

Development of SAC3-Assisted Digital Learning Media to Enhance Students' Mathematical Literacy in Matrix Topics

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Corresponding author: Safwan Ibrahim Haz safonehz22@gmail.com	Abstract The advancement of information and communication technology has driven innovation in education, particularly in the development of learning media aligned with the competencies required in the 21st century. This study aims to develop digital learning media assisted by Smart Apps Creator 3 (SAC3) to enhance students' mathematical literacy in matrix topics. The development model employed is ADDIE, which includes the stages of Analysis, Design, Development, Implementation, and Evaluation. Validation results from subject matter and media experts indicate that the product is highly valid and appropriate for use in the learning process. Practicality and effectiveness testing involving 33 eleventh-grade students (class XI.2) demonstrated that the use of this media significantly improved students' learning interest, conceptual understanding, and mathematical literacy skills compared to conventional teaching methods. Therefore, SAC3-assisted digital learning media on matrix material offers an innovative solution for enhancing the quality of mathematics instruction in the digital era.
Keywords: Digital Learning Media, SAC3, Mathematical Literacy, Matrix	

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INTRODUCTION

Education is a complex and continuous process aimed at shaping individuals to acquire the knowledge, skills, and attitudes necessary to face life's challenges. It plays a vital role in enabling human resources to grow and develop optimally (Jeniver et al., 2023; Patty et al., 2023). In the digital era, education is crucial in preparing competitive human capital. In this context, it serves not only as a means of transmitting knowledge but also as a strategic instrument for fostering critical thinking, creativity, and adaptability in response to ever-evolving global dynamics.

Learning is a systematic process of interaction between learners, educators, and learning resources within a structured environment aimed at achieving educational objectives. The development of learning media is a strategic effort to enhance the effectiveness and efficiency of the learning process (Maharani & Hidayah Putri, 2023). When appropriately designed and aligned with the learners' characteristics, learning media can facilitate active engagement, strengthen conceptual understanding, and support the attainment of optimal learning outcomes (Oktaviana & Ramadhani, 2023).

The professional development of learning media by educators not only contributes directly to the smooth implementation of instructional activities but also has a lasting positive impact on the overall quality of education. Despite advancements in educational theory, conventional methods such as lectures and textbook use still dominate field practices and have proven less effective in engaging students and enhancing their understanding (Wahyuni & Ananda, 2022). Such an approach is often monotonous and fails to effectively engage students, potentially hindering the development of their learning absorption capacity (Gogahu & Prasetyo, 2020). This situation is often observed during the learning process, as some students display signs of disengagement, such as talking with friends or failing to focus on the material being presented. The development of innovative, interactive, and contextual learning media is essential to enhance students' active participation, foster creativity, and strengthen conceptual understanding in mathematics learning (Ritonga et al., 2022).

Mathematics education is a process of interaction among learning elements aimed at enhancing students' thinking abilities to solve problems (Gusteti & Neviyarni, 2022). Mathematics education aims to facilitate students' understanding of fundamental concepts, develop their logical thinking skills, and enable them to apply mathematical knowledge in everyday contexts (Himmah et al., 2024). Mathematics learning not only involves teaching calculations but also fosters students' ability to think creatively, critically, and systematically in solving various conceptual problems that reflect mathematical literacy skills.

In mathematics education, literacy skills are a crucial indicator of students' conceptual understanding and their ability to apply mathematics in real-life contexts (Agustiani & Nurcahyono, 2021). Mathematical literacy remains a central issue in Indonesian education, particularly at the secondary school level. International assessments such as the Programme for International Student Assessment (PISA) and the Trends in International Mathematics and Science Study (TIMSS) consistently show that Indonesian students' mathematical literacy skills are below the international average (OECD, 2023). Similarly, other studies report that the level of mathematical literacy in Indonesia remains critically low, with PISA results indicating that Indonesian students are not yet able to compete with their peers in other countries (Setyowati et al., 2022). Further research also highlights that many students still struggle to solve problems related to mathematical literacy (Hayati & Jannah, 2024). These findings underscore the urgent need to enhance mathematical literacy as a strategic effort to improve the quality of national education and to prepare the younger generation to adapt to the challenges of the 21st century.

One of the strategic efforts that can be made to improve students' mathematical literacy is through the use of digital learning media (Firdha & Zulyusri, 2022; Sukariada et al., 2024). Digital media has the potential to present mathematical material in an interactive, visual, and contextual manner, thereby enhancing conceptual understanding, sparking interest in learning, and encouraging active student engagement in the learning process. The integration of technology in mathematics education also allows teachers to present a more varied and adaptive learning experience to meet the needs of students. This demands innovation in the learning process so that students can more easily understand and master the material being taught (Widdah & Faradiba, 2022).

