

**Multimedia system for integrated reading acceleration and assistance (SMAART)
in literacy learning in high school**

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ABSTRACT

This study aimed to develop the Multimedia System for Accelerated and Assisted Integrated Reading (SMAART), an interactive learning application specifically designed to support high school students with literacy disabilities. Utilizing the ADDIE (Analysis, Design, Development, Implementation, Evaluation) model, the study only reached the development stage. This study followed a systematic development process to ensure the application's pedagogical and technical effectiveness. The analysis phase identified key literacy challenges through teacher interviews and student observations, while the design phase incorporated multimedia principles to create an engaging and accessible interface. During development, the application was built using Articulate Storyline 3, integrating text, audio, and visual elements to accommodate diverse learning needs. Expert validation was conducted with media specialists (assessing usability and design) and literacy educators (evaluating content relevance), resulting in high scores for display quality (4.6/5) and instructional effectiveness (4.4/5). User feedback highlighted the application's intuitive navigation (89% satisfaction rate), interactive exercises, and motivational multimedia components. The evaluation phase confirmed the effectiveness of SMAART as a complementary tool for literacy education, especially for students with learning disabilities. Its success underscores the potential of adaptive multimedia technology to promote inclusive education. Future research could expand testing to broader demographics and explore AI-based personalization. Ultimately, SMAART offers a scalable model for digital literacy interventions, aligning with the School Literacy Movement (GLS) initiative in Indonesia and addressing the gap in accessible learning resources for students with disabilities.

Keywords: ADDIE model, inclusive education, interactive learning media, literacy disabilities, multimedia-assisted learning

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INTRODUCTION

Literacy is a fundamental skill that includes reading, writing, speaking, and critical thinking skills (Kemendikbud, 2016; Kholiq & Luthfiyati, 2020). Good literacy skills enable students to access information, construct knowledge (Mayer 2002; Novak 2010), and actively participate in society (Nurmahanani 2021). However, in Indonesia, many high school students still experience serious literacy barriers, such as difficulty reading complex texts and understanding lesson materials (Fikri, Madona, and Morelent 2019). Data shows that 30% of high school students in remote areas (including the 3T category) have below-standard literacy skills (Kemendikbudristek, 2022). These barriers are triggered by multidimensional factors, including: 1) individual factors, namely learning disorders (eg. dyslexia) or lack of early literacy exposure (Leahy and Fitzpatrick 2017); 2) environmental factors, in the form of minimal access to quality reading materials and parental support (Syahroni et al., 2022); and 3) pedagogical factors, in the form of conventional teaching methods that are less innovative (Agustin and Basri 2024) and the implementation of the School Literacy Movement (GLS) which is not optimal (Dafit and Ramadan 2020). As a result, students experience a decline in academic achievement (Farlidya,

Magdalena, and Huliatusunisa 2023), self-confidence, and learning motivation (Rahma et al. 2023). Therefore, technology-based solutions are needed to address this problem inclusively.

This study develops a Multimedia System for Integrated Reading Acceleration and Assistance (SMAART), an interactive media based on Articulate Storyline 3 specifically designed for high school students with literacy disabilities. The uniqueness of SMAART lies in: 1) multimodal integration, in the form of text, audio, video, and animation based on the principles of multimedia learning (Irwanto 2021; Miftah 2018; Nazalin 2016); 2) adaptive features that guide independent learning according to the student's learning pace; and 3) an inclusive approach for students in 3T areas with minimal literacy facilities. This study is based on: 1) multimodal literacy theory which states that literacy is not only text, but also involves visuals and audio; 2) Cognitive Theory of Multimedia Learning (Mayer, 2009) which states that learning is more effective when combining visual and verbal elements; and 3) the concept of Meaningful Learning (Novak, 2010) which states that meaningful learning occurs when students actively construct knowledge.

The use of interactive multimedia in education has been proven effective in increasing student motivation and engagement in the learning process. Articulate Storyline 3, as one of the multimedia development platforms, offers various features that enable more interesting and interactive teaching (Budiarto and Jazuli 2021; Nurlaela, Santhi, and Ardiasih 2024). By utilizing multimedia, students can learn in a more enjoyable way and according to their learning style. Previous research has shown that the use of varied learning media can improve students' understanding and literacy skills (Chan, Budiono, and Setiono 2019). In addition, the use of multimedia in learning not only improves academic results, but also students' attitudes towards the subjects taught, such as science (Erchan 2014). This shows that multimedia not only functions as a tool, but also as a factor that influences student motivation and engagement in the learning process. Therefore, this study will develop interactive multimedia-based learning materials that can help high school students who have difficulty reading.

