UNNES JOURNALS

Kreano, Jurnal Matematika Kreatif-Inovatif
Volume 14, number 1, 2023, pp. 111-122

Development of Codular-Based Mathbox Media to Improve Students' Self-assessment and Understanding of The Pythagorean Theorem

Siti Maria Ulfa[1], Moh. Mahfud Effendi[1], and Rizal Dian Azmi[1]

[1]Mathematics Education, FKIP, University of Muhammadiyah Malang

Correspondence should be addressed to Moh. Mahfud Effendi: mahfud@umm.ac.id

Abstract

This study uses 'Matchbox' media which is focused and aims to improve students' self-assessment and understanding and is developed using the Codular website. The research method used is Research and Development (R&D) with the ADDIE model (Analysis, Design, Development, Implementation, Evaluation). The development of this learning media proved to be valid with an average percentage of 95.45% of the 'Very Good' Media Checker criteria as measured using the Guttmann scale. There was an 11.1% increase in the pre-test to post-test self-assessment scores which were measured using a Likert scale. The difference in the scores of students' understanding tests with the Paired T-test shows that the application of media affects students' understanding test scores. Based on the results obtained, it can be concluded that the designed Codular web-based Mathbox media is a valid medium and can improve students' self-assessment and understanding of the Pythagorean theorem.

Keywords: *media development; learning media; self-assessment; Codular websites; Pythagorean theorem*

Information of Article

Subject classification	*97U10 Comprehensive works on educational material and media and educational technology in mathematics education*
Submitted	*9 February 2023*
Review Start	*11 February 2023*
Round 1 Finish	*14 February 2023*
Round 2 Finish	*18 March 2023*
Accepted	*29 March 2023*
Published	*3 April 2023*
Similarity Check	*9%*

Abstrak

Penelitian ini menggunakan media 'Mathbox' yang difokuskan dan bertujuan untuk meningkatkan penilaian dan pemahaman diri siswa, serta dikembangkan menggunakan website Codular. Metode penelitian yang digunakan adalah Research and Development (R&D) dengan model ADDIE (Analysis, Design, Development, Implementation, Evaluation). Pengembangan media pembelajaran ini terbukti valid dengan persentase rata-rata 95,45% kriteria validasi media 'Sangat Baik' yang diukur menggunakan skala Guttmann. Ada peningkatan 11,1% pada skor self-assessment pre-test hingga post-test yang diukur dengan menggunakan skala Likert. Perbedaan nilai tes pemahaman siswa dengan Paired T-test menunjukkan bahwa penerapan media berpengaruh terhadap nilai tes pemahaman siswa. Berdasarkan hasil yang diperoleh, dapat disimpulkan bahwa media Mathbox berbasis web Codular yang dirancang merupakan media yang valid dan dapat meningkatkan penilaian diri dan pemahaman siswa terhadap teorema Pythagoras.

INTRODUCTION

Pythagorean Theorem, as the primary material in the new curriculum, can be accepted by junior high school education level students. Studying the Pythagorean theorem is essential for calculating the distance and magnitude of the vector so that students can solve various problems related to the Pythagorean theorem (Roldán-Zafra et al., 2022). Leaving aside calculating the distance and magnitude of vectors, studying the Pythagorean theorem requires students first to have the ability to understand concepts to achieve one of the learning targets (Vellayati et al., 2020). This is because understanding concepts is a crucial and fundamental ability (Nichols & Howlett, 2021), as well as being the focus of mathematics learning activities (W. Lestari et al., 2021).

In mathematical terms, the ability to understand concepts not only helps students memorize formulas, but also can realize meanings in mathematics learning (Shofiah et al., 2021), and make it easier for students to solve mathematical problems (Jonsson et al., 2020). In addition to understanding concepts, self-assessment skills by students are also needed so that students understand what must be done in the learning process (Hairida, 2018). Self-assessment requires students to independently assess the status, learning process, and achievement of the material learned in learning by referring to the specified standards (Winarti & Rosyidah, 2020). In addition, self-assessment also assesses performance against predetermined criteria and aims to make students more independent, as well as to reflect on themselves (Abdillah et al., 2022). In simple terms, self-assessment is carried out to let students know the abilities that exist in themselves. As in the process of learning mathematics, learning the material of the Pythagorean theorem also requires these two abilities to achieve learning objectives (Tsai & Chin, 2022).

The Pythagorean theorem is classified as accessible material once you understand the concept. However, few students often experience problems solving various problems (Yuehuan & Zhou, 2022). In general, this is because students tend to memorize formulas, making it difficult for students to solve Pythagorean theorem problems (Towe & Julie, 2020). Not only that, the slow ability of students to receive material causes students to take longer to understand the material presented (Samo, 2021). These problems can be overcome by using excellent and appropriate learning media, such as learning media based on the Codular website.