One of the potential innovations is the use of interactive, contextual, and flexible Android-based digital media. The use of the Smart Apps Creator 3 (SAC3) application allows educators to present material in a visual and dynamic form, which can facilitate the understanding of abstract concepts such as matrices. Therefore, this research aims to develop digital learning media assisted by SAC3 on matrix material to improve high school students' mathematical literacy skills. Through the features provided by SAC3, matrix material can be presented visually and dynamically, thereby helping students understand the concepts more easily and engagingly, as well as strengthening their mathematical literacy skills.

However, the facts on the ground show that mathematics learning, particularly on the topic of matrices, still faces various obstacles. Previous research has revealed that students' mathematical literacy skills in this subject are still relatively low, particularly in the aspects of representation, mathematization, and the use of mathematical tools (Salmiati et al., 2021). Furthermore, the learning media used in schools are generally still conventional and do not optimally utilize digital technology, resulting in students being passive and less motivated in their studies (Widdah & Faradiba, 2022).

This study offers a novel contribution by developing an Android-based digital learning medium supported by SAC3 for teaching matrix material. This innovation is significant as it not only utilizes technology that is familiar to students in their daily lives, but it is also specifically designed to enhance mathematical literacy through a more visual, interactive, and adaptive approach (Epran & Muhammad, 2023). Therefore, this research is expected to make a meaningful contribution to improving the quality of mathematics education and addressing the challenges of mathematical literacy in the digital era.

RESEARCH METHOD

The research method employed in this study is research and development (R&D). Research and development is a methodological approach aimed at producing a specific product and testing its effectiveness within its intended context of use (Harahap et al., 2021). In this study, the researchers developed a product in the form of an Android-based digital learning medium using Smart Apps Creator 3, designed to enhance students' mathematical literacy, particularly in the topic of matrices. This approach was chosen because it aligns with the research objectives, which are to produce learning media that are valid, practical, and effective for use in the mathematics learning process.

In this study, the ADDIE model (Analysis, Design, Development, Implementation, Evaluation) is utilized. This model is designed to ensure that the learning process is developed effectively and efficiently by taking into account the learners' needs and the intended learning objectives (Rangkuti, 2019). The researcher chose this model because its stages are practical, systematic, straightforward, and clearly structured.

This research was conducted through five systematic stages of the ADDIE model to ensure the effectiveness of developing interactive learning media. The Analysis phase focuses on identifying learning needs, student characteristics, and challenges in understanding matrix material. The Design stage includes the conceptualization of the application, selection of materials, interface design, and

the preparation of research instruments. In the Development stage, the media is developed using Smart Apps Creator 3 and validated by experts to assess the quality of content, visuals, and functionality. The Implementation stage is carried out through limited trials in the classroom to measure the impact of the media on students' mathematical literacy skills. Finally, the Evaluation stage is used to assess the overall effectiveness of the media and as a basis for improvements to produce an optimal product.

This research was conducted at SMAN 14 Gowa. The subjects of the study were students from class XI.2, consisting of 33 students. Data collection techniques included questionnaires, observation sheets, and tests, all of which were validated by subject matter experts. The data obtained from expert validations and user trials were primarily quantitative, derived from the validation questionnaires. The data were analyzed using descriptive statistical analysis based on the following formula:

$$N = \frac{k}{Nk} \times 100\%$$

Note : N = Percentage score
 k = The obtained score
 Nk = Score maximal

Based on the results, it can be categorized according to the following qualitative criteria:

Table 1. Qualitative Criteria

No.	Interval	Criteria
1.	0% - 25%	Very Poor
2.	26% - 43,75%	Poor
3.	43,76% -62,50 %	Fair
4.	62,51% - 81,25%	Good
5.	81,26% - 100%	Very Good

After being categorized based on qualitative criteria, the N value is determined according to the evaluated aspects. This N value is then classified based on the score interpretation criteria and subsequently used to draw general conclusions regarding the quality of the developed interactive learning media. The criteria for validating the percentage analysis results can be seen in Table 2.

