula memorization rather than conceptual understanding. The integration of animations, instructional videos, and game-based exercises in *Pytha-Go* was shown to increase student engagement and learning motivation. This finding aligns with Usman et al., (2022) and Bito & Masaong, (2023), who emphasized that multimedia learning can concretize abstract mathematical concepts and make learning more engaging.

The validation and readability test results demonstrated that the Pytha-Go multimedia is suitable for use with minor revisions. This outcome is in line with the studies of Indrawan et al., (2020) and Caesariani et al., (2018), which reported that Android-based learning media are feasible and appropriate for classroom implementation. Furthermore, the highly positive responses from teachers and students reinforce the findings of Ali et al., (2023) and Rahayu et al., (2022), who concluded that Android-based mathematics media are practical and effective. Overall, this study confirms and extends previous research, demonstrating that Android-based learning multimedia is an effective solution for improving students' mathematical understanding, particularly of the Pythagorean Theorem at the junior high school level.

CONCLUSION

This study answers the research question by demonstrating that the Android-based interactive learning multimedia Pytha-Go is valid, practical, and feasible for use in learning the Pythagorean Theorem for eighth-grade students at SMP Negeri 13 Tibawa. The development process, which employed a modified 4D model, resulted in multimedia that effectively supports students' learning through interactive content, animations, videos, and evaluation features. Expert validation results confirmed that Pytha-Go meets the required standards of content accuracy and media quality, with only minor revisions needed. Readability testing and limited

trials further showed positive responses from students and teachers, indicating that the multimedia is easy to use, engaging, and effective in supporting mathematics learning. These findings confirm that Pytha-Go can serve as a practical instructional medium to enhance students' motivation and understanding of the Pythagorean Theorem.

For future research, it is recommended that Pytha-Go be implemented on a larger scale to examine its effectiveness in improving students' mathematical understanding through experimental or quasi-experimental designs. Further studies may also explore the integration of additional mathematical topics, adaptive learning features, or learning analytics to enhance personalization and learning outcomes.

REFERENCES

Ali, M. S. B., Yasmeen, R., & Munawar, Z. (2023). The impact of technology integration on student engagement and achievement in mathematics education: A systematic review. International Journal of Computer Integrated Manufacturing, 6(3), 222–232.

Bito, N., & Masaong, A. K. (2023). *Peran Media Pembelajaran Matematika sebagai Teknologi dan Solusi dalam Pendidikan Di Era Digitalisasi dan Disruption*. *4*(1), 88–97.

Bito, N., Mululing, R.A., & Isa, D. R. (2023). Pengembangan multimedia pembelajaran interaktif berbasis android pada materi koordinat kartesius kelas viii smp negeri 1 suwawa 1,2,3). FIBONACCI: Jurnal Pendidikan Matematika Dan Matematika, 9, 141–156.

Bito, N. (2009). Pembelajaran berdasarkan masalah untuk sub materi pokok prisma dan limas di kelas VIII SMP Negeri 11 Gorontalo. Universitas Negeri Surabaya.

Caesariani, N. A., Matematika, M. P., Pasca, P., & Universitas, S. (2018). PEMANFAATAN MULTIMEDIA INTERAKTIF PADA MODEL PROBLEM BASED LEARNING (PBL) DALAM PEMBELAJARAN MATEMATIKA. 2, 832–840.

Dewi, E., Ritonga, S., & Hasibuan, L. R. (2022). Analisis Kesulitan Siswa dalam Pembelajaran Matematika Materi Teorema Pythagoras Ditinjau dari Minat Belajar Siswa di SMP Negeri 1 Rantau Utara. 06(02), 1449–1460.

Hanifah, U., Worowirastri, D., Fitri, D., & Aini, N. (2023). A systematic literature review of mathematics learning media and its contributions.

Indrawan, I., Wijoyo, H., Wiguna, I. M. A., & Wardani, E. (2020). Media Pembelajaran Berbasis Multimedia. Pena Persada. Purwokerto Selatan.

Layco, E. P. (2022). Mathematics Education 4 . 0 : Teachers ` Competence and Skills ` Readiness in Facing the Impact of Industry 4 . 0 on Education. 6(2), 1233–1259.

Paputungan, I., & Mohidin, A. D. (2023). Research in the Mathematical and Natural Sciences Analisis Pemahaman Matematika dalam Pembelajaran Menggunakan Multimedia Interaktif Pada Materi Segiempat. 2(1), 1–8. https://doi.org/10.55657/rmns.v2i1.71

Pauweni, K. A. Y., Uwange, D. I., Ismail, S., & Kobandaha, P. E. (2022). Peningkatan Hasil Belajar Siswa pada Materi Teorema Pythagoras Menggunakan Aplikasi Geogebra di Kelas VIII SMP Negeri 15 Gorontalo. 06(03), 2660–2672.

Rahayu, W., Irawan, A., & Nuzulah, R. (2022). Android-Based Mathematics Learning Application with Elements of Etnomathematic Sundanese Traditional Games. 6(1), 39–48.

Saputri, N., Izzati, N., & Siregar, N. A. R. (2023). Video Pembelajaran Interaktif dengan Konteks Kemaritiman pada Materi Teorema Phytagoras. AKSIOMA : Jurnal Matematika Dan Pendidikan Matematika, 14(3), 469–482.

Sugiyono, P. D. (2019). metode penelitian pendidikan (kuantitatif, kualitatif, kombinasi, R&D dan penelitian pendidikan). Metode Penelitian Pendidikan, 67, 18.

Supriyatno, T., Negeri, F. I., & Malik, M. (2020). Cypriot Journal of Educational E-learning development in improving students ' critical thinking ability. 15(5), 1099–1106.

Usman, P., Yahya, L., Bito, N., & Rianto, B. (2022). Efektivitas Pembelajaran Matematika Menggunakan Multimedia pada Materi Kerucut. 3(2), 100–106. https://doi.org/10.34312/jmathedu.v3i2.10