Applications or software that are now widely used to develop learning media includes APPYPIE, Swishmax, Adobe Animate CC, Adobe Flash, Quizizz, Construct 2, and others. The Codular website has advantages in terms of simplicity, easy-to-understand features, availability

of supporting devices, and easy operation (Syarlisjiswan et al., 2021). So that this gives the Codular website the potential to be used and optimized in the world of education such as learning media.

Codular is a website that provides tools similar to MIT App Inventor to create Android applications using block programming (D. A. Lestari, 2019). The existence of a block programming tool makes it easier for teachers to make applications through the Codular website because there is no need to type in program code manually (Srilatha et al., 2021). Based on the general understanding, learning can be said to be a tool, material, or learning material used by teachers and students in learning activities that are formed systematically (Aji & Setiyadi, 2020). This learning can help develop abilities in learning mathematics, such as problem-solving, understanding material concepts, mathematical connections, mathematical communication, and mathematical representation (Villeneuve et al., 2019).

Research on the topic of developing website-based learning media and applications has been carried out by several researchers. The research was conducted by Aditya (2018) regarding the development of web-based mathematics learning media on circle material for class VIII students. Research conducted by Aditya (2018) uses the web (e-learning), which still requires several instructor models and complete tools or materials. This research produced learning media in the form of a web that can only be accessed when a cellphone/laptop is connected to the internet. The research was conducted by Charissudin et al (2021) regarding the development of mathematics learning media with animation using the Swishmax application. This research develops animation as a learning medium, but delivering the Swishmax application still requires special equipment and abilities in making applications. Research conducted by Agung Saputro et al (2018) regarding the development of learning media using the application of Construct 2 to class VII Algebra material. Research conducted by Agung Saputro et al (2018) still uses html scripts which require users to have the ability to independently process scripts and learning media produced based on educational games. The novelty of this research compared to previous research is its simplicity, practicality, completeness of features that are easy to understand, availability of supporting devices, and production products in the form of Android applications which students can easily access via their respective cell phones.

From the preceding, it shows that "Development of Codular-Based Mathbox Media to Improve Students' Self-Assessment and Understanding of the Pythagorean Theorem" needs to be held because of its simplicity, practicality, completeness of easy-to-understand features, and the availability of supporting devices, able to help improve self-assessment and students' understanding of the material of the Pythagorean theorem. This study aimed to produce a Mathbox application based on the Codular website to improve students' self-assessment and understanding of the Pythagorean theorem. Hopefully, this research can be helpful for students and teachers in supporting teaching and learning activities and as a reference for other researchers who will develop website-based learning media.

METHOD

This research uses the Research and Development (R&D) method (Fadillah et al., 2021). Research and Development (R&D) are steps to develop or perfect an existing and accountable product (Fatmadiwi et al., 2021). In this study, Mathbox learning

media based on the Codular website was developed using the ADDIE model, which consists of 5 stages of research, namely Analyze, Design, Development, Implementation, and Evaluation (Pangestu & Setyadi, 2020).

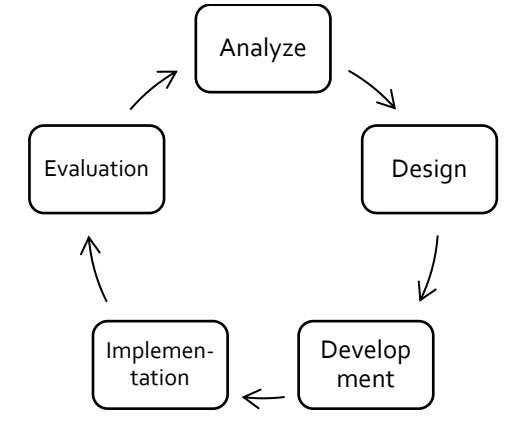

Figure 1. Research process

Analyze. At this stage, various information is collected in full through observation and direct interviews. Information such as needs analysis, curriculum analysis, and media analysis. The needs analysis includes the material, the student's self-assessment, and the learning media used. Curriculum analysis is carried out to determine indicators and learning outcomes. Media analysis was performed to develop the Mathbox application.

Design. At this stage, researchers design the Mathbox application before it is developed through the Codular website. Researchers compile material listed on the Mathbox application and compile research instruments to collect development research data. Research instruments include self-assessment questionnaires, student comprehension tests, and media validation questionnaires.

Development. At this stage, the development process of the Mathbox application is carried out based on the hypothesis design that has been designed, then further developed and programmed as needed, and realized into an Android application product. Academic validators and practitioners test the resulting Mathbox application products. Validation is carried out to measure the feasibility of the product developed by filling out the media validation questionnaire. These assessments are used as guidelines for improving the Mathbox app. Once the Mathbox application is refined based on the results of media validation, it can then be deployed to target learners.

Implementation. At this stage, researchers conducted product trials on four validators to determine the feasibility of Mathbox applications before the applications were applied to students. Then it was tested on class VIII MTs Muhammadiyah 1 Malang students three times by providing pre-test and post-test self-assessment questionnaires and a material understanding test of the Pythagorean theorem to find out student responses about the feasibility and achievement of the Mathbox application in improving self-assessment and student understanding.