Table 2. Criteria for validating percentage analysis result

No.	Interval	Criteria
1.	0% - 20%	Very Invalid
2.	21% - 40%	Less Valid
3.	41% - 60%	Fairly Valid
4.	61% - 80%	Valid
5.	81% - 100%	Very Valid

The N-Gain test is used to determine whether the developed learning media improves students' mathematical literacy skills on matrix material by comparing performance before and after the treatment. The N-Gain test formula is as follows:

$$N - gain(g) = \frac{posttest\ score - pretest\ score}{max\ score - pretest\ score}$$

Note : N-gain = Gain factor value
 Pretest score = Initial test score
 Posttest score = Final test result score
 Max Score = Maximun test score

Table 3. Criteria

Interval	Criteria
$g > 0,7$	High
$0,3 \leq g \leq 0,7$	Medium
$g < 0,3$	Low

RESULTS AND DISCUSSION

This study resulted in the development of an interactive learning media on matrix material for Grade XI in the form of an Android-based application named “MatriXplore.” The MatriXplore application is designed to support independent and engaging mathematics learning, featuring three main components: “Matrix Learning”, “Instructional Videos”, and “Evaluation”. The Matrix Learning feature presents instructional content aligned with the 2013 Curriculum for Grade XI senior high school students, delivered in an interactive and easy-to-understand format. The Instructional Videos feature aims to reinforce conceptual understanding and enhance students’ mathematical literacy through contextual and practical visual presentations. Meanwhile, the Evaluation feature includes a set of practice questions designed to assess students’ conceptual mastery, critical thinking skills, and overall mathematical literacy. The integration of these three features is expected to create an effective and flexible learning experience tailored to the needs of students in the digital era.

Analysis

This analysis examines student development in relation to the needs and challenges they encounter. The findings indicate that teachers rarely utilize interactive digital learning media, despite the fact that school facilities are sufficiently equipped to support such learning. Furthermore, students are seldom given tasks that require the application of mathematical literacy; instead, they primarily work on routine problems. Consequently, they are not accustomed to solving problems that demand mathematical literacy skills. Matrix material is also regarded as one of the more challenging topics for students.

Design

The development of the learning media in this study was carried out by the researcher using Smart Apps Creator 3 software to design an interactive application that presents matrix material in a contextual manner aimed at enhancing students'

mathematical literacy skills. This stage involved four main steps: (1) developing mathematical literacy test instruments, (2) selecting appropriate learning media, (3) choosing the application development software, and (4) creating the initial design of the application's interface and content.

The preparation of the instrument began with the development of a question grid based on core competencies, basic competencies, and learning objectives, which resulted in five contextual fill-in-the-blank questions designed to assess students' mathematical literacy. The selection of media was guided by the characteristics of matrix material, which were linked to real-life contexts to strengthen the connection between mathematical concepts and students' everyday experiences. The MatriXplore application was designed to be accessible offline, providing flexibility for use in various learning environments. The choice of Smart Apps Creator 3 was based on its capacity to integrate interactive elements such as animations, audio, video, and quizzes into a single, user-friendly platform. All content was structured visually and interactively, and enriched with simulations to reinforce students' conceptual understanding in a concrete and meaningful way.



Figure 1. Smart Apps Creator 3



Figure 2. App MatriXplore

In the planning of the learning application for the subject of matrices, there are several activity flows, namely: learning objectives, materials, learning videos, evaluations, and bibliography.

Development

At this stage, it is necessary to prepare the materials required for media development, including the background, navigation buttons, animations, images, content, and evaluation questions. Several screenshots of the media development process are presented in the figures below.



Figure 3. Opening



Figure 4. Main Menu

When students open the application, the display begins with an introductory screen, as shown in Figure 3, followed by an interactive opening video that welcomes them to matrix learning, encourages preparation, and includes a moment of prayer before beginning the lesson. Subsequently, the main menu appears, as illustrated in Figure 4, featuring various menu options that users can navigate according to their needs. Each menu such as Learning Objectives, Material, and others is equipped with a home button that allows users to return to the main menu.

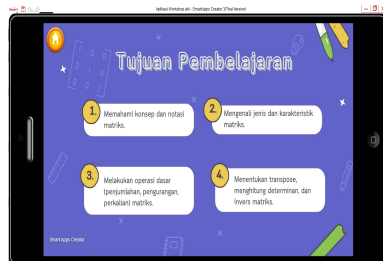


Figure 5. Learning Objectives

When the user clicks the “learning objectives” button, the screen displays a description of the learning objectives to be achieved in the matrix lesson, as shown in Figure 5. In the top-left corner, there is a home button that allows users to return to the main menu, as illustrated in the figure.



Figure 6. Matrix Material List

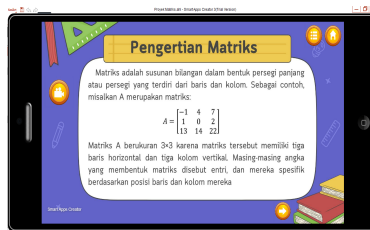


Figure 7. Matrix Material

When the user clicks the “material” button, the screen displays a list of subtopics to be studied, as shown in Figure 6. Users can click on a subtopic to access its corresponding content, as illustrated in Figure 7. In Figure 7, several navigation icons are available: a list icon to return to the subtopic list, a home icon to return to the main menu.