This is supported by other studies that found that the use of multimedia in learning can make students more interested and enthusiastic about learning, and improve their understanding of the concepts taught (Prayoga et al., 2022; Saubari & Sudatha, 2023). In addition, the use of interactive multimedia in education is very important to improve the effectiveness of learning outcomes. By integrating technology into teaching methods, educators can create more engaging and effective learning experiences for students, which will ultimately contribute to achieving better learning outcomes (Putri and Muhtadi 2018; Wibawanto, Roemintoyo, and Rejekiningsih 2022; Yuyun, Harjono, and Gunada 2022). This study is also expected to be a reference for educators and curriculum developers in designing learning programs that are more innovative and responsive to student needs (Humairoh 2023). Through the development of this learning media, it is hoped that students will not only be able to read well, but can also enjoy the learning process and develop a love of literacy.

The gap in this research is that previous studies on literacy media (Chan et al., 2019; Prayoga et al., 2022) are still limited to: 1) targeting elementary/junior high school children, not specifically for high school; 2) web/Android-based media, not utilizing Articulate Storyline 3 for interactive design; and 3) less comprehensive effectiveness evaluation, namely only a feasibility test, without measuring literacy improvements. The objectives of this study are 1) to develop SMAART as an interactive media to overcome literacy barriers for high school students; 2) to test the feasibility of SMAART from the aspects of design, navigation, and content; and 3) to evaluate the effectiveness of SMAART in improving reading skills and learning motivation. This study is expected to (1) provide tools for teachers for inclusive learning, especially in 3T areas; (2) enrich digital literacy studies with adaptive multimedia models; and (3) provide recommendations for the development of technology-based GLS programs.

METHOD

This study used the research and development (RnD) method with the ADDIE model, which consists of Analysis, Design, Development, Implementation, and Evaluation by Dick and Cary. However, due to time and cost constraints, the research phase was limited to the development stage. This study was conducted from October to December 2024. The subject of the limited test was one 10th-grade student at SMA Negeri 1 Sumberjaya who experienced literacy difficulties.

This study began with a needs analysis through observation and in-depth interviews with Indonesian language teachers at SMA Negeri 1 Sumberjaya on one grade X student who was identified as having literacy barriers. The analysis covers three aspects: (1) student learning needs based on the

independent curriculum (Kemendikbudristek No. 33/2022), (2) evaluation of existing learning media used by schools, and (3) identification of characteristics of specific literacy barriers in the research subject. Data were collected through field notes and interview recordings which were then analyzed thematically to determine product specifications.

Based on the analysis results, a SMAART prototype was designed with the following steps: (1) compiling a literacy competency map according to Phase E Learning Outcomes, (2) designing a storyboard that integrates multimedia (text, audio, visual) based on the principles of the Cognitive Theory of Multimedia Learning (Mayer, 2009), and (3) developing a validation instrument in the form of a closed questionnaire (Likert scale 1-5) and open to media and material experts. The instrument was tested for content validity using the Aiken's V formula with a minimum criterion of 0.70. The application flowchart was created with a user-centered design approach to ensure intuitive navigation.

The product was developed using Articulate Storyline 3 with an iterative process: (1) validation by 1 media experts (interface design and usability) and 1 material expert (literacy content), (2) limited trials with research subjects, and (3) revisions based on input. Validation data was analyzed quantitatively (percentage of agreement between experts) and qualitatively (comparative analysis of suggestions for improvement). Eligibility criteria are determined if an average score of ≥ 4.0 is achieved in all aspects of the assessment. This stage produces a final prototype that is ready to be implemented. At this stage, a limited trial was also conducted on one student with literacy difficulties.

This study used a mixed-method explanatory sequential design where quantitative data (validation scores, test results) were analyzed first, then further refined with qualitative analysis (interviews, observation notes) to explain the findings. Analysis techniques included: (1) Wilcoxon test to measure literacy improvement, (2) content analysis for qualitative data, and (3) method triangulation to validate the consistency of findings. The entire research process was documented in a logbook to ensure an audit trail.