Evaluation. At this stage, an evaluation is carried out based on the results of the response questionnaire and student concept understanding tests to determine the quality and feasibility of the Mathbox application.

The technique of collecting data for this research uses a response questionnaire and an understanding test. This study has two response questionnaires; the media validation questionnaire and the self-assessment questionnaire. The media validation questionnaire is addressed to academic and practitioner validators. Self-assessment questionnaires and comprehension tests are intended for students. In the media validation questionnaire using an assessment with the Guttman scale, there are two if "yes" is

worth one (1) and if "no" is zero (0) (Saputrama et al., 2022). The results of the media validation are percentages, then analyzed according to the Likert scale score percentage criteria (Sukma & Kholiq, 2021), as in the Table 1.

Table 1. Likert Scale Score Percentage Criteria

Percentage (%)	Criterion
x ≤ 20	Very Less
20 < x ≤ 40	Less
40 < x ≤ 60	Enough
60 < x ≤ 80	Good/Valid
x > 80	Very Good/Very Valid

In the self-assessment questionnaire, students use the Likert scale, with the highest Likert scale score being 4 (Strongly Agree) and the lowest being 1 (Strongly Disagree) (Liliana et al., 2020). The questionnaire results are percentages, then analyzed according to the validation assessment criteria (Saniriati et al., 2021) presented in the Table 2.

Table 2. Validation Assessment Criteria

P value (%)	Percentage Categories
85 < P ≤ 100	Very Good
70 < P ≤ 85	Good
55 < P ≤ 70	Enough
40 < P ≤ 55	Not Good Enough
P ≤ 40	Less Than Once

Students' understanding tests were carried out by providing several problems related to the Pythagorean theorem before and after the Mathbox application was implemented. For student comprehension, test results in the form of pretest and post-test scores are analyzed using the Paired T-test on the Minitab to determine whether there is an increase in students' understanding of the Pythagorean theorem.

The data analysis technique of this study is descriptive qualitative, which describes the results of the development of the Mathbox application. The response questionnaire and comprehension test data were analyzed using statistical calculations. The results of the assessment and the response from the validator are then searched for the average score to determine the quality and feasibility of the Mathbox application to improve students' self-assessment and understanding of the Pythagorean theorem.

RESULTS AND DISCUSSION

Result

This research uses the ADDIE development model, which consists of 5 stages: analysis, design, development, implementation, and evaluation.

Analysis

The results of the analysis of the development of Codular-based Mathbox media are as follows.

Needs analysis. Needs analysis is carried out based on school observations to find problems related to the learning process. The information obtained is: 1) The number of materials the student must master. The amount of material to be mastered makes students feel depressed for students with low memory and understanding; 2) the student's lack of understanding of the Pythagorean theorem. This is due to the varied understanding of students at the elementary school level; 3) Students still need self-assessment. This is known from the results of an interview with one of the mathematics teachers at MTs Muhammadiyah 1 Malang; 4) The learning conditions used have weaknesses in the unevenness of each student's understanding and require much time for students to understand the material presented. This makes students less confident in learning the Pythagorean theorem. So that learning media is

needed that can support and increase students' confidence to be more active in the learning process.

Curriculum analysis. Based on the 2013 revised 2016 curriculum used by MTs Muhammadiyah 1 Malang, curriculum analysis was carried out. The result of this analysis is that there needs to be more emphasis on student self-assessment and understanding, such as practice questions and explanations of the core problems given are still less than learning outcomes and indicators of understanding. Thus, the analysis results impacted students' self-assessment and need for improvement in students' understanding of the Pythagorean theorem material.

Media analysis. Based on the analysis, it was found that the previously used learning media yang has not strengthened students' self-assessment and understanding. Therefore, the Mathbox application was developed based on the results of such analysis. The Codular and Companion websites became the main ingredients used to develop the Mathbox application.

Design

The next stage is the design of the Mathbox application. This application is designed with the development goal of improving student self-assessment and understanding. This goal is realized with complete and explicit material in its application so that students can understand what is learned. For self-assessment, researchers realize this through quizzes that provide feedback points with correct and fast workmanship.

Media reference. In developing the Mathbox application, researchers seek and collect references from various sources. Application display references and images from Freepik.com; moving icon from Lotties; various icon shapes from Svg.repo; background view from Canva; and video material from Youtube. Video material is included in the Mathbox application to help students understand the Pythagorean theorem.

Media design. The design was created as a simple illustration of the Mathbox application. The design of the Mathbox application consists of 1) Initial display. This view contains symbols from the "Mathbox" application and moving icons with a time duration. 2) Display the initial menu. This view contains an image with a math theme and six icon buttons with their respective functions. 3) Display how to use. If the how-to icon is clicked, six ways to use the app will appear and are explained in detail. 4) Display of learning outcomes. This display contains learning outcomes students must achieve when studying the Pythagorean theorem. 5) Profile view. This view contains the application developer profile. 6) Material display. This view contains material from the video and a brief introduction to the Pythagorean theorem. 7) Display of practice questions. It contains several questions students can work on to hone their learning skills. 8) Quiz view. The last display of this application is a Kahoot-assisted quiz. Not only that, but there are also instructions for operating the Kahoot quiz.