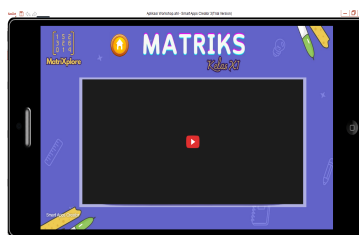


Figure 8. Educational Video

When the user clicks on the learning video, a full material learning video will appear as shown in image 8, which will direct the students to YouTube.



Figure 9. Evaluation

When the user clicks the “evaluation” button, the screen displayed is shown in Figure 9. The evaluation consists of two parts. The first part is a practice exercise containing five matrix literacy questions, where solutions are displayed upon selecting one of the answer options (a, b, c, or d). The second part is a quiz comprising ten matrix questions, ranging from easy to difficult, including a few mathematical literacy questions. This quiz is time-limited and functions such that after selecting an answer (a, b, c, or d), the screen will automatically proceed to the next question when the user clicks the arrow icon. A score is shown in the top-right corner. No solutions are provided for the quiz questions, and users are not allowed to return to previous questions. If the time runs out, the application will automatically redirect to the final quiz screen.

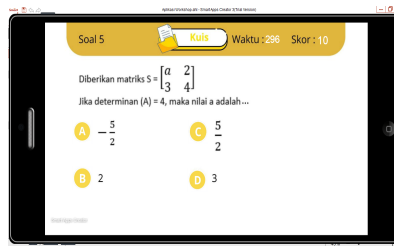


Figure 10. Quiz Questions



Figure 11. Final Quiz Screen

When students complete the multiple-choice quiz, they will receive a score display as shown in Figure 11. The assessment result is presented as a score ranging from 0 to 100, along with the Minimum Mastery Criterion (MMC) set at 50 points. If a student's score is ≤ 50 , they are considered not to have passed; otherwise, they are considered to have passed. The "Try Again" icon can be used for remedial purposes if the student did not pass.

Subsequently validated by experts which consists of subject matter experts and media experts media. Validation is carried out in the form of assessment through a validation sheet that contains several indicators. Validation was conducted by an expert validator, Mr. Farham Majid, S.Pd., M.Pd., as a mathematics education lecturer.

The SAC3-assisted digital learning media developed in this study needed to be validated to ensure its appropriateness for use in the learning process. For product validation, media and content experts were surveyed using the SAC3-assisted digital learning media along with an evaluation sheet containing 15 statements related to the product. The following presents the results of the media expert validation.

Table 4. Results of the Media Expert Validity Assessment

No	Aspect	Score	Max Value	Percentage	Note
1	Media Quality	41	45	91,11%	Very Good
2	Language Usage	5	5	100%	Very Good
3	Media Layout	22	25	88%	Very Good

The results of the media expert evaluation indicate that the validity score for the media quality aspect was 91.11%, categorized as very good; the evaluation of the language use aspect received a perfect score of 100%, also categorized as very good; and the media layout aspect achieved a score of 88%, which likewise falls into the very good category. Based on these assessments covering media quality, language use, and layout it can be concluded that the digital learning media

developed to enhance students' mathematical literacy skills is of very high quality. Subsequently, the material validation was conducted by providing the SAC3-assisted digital learning media product along with an assessment sheet containing 15 statements related to the developed digital media. The results of the material expert evaluation are presented below.

Tabel 5. Results of Expert Material Validity Assessment

No	Aspect	Score	Max Value	Percentage	Note
1	Accuracy of content with the competencies to be achieved	23	25	92%	Very Good
2	Completeness of Completeness	17	20	85%	Very Good
3	Coherence of Material	19	20	95%	Very Good

According to the assessment results from the material experts, the accuracy of the content in relation to the targeted competencies was 92%, the completeness of the material was 85%, and the coherence of the content was 95%—all of which are categorized as very good. These results indicate that the interactive learning videos developed to enhance mathematical skills fall into the very good category.

Implementation

The implementation stage was conducted in Class XI.2, which consisted of 33 students. The *MatriXplore* application was integrated into the learning activities as a supplementary medium for delivering matrix material. The implementation began with an introduction to the application, installation on students' devices, and teacher-led guidance on how to use each feature.