RESULTS AND DISCUSSION

Results

The following data was successfully collected based on the ADDIE stages, namely Analysis, Design, Development, Implementation, Evaluation.

Analysis




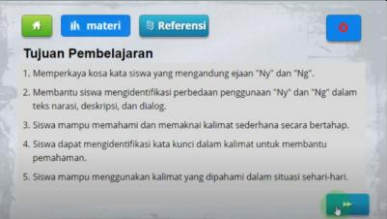

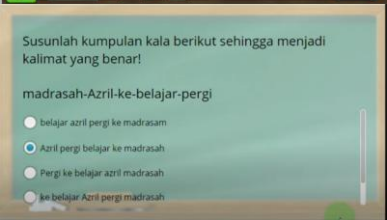

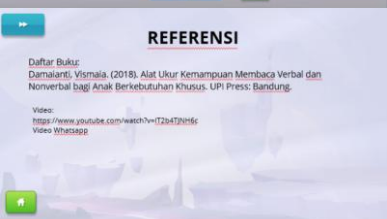
The analysis stage begins by evaluating the Articulate Storyline 3 software, which is the main tool in developing interactive learning applications. This stage aims to understand the technical specifications, terms of use, and main functions of the software. Articulate Storyline 3 provides similar features to PowerPoint but has the additional advantage of a trigger function that allows interactive navigation settings without the need for coding. This convenience makes the software very suitable for use in creating learning media.

The use of Articulate Storyline 3 requires certain hardware and software so that it can be installed and run optimally. In terms of hardware, the minimum specifications that must be met include a minimum CPU processor of 2 GHz (32-bit or 64-bit), 2 GB of memory, a minimum of 1 GB of disk space, a screen with a resolution of 1280×720 or higher, and a multimedia card, speakers, and a webcam to support voice or video recording. Meanwhile, in terms of software, the supported operating systems include Windows 7, 8, or 10 (32-bit or 64-bit), Mac OS version 10.6.8 or later, .NET Framework minimum version 4.5.2, Visual C++, and Adobe Flash Player version 10.3 or higher. This combination of specifications ensures that the software runs smoothly to support the learning application development process. (Rohmah & Bukhori, 2020).

Design Stage

At the design stage, various important steps are taken to ensure that the application development goes according to plan. One of the initial steps is to prepare a research instrument in the form of an interactive learning multimedia evaluation questionnaire. This questionnaire is intended for media experts, learning material experts, students as respondents.

Table 1. Designing the story board

No.	Story Board Design Results	Information
1		The intro or opening section of the SMAART application
2		Greeting section, in this section the application will greet students as users.
3		Motivational video section, in this section there are two motivational reading videos as a start for students to start learning.
4		Learning objectives section: On this slide, the learning objectives are displayed accompanied by sound or reading of the learning objective text.
5		Example of material: This slide displays vocabulary containing the consonant "ny", as well as sounds to repeat or recheck the correct pronunciation of each vocabulary.
6		Example of exercise: In this slide, students with literacy disabilities try to construct scrambled sentences.
7		Practice result score: On this slide, the grades will be displayed after students answer the questions provided in the SMAART application.
8		Reference: This slide presents reference sources and video assets that are used as learning motivation for students with literacy barriers.

In addition to preparing the instrument, the design stage also includes the development of a flowchart or flow diagram that describes the structure and workflow of the application. This flowchart is designed based on the learning needs of the first meeting sub-material, namely about the nature and urgency of digitalizing learning. This flowchart serves as a guide in integrating various learning features and content into the application in a logical and structured manner. Figure 1 shows a representation of the flowchart that has been designed, providing a visual depiction of the planned learning process.