Development

At this stage, it is to develop the application according to the design made at the design stage. The media used to develop the Mathbox application is the Codular website. The steps for developing the Mathbox application are to create an application on the Codular website using materials collected individually. For material display, the material is developed in video form to make it easier for students to repeat explanations. Quizzes developed with the help of Kahoot.id will be

displayed when students have finished reading and understanding the material. Mathbox application development can be seen in Appendix A.

After being developed and realized into an Android application. The Mathbox application was validated by four validators, of which three validators were from Mathematics Education lecturers at the University of Muhammadiyah Malang, and one validator was from a mathematics teacher MTs Muhammadiyah 1 Malang. After the validation process is complete, the Mathbox application is refined according to the suggestions given to produce a Mathbox application ready to be used for learning media.

Implementation

At the implementation stage, testing applies to the validated and refined Mathbox application. The application trial occurred at MTs Muhammadiyah 1 Malang with class VIII B of 35 students. However, some students still needed to meet several requirements, so as many as 22 students became the research subjects. Testing is carried out by students first downloading the Mathbox application and then students review a little Pythagorean theorem material in the Mathbox application. Then do some questions to determine students' understanding of the Pythagorean theorem material. Finally, students fill out a self-assessment questionnaire to measure their ability to assess themselves. From the several implementations carried out, there was an almost consistent increase at each meeting regarding indicators of understanding the concept, namely writing the general form of the Pythagorean theorem, and using the concept of the Pythagorean theorem in solving problems related to everyday life.

Evaluation

The final stage in the development of the Mathbox application is evaluation.

Validity Analysis. Validity analysis is carried out based on the results of an assessment by validators to determine the feasibility of the Mathbox application developed. The results of the evaluation of the Mathbox application by each validator can be seen in Table 3.

Table 3. Validator Assessment Results (P)

Validator	Σx	Σi	P (%)	Criterion
1	10	11	90,9	Very Good
2	11	11	100	Very Good
3	10	11	90,9	Very Good
4	11	11	100	Very Good
P Average =			95,45	Very Good

Information: P = Percentage | Σx = Total number of respondents' answers across all items | Σi = Ideal total score per item

Table 3 shows an average percentage of 95.45% in the "Very Good" category, so the Mathbox application is stated to be very good for use as a learning medium. The results of the validity analysis were strengthened by research by Makmuri et al (2021), that at the media validation stage, a percentage of 83.60% was obtained, also classified as the "Very Good" category, so this Android-based learning application was feasible to use.

Self-assessment analysis. This analysis was carried out twice, namely pre-test and post-test to assess students' self-understanding in learning the Pythagorean theorem. Pre-test and post-test self-assessment analyses are based on student questionnaire responses before and after several questions were given. The results of the pre-test self-assessment analysis showed that the average percentage of student response questionnaires was 50.96% with the "Enough" criterion. The results of the post-test self-assessment analysis showed that the average rate of student response questionnaires

was 62.06% with the "Good/Valid" measure. The average percentage on the questionnaire has increased, *so* self-assessment by students increases when the Mathbox application has been implemented. These results are by Nugroho (2019) research which shows students' increased self-assessment due to the application of developed learning tools.

Effectiveness Analysis. Based on the results of the effectiveness analysis using the Paired T-Test test on the Minitab, the results of the Paired T-Test output show that p-value = 0,000. If p-value < α, then Ho is rejected. Following Ho's rejection criteria, it can be concluded that there is an improvement between students' scores on the pre-test *and post*-test. Thus, using the Mathbox application as a learning medium on the material of the Pythagorean theorem was declared effective in improving student understanding. This is in line with the research of Anggraeni et al (2021), which shows an increase in average knowledge of concepts and is in the "Medium" category so that the learning media used can improve students' concept comprehension skills. The results of the Paired T-Test can be seen in Figure 2.

Paired T-Test and CI: pre-test; post-test

Descriptive Statistics

Sample	N	Mean	StDev	SE Mean
pre-test	22	1,045	0,575	0,123
post-test	22	1,773	0,429	0,091

Estimation for Paired Difference

Mean	StDev	SE Mean	95% CI for μ_difference
-0,727	0,703	0,150	(-1,039; -0,416)

μ_difference: population mean of (pre-test - post-test)

Test

Null hypothesis	H_0: μ_difference = 0
Alternative hypothesis	H_a: μ_difference ≠ 0

T-Value	P-Value
-4,86	0,000

Figure 2. Paired T-Test results

Discussion

The media developed in this study is the Codular website-based Mathbox application. The Codular website was chosen because it provides various easy-to-understand tools and programming code that makes it easier for teachers to create learning media. Generally, making applications difficult in the program code section so that the application can run (Kather et al., 2022), but on the Codular site, programming is quickly done by pairing program code like game puzzles. Apart from making it easier for teachers to program applications, the Codular website also helps students understand the material being taught in the form of learning media.