Table 6. Results of the Teacher Response Questionnaire Analysis

No	Aspect	Score	Max Value	Percentage	Note
1	Appearance	5	5	100%	Very Good
2	Content Presentation	29	30	96,67%	Very Good
3	Benefits	13	15	86,67%	Very Good

The results of the teacher questionnaire evaluation above show that the practicality in terms of display quality is 100%, content presentation is 96.67%, and usefulness is 86.67%. Overall, the media's practicality percentage reaches 94%, which falls into the very good category. This indicates that the SAC 3 digital learning media is suitable for use in mathematics teaching in the classroom.

The level of effectiveness of the SAC 3-assisted digital learning media developed can be reviewed from the results of the analysis of student response questionnaire data and learning test results. The analysis of the student response questionnaire data shows how effective the developed digital learning media is. The results of this analysis are shown as follows:

Table 7. Results of Student Response Questionnaire Analysis

No	Aspect	Score	Max Value	Percentage	Note.
1	Appearance	416	495	84,04%	Very Good
2	Content Presentation	554	660	83,94%	Very Good
3	Benefits	400	495	80,81%	Good

The pretest and posttest results of the XI.2 class students can be used to determine how effective this digital learning media is in improving students' mathematical literacy skills. Here are the pretest and posttest results.

Table 8. Result Pretest dan Posttest

	N	X	N-gain	Note
Pretest	33	63.03	0,38	Medium
Posttest	33	77.00		

The average pretest score of the students was 63.03 and increased to 77.00 on the posttest, resulting in an N-Gain value of 0.38, which is categorized as moderate effectiveness. This indicates that the use of media can significantly improve students' mathematical literacy skills, particularly in the aspects of representation, conceptual understanding, and context-based problem solving.

These findings are in line with the research by Sirait et al. (2024) on media based on Smart Apps Creator 3, which found that visual and interactive presentations significantly help students understand abstract mathematical concepts, such as geometry and algebra. However, the N-Gain value obtained in this study is still in the moderate category. This may be due to the limited duration of media usage and the less than optimal utilization of features by all students. Therefore, more intensive support strategies and longer media usage time are needed to achieve more optimal results.

Evaluation

The evaluation phase within the ADDIE model aims to assess the extent to which the developed learning media meets the criteria of validity, practicality, and effectiveness. The evaluation was conducted in two forms: formative and summative. Formative evaluation involved expert validation from media and content specialists to ensure that the instructional content, interface design, and interactive elements aligned with the learning objectives and students' characteristics. The validation results indicated that MatriXplore achieved a score of 93.03% from the media expert and 90.6% from the content expert, both of which fall into the "excellent" category. These findings suggest that the developed media meets substantial standards of quality and appropriateness for classroom use.

The summative evaluation was carried out after classroom implementation involving 33 students as research subjects. Instruments used included teacher and student response questionnaires and mathematical literacy tests administered before and after the intervention. The student questionnaire results revealed a very high level of acceptance, with a score of 82.93%, categorized as "very high acceptance." Teachers also rated the media as highly practical in terms of content delivery and user interface functionality. In terms of effectiveness, students' mathematical literacy scores improved from a pretest average of 63.03 to a posttest average of

77.00. The calculated N-gain value was 0.38, which falls into the “moderate” category. This indicates that the MatriXplore media contributed positively to enhancing students’ mathematical literacy skills, particularly in the areas of representation, conceptual understanding, and contextual problem-solving.

These findings are consistent with previous research by Wahyuni & Ananda (2022), who demonstrated that well-validated and interactive digital media can significantly improve student engagement and learning outcomes. Similarly, Zahroh & Yuliani (2021) found that science literacy-based digital media fosters students’ critical thinking and learning motivation. Therefore, MatriXplore is considered not only academically sound but also practically relevant and suitable for broader implementation in mathematics instruction aimed at developing students’ literacy in the digital era.

CONCLUSION

Based on the research and evaluation results that have been conducted, it can be concluded that the Android-based digital learning media MatriXplore, developed with the help of Smart Apps Creator 3, is very suitable for use in mathematics learning, particularly on the topic of matrices. Expert validation shows that this media is very good in terms of content quality, design, and feature integration. Implementation in the classroom shows a high level of practicality and acceptance by both teachers and students.

The use of this media has proven effective in improving students’ mathematical literacy skills, as reflected in the increase in learning outcome scores and an N-gain value of 0.38 (medium category). Thus, the MatriXplore media provides a positive contribution to mathematics literacy-based learning and can serve as an alternative solution in addressing the challenges of learning in the digital era. However, it is recommended that further development consider the integration of media with a broader curriculum, as well as conduct extended trials on a larger scale to achieve stronger result generalization.

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