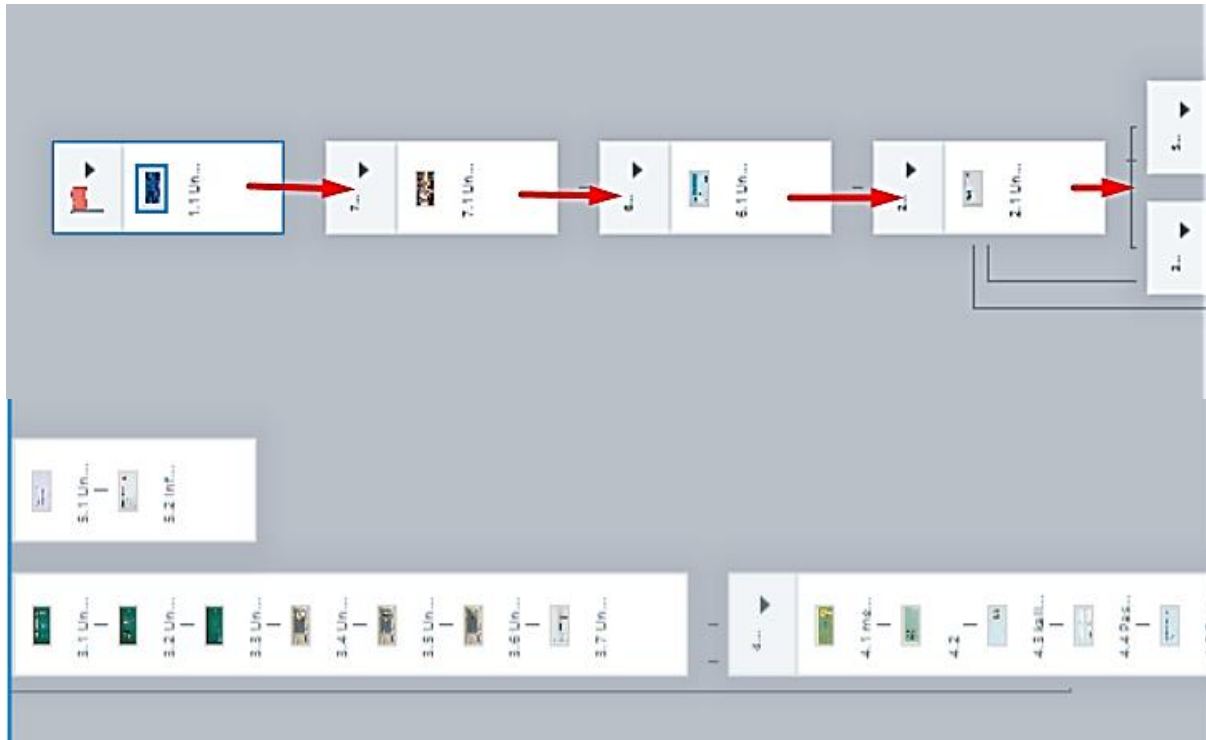


Figure 1. Flowcart

Development Stage

In the development stage, the main focus is on the validation of the designed product. The validation process involves two main aspects, namely media validation and validation of reading learning materials. The aspect of learning integration was assessed as good by experts with a score of 4. This shows that the SMAART learning application has succeeded in integrating learning elements systematically, starting from content, objectives, to learning flow. However, this score also indicates that there is room for improvement, such as strengthening the relationship between materials and more structured activities. The effectiveness of the application in improving student literacy also received a score of 4, indicating that the application is quite effective in supporting students in understanding the material. Even so, this evaluation provides a signal that there is potential to further increase effectiveness, for example by providing additional features such as interactive text or more varied exercises. Student motivation in using this application was assessed as good with a score of 4. The design and features of the application are able to attract students' attention to learn. To further increase motivation, gamification elements, such as a reward system or leaderboard, can be considered to increase the appeal of the application for students.

This application is considered quite appropriate for the literacy level of students, as indicated by a score of 4. This indicates that the content and activities in the application have been designed based on the needs of students with literacy disabilities. However, improvements in the form of personalizing materials according to individual student abilities can further improve this suitability. The learning evaluation aspect received the highest score, namely 5. This indicates that the evaluation mechanisms in the application, such as quizzes and automatic feedback, are considered very effective and relevant. This assessment reflects that the evaluation features have met expert expectations in supporting the student learning process. Based on the assessment results of reading learning experts Dr. Emah Khuzaemah, M.Pd., the SMAART application has met good standards in all aspects of the assessment,

with an average score of 4.2. However, some areas still have potential for improvement, such as the use of the phonemes *ny* and *ng* separated into two slides. Addition of motivational reading videos.