The Mathbox application developed contains material on the Pythagorean theorem, several practice questions, and quizzes that students can do to hone their comprehension skills. In the Mathbox application, video material is presented to make it easier for students to repeat material explanations. This aligns with Attalina & Irfana (2020), which state that learning media must make it easier for students to understand the material and create real situations. When the application is implemented for students during learning, the Mathbox application gets a positive response from the existence of quizzes in the form of games where the final result has a level of answering questions that are the fastest, the most precise, and the right. In addition to the positive response from students, mathematics teachers at MTs Muhammadiyah 1 Malang also gave their opinions regarding the Mathbox application. The application received an excellent assessment for use as a learning medium in terms of design, language, operation, and materials.

In addition, the Mathbox application

is suitable for students when studying independently because it can be used anywhere and anytime. As a result of students' positive responses, the Mathbox application is an effective and efficient learning medium to help improve student understanding. The development of Codular website-based learning media has also been carried out by researchers before, but what distinguishes this research is the media produced and the purpose of the study. The research of Rizqiyani et al (2022) made an E-Module to improve students' mathematical literacy skills. Research by Rismayanti et al (2022) produced an E-Module to enhance students' mathematical thinking skills.

The advantages of the developed learning media are 1) media development can be done by anyone, including teachers, because of the easy-to-access programming features, 2) students can easily access the Mathbox application using their respective mobile phones, 3) attractive media display designs with matching color combinations, 4) material presented in video form makes it easier for students to repeat material, 5) practice questions in the Mathbox application can hone students' skills in solving various kinds of questions, 6) adding game-based quizzes makes students more interested and challenged to solve questions presented in the quiz, 7) the Mathbox application can be used anywhere and anytime so that it can be used as an independent learning media for students, 8) can improve student self-assessment and understanding.

But running this application requires an internet network to access materials and quizzes, and only Android-based phones can use this application. In addition, the quizzes in the Mathbox application have a limited active period of only one month.

Implications

This research implies that the school or research subjects provide several conditions when conducting research. The requirements are the willingness and agreement between the researcher and the research subject. In addition, this research produces learning media based on Android applications that facilitate the learning process and improve students' self-assessment and understanding of the Pythagorean theorem. This application can also be used in independent learning because it can be accessed anywhere and anytime.

Limitations

The limitations of this research are the circumstances in the school environment of the research subjects, which are challenging to control correctly, the difficulty of managing research time so as not to interfere with ongoing learning time at school, and limited research time. In addition, there is also a limit on the active period of the quiz contained in the learning media. However, this is not an obstacle for researchers because both parties can overcome these limitations well.

CONCLUSION

Based on the research results, the developed Codular website-based Mathbox application proved valid, and practical and could improve students' self-assessment and understanding of the Pythagorean theorem. This can be seen from the Mathbox application, which is supported by video material that allows students to repeat explanations and some practice questions to hone students' skills in understanding the material, as well as quizzes to find out how students understand the Pythagorean theorem has increased.

This application is still limited to the use of the internet network and the active period of the quiz, therefore future researchers are expected to develop better and more innovative learning media, of course with different contexts.

REFERENCE

Abdillah, R., Kuncoro, A., Erlangga, F., & Ramdhan, V. (2022). Pemanfaatan Aplikasi Kahoot! dan Quizizz Sebagai Media Pembelajaran Interaktif Berbasis Gamifikasi. *Jurnal Pendidikan Sains Dan Komputer*, *2*(01), 92-102. https://doi.org/10.47709/jpsk.v2i01.1363

Aditya, P. T. (2018). Pengembangan Media Pembelajaran Matematika Berbasis Web Pada Materi Lingkaran Bagi Siswa Kelas VIII. *Jurnal Matematika Statistika Dan Komputasi*, *15*(1), 64-74. https://doi.org/10.20956/jmsk.v15i1.4425

Agung Saputro, T., Kriswandani, K., & Ratu, N. (2018). Pengembangan Media Pembelajaran Mengunakan Aplikasi Construct 2 Pada Materi Aljabar Kelas VII. *JTAM | Jurnal Teori Dan Aplikasi Matematika*, *2*(1), 10-23. https://doi.org/10.31764/jtam.v2i1.219

Aji, W. N., & Setiyadi, D. B. P. (2020). Aplikasi Tik Tok Sebagai Media Pembelajaran Keterampilan Bersastra. *Metafora*, *VI*(2).

Attalina, S. N. C., & Irfana, S. (2020). Upaya Meningkatkan Kemampuan Pemahaman Konsep Dasar Perkalian Dengan Menerapkan Model PBL (Problem Based Learning) Berbantuan Media Pembelajaran Tolkama (Botol Perkalian Matematika) Pada Peserta Didik Kelas II Sekolah Dasar. *Tunas Nusantara*, *2*(2), 210-219. https://doi.org/10.34001/jtn.v2i2.1501

Charissudin, A., Farida, F., & Putra, R. W. Y. (2021). Pengembangan Media Pembelajaran Matematika dengan Animasi Menggunakan Aplikasi Swishmax. *Square : Journal of Mathematics and Mathematics Education*, *3*(1), 10-19. https://doi.org/10.21580/square.2021.3.1.7522

Fadillah, A., Bilda, W., Saleh, H., & Yenni, Y. (2021). Design of Interactive Learning Media In The Covid-19 Pandemic Time Using Ispring. *Prima: Jurnal Pendidikan Matematika*, *5*(1), 1-10. https://doi.org/10.31000/prima.v5i1.3260

Fatmadiwi, A., Hairida, H., Sartika, R. P., Melati, H. A., & Rasmawan, R. (2021). Pengembangan Video Pembelajaran pada Konsep Asesmen Autentik untuk Mahasiswa. *EDUKATIF : Jurnal Ilmu Pendidikan*, *4*(1), 266-277. https://doi.org/10.31004/edukatif.v4i1.1322

Hairida, H. (2018). Penilaian Sikap Siswa Dalam Pembelajaran Kimia Melalui Teknik Self Assessment dan Peer Assessment. *Jurnal Pendidikan Matematika Dan IPA*, *9*(2), 37-48. https://doi.org/10.26418/jpmipa.v9i2.25832

Jonsson, B., Granberg, C., & Lithner, J. (2020). Gaining Mathematical Understanding: The Effects of Creative Mathematical Reasoning and Cognitive Proficiency. *Frontiers in Psychology*, *11*, 574366. https://doi.org/10.3389/fpsyg.2020.574366

Kather, P., Duran, R., & Vahrenhold, J. (2022). Through (Tracking) Their Eyes: Abstraction and Complexity in Program Comprehension. *ACM Transactions on Computing Education*, *22*(2), 1-33. https://doi.org/10.1145/3480171

Lestari, D. A. (2019). *Pengertian Kodular*. 4 April.

Lestari, W., Kusmayadi, T. A., & Nurhasanah, F. (2021). Kemampuan Pemecahan Masalah Matematika Ditinjau Dari Perbedaan Gender. *AKSIOMA: Jurnal Program Studi Pendidikan Matematika*, *10*(2), 1141-1150. https://doi.org/10.24127/ajpm.v10i2.3661

Liliana, R. A., Raharjo, W., Jauhari, I., & Sulisworo, D. (2020). Effects of the online interactive learning media on student's achievement and interest in physics. *Universal Journal of Educational Research*, *8*(3B), 59-68. https://doi.org/10.13189/ujer.2020.081507

Makmuri, M., Wijayanti, D. A., Salsabila, E., & Nur Fadillah, R. (2021). Pengembangan Aplikasi Pembelajaran Matematika Berbasis Android Dengan Pendekatan Kontekstual Pada Materi Persamaan Garis Lurus Untuk Peserta Didik Kelas VIII. *Jurnal Cendekia : Jurnal Pendidikan Matematika*, *5*(1), 643-654. https://doi.org/10.31004/cendekia.v5i1.535

Nichols, E. D., & Howlett, J. L. (2021). Experimental Programs: A Study of Placement Methods for Entering College Freshmen in the Proper Mathematics Sequence at Michigan Technological University. *The Mathematics Teacher*, *62*(8), 651-659. https://doi.org/10.5951/mt.62.8.0651

Nugroho, D. A. (2019). Pengembangan Perangkat Pembelajaran Geometri dengan Mengadaptasi Model Core untuk Meningkatkan Efikasi Diri. *Jurnal Riset Pendidikan Matematika*, *6*(1), 39-52. https://doi.org/10.21831/jrpm.v6i1.11599

Pangestu, Y. S., & Setyadi, D. (2020). Pengembangan Media Pembelajaran Aplikasi Android Pytha Fun untuk Teorema Pythagoras SMP. *Jurnal Cendekia : Jurnal Pendidikan Matematika*, *4*(1), 113-125.

https://doi.org/10.31004/cendekia.v4i1.177

Rismayanti, T. A., Anriani, N., & Sukirwan, S. (2022). Pengembangan E-Modul Berbantu Kodular pada Smartphone untuk Meningkatkan Kemampuan Berpikir Kritis Matematis Siswa SMP. *Jurnal Cendekia : Jurnal Pendidikan Matematika*, *6*(1), 859-873. https://doi.org/10.31004/cendekia.v6i1.1286

Rizqiyani, Y., Anriani, N., & Pamungkas, A. S. (2022). Pengembangan E-Modul Berbantu Kodular pada Smarthphone untuk Meningkatkan Kemampuan Literasi Matematis Siswa SMP. *Jurnal Cendekia : Jurnal Pendidikan Matematika*, *6*(1), 954-969. https://doi.org/10.31004/cendekia.v6i1.1172

Roldán-Zafra, J., Perea, C., Polo-Blanco, I., & Campillo, P. (2022). Design of an Interactive Module Based on the van Hiele Model: Case Study of the Pythagorean Theorem. *International Electronic Journal of Mathematics Education*, *17*(1), 10 pages. https://doi.org/10.29333/iejme/11556

Samo, D. D. (2021). Analysis of Mathematical Connections Ability on Junior High School Students. *International Journal of Educational Management and Innovation*, *2*(3), 261-271. https://doi.org/10.12928/ijemi.v2i3.3785

Saniriati, D. M. D., Dafik, D., & Murtikusuma, R. P. (2021). Pengembangan Media Pembelajaran Adobe Animate Berbantuan Schoology Pada Materi Barisan dan Deret Aritmetika. *Jurnal Riset Pendidikan Dan Inovasi Pembelajaran Matematika (JRPIPM)*, *4*(2), 132-145. https://doi.org/10.26740/jrpipm.v4n2.p132-145

Saputrama, R., Fitrianti, Y., & Ramury, F. (2022). Development of Arithmetic Rows and Series Learning Media in Malay Islam Context. *Kreano, Jurnal Matematika Kreatif-Inovatif*, *13*(1), 88-99.

Shofiah, N. F., Purwaningrum, J. P., & Fakhriyah, F. (2021). Kemampuan Pemahaman Konsep Matematis Siswa Sekolah Dasar melalui Pembelajaran Daring Dengan Aplikasi Whatsapp. *EDUKATIF : Jurnal Ilmu Pendidikan*, *3*(5), 2683-2695. https://doi.org/10.31004/edukatif.v3i5.907

Srilatha, M., Abhinav, C., Balaram, M., & Sanjana, A. (2021). Smart monitoring and collection of garbage system using the internet of things. *Proceedings of the 3rd International Conference on Intelligent Communication Technologies and Virtual Mobile Networks, ICICV 2021* (pp. 335-342). IEEE. https://doi.org/10.1109/ICICV50876.2021.9388438

Sukma, A. K., & Kholiq, A. (2021). Pengembangan SI VINO (Physics Visual Novel) untuk Melatihkan Berpikir Tingkat Tinggi Siswa SMA. *Jurnal Ilmiah Pendidikan Fisika*, *5*(2), 123-137. https://doi.org/10.20527/jipf.v5i2.3313

Syarlisjiswan, M. R., Sukarmin, & Wahyuningsih, D. (2021). The development of e-modules using Kodular software with problem-based learning models in momentum and impulse material. *IOP Conference Series: Earth and Environmental Science*, *1796*(1), p. 012078. IOP Publishing https://doi.org/10.1088/1742-6596/1796/1/012078

Towe, M. M., & Julie, H. (2020). Developing learning trajectories with the RME of phytagorean theorem. *Journal of Physics: Conference Series*, (Vol. 1470, No. 1, p. 012027). IOP Publishing. https://doi.org/10.1088/1742-6596/1470/1/012027

Tsai, H., & Chin, E.-T. (2022). Pupil's Fraction Learning based on Board Game Playing of Confidence Intervals (MICIH) Kernel Density Estimation Approach. *ATHENS JOURNAL OF SCIENCES*, *9*(1), 65-90. https://doi.org/10.30958/ajs.9-1-4

Vellayati, S., Nurmaliah, C., Sulastri, S., Yusrizal, Y., & Saidi, N. (2020). Identifikasi Tingkat Pemahaman Konsep Siswa Menggunakan Tes Diagnostik Three-Tier Multiple Choice pada Materi Hidrokarbon. *Jurnal Pendidikan Sains Indonesia*, *8*(1), 128-140. https://doi.org/10.24815/jpsi.v8i1.15715

Villeneuve, E. F., Hajovsky, D. B., Mason, B. A., & Lewno, B. M. (2019). Cognitive Ability and Math Computation Developmental Relations with Math Problem Solving: An Integrated, Multigroup Approach. *School Psychology Quarterly*, *34*(1), 96-108. https://doi.org/10.1037/spq0000267

Winarti, W., & Rosyidah, R. (2020). Penilaian Diri Dalam Keterampilan Berbicara Bahasa Jerman Sebagai Wujud Penilaian Dalam Pendidikan Abad 21. *PRASI*, *15*(02), 110-124. https://doi.org/10.23887/prasi.v15i02.29844

Yuehuan, M., & Zhou, Y. (2022). Development of a New Teaching Model to Promote the Development of Second Graders' Metacognitive Monitoring. *Journal of Teaching and Learning In Elementary Education (JTLEE)*, *5*(1), 19-33. https://doi.org/10.33578/jtlee.v5i1.7902

Appendix

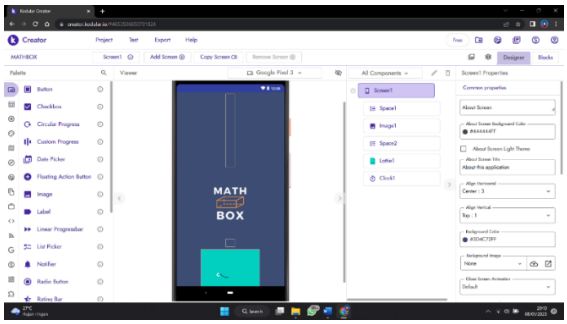

Figure 3. Initial view

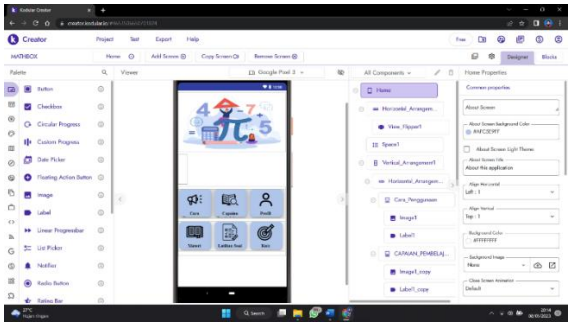

Figure 4. "Home menu" display

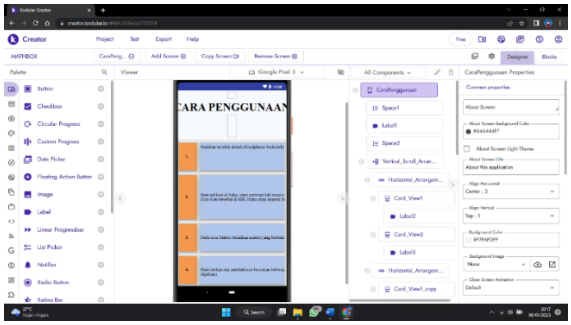

Figure 5. "How to use" view

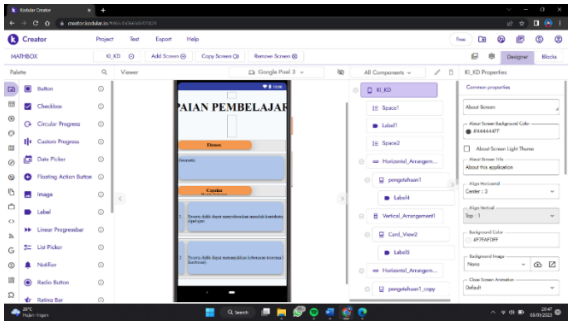

Figure 6. "Learning outcomes" view

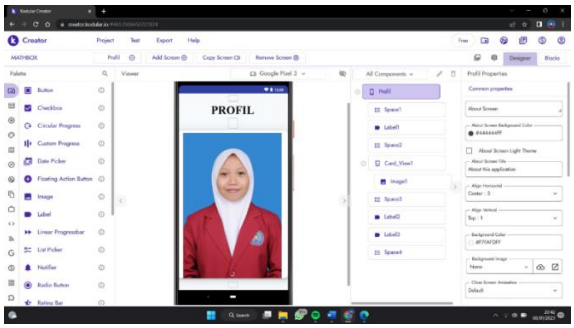

Figure 7. "Profile" view

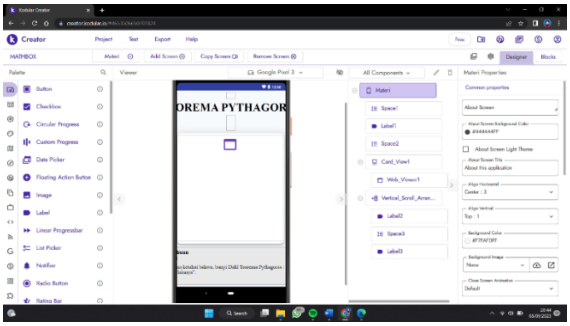

Figure 8. Display of "material"

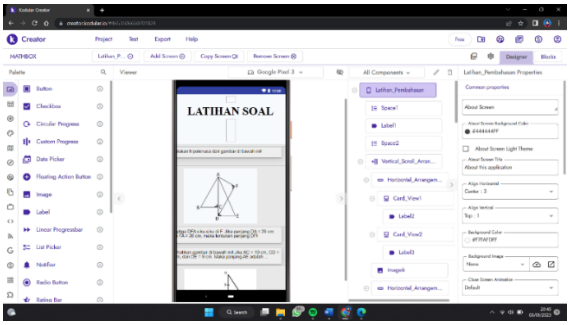

Figure 9. Display of "practice questions"

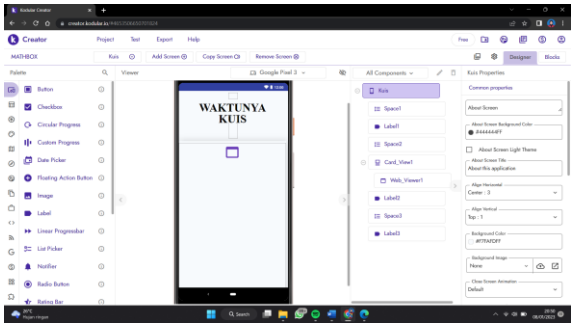

Figure 10. "Quiz" view