The following is an analysis of the results of the learning media expert assessment based on the table provided. The display design aspect was assessed as good with a score of 4, indicating that the application has been designed with a fairly attractive interface and supports user interaction with learning content. However, there is still room to improve aesthetics and visual comfort, such as the use of more attractive and consistent colors, layouts, or graphic elements. The ease of navigation aspect received the highest score, which is 5. This indicates that the application greatly supports users in exploring its features easily. The use of technology features that support readability and accessibility is optimal, so that no obstacles are found in using the application. Interactivity was rated good with a score of 4, indicating that the application was able to facilitate fairly effective interaction between users and learning content. However, to improve this score, the application could include more complex interactive elements, such as simulations, drag-and-drop, or more dynamic direct response features. The use of technology in the application received a score of 4, indicating that the technology used sufficiently supports readability and literacy mastery. However, this assessment also indicates the need for further exploration of advanced technology features, such as the integration of artificial intelligence (AI) to provide personal feedback to users.

The aspect of attraction and motivation received the highest score, namely 5. This indicates that the application is able to attract students' attention and motivate them to learn. Features that encourage student interest, such as attractive design and gamification elements, are considered very effective in increasing learning motivation. Based on the assessment results by Dr. Ahmad Ripai, M.Pd., the learning media application has the main strengths in the aspects of ease of navigation and attraction and motivation. The average score of all aspects is 4.4, indicating that the application is already in the good category. However, to achieve perfection, improvements need to be made to the aspects of display design, interactivity, and use of technology by adding innovative elements that better support the learning process. In terms of interface appearance, this application is considered attractive with an average score of 5. Students like the simple yet intuitive design, which makes it easy to navigate in the application. However, several students provided input so that the colors and visualization of the application could be made brighter to increase its appeal. This shows that although the application has succeeded in attracting students' attention, there is an opportunity to improve the visual aspect to be more optimal.

Interactive features such as animation, audio narration, and practice questions received positive responses with an average score of 4. Students felt that these features not only helped them understand the text but also increased their interest in reading. Audio narration, for example, is very useful for students who have difficulty reading independently, while animations can make the story more lively and interesting. The instant feedback provided by the application on each exercise is also considered effective in improving understanding. In addition, the application is considered easy to use without intensive assistance from teachers, with a score of 4. However, some students admitted that the initial guidance when they first used the application was very helpful in understanding how each feature works. This emphasizes the importance of having simple and clear instructions so that the application can be used independently by all students, including those who are less familiar with technology. Finally, most students reported increased confidence in reading and understanding texts after using this application. With a score of 5, the SMAART application has provided a learning experience that supports students to be more confident in dealing with more complex reading. In conclusion, this application has succeeded in being an effective solution to help students with literacy barriers, although there are some aspects that can be improved, such as a more attractive visual design and a more concise user guide.

The next stage was a limited trial conducted with a student with literacy difficulties or reading difficulties. The student provided feedback on the assessment of the SMAART application. The following are the responses from students with literacy difficulties. In terms of interface appearance, the application was rated attractive with a score of 5. Students appreciated its simple yet intuitive design, which made it easier to navigate. However, the student provided feedback that the application's colors and visualizations could be brightened to make it more appealing. This indicates that although the application successfully captured students' attention, there is still room for improvement in the visual aspects to optimize it. Interactive features such as animations, audio narration, and practice questions received positive feedback with an average score of 4. Students felt that these features not only helped

them understand the text but also increased their interest in reading. Audio narration, for example, is very useful for students who have difficulty reading independently, while animations can make stories more lively and engaging. The instant feedback provided by the application on each exercise was also considered effective in improving comprehension. Furthermore, the app was rated as easy to use without intensive teacher assistance, with a score of 4. However, students in the limited trial acknowledged that the initial guidance provided when first using the app was helpful in understanding how each feature worked. This underscores the importance of providing simple and clear instructions so that the app can be used independently by all students later in the implementation phase, including those less familiar with technology. Finally, some students reported increased confidence in reading and comprehending texts after using the app. With a score of 5, the SMAART app has provided a learning experience that supports students' confidence in tackling more complex reading. In conclusion, the app is an effective solution for helping students with literacy challenges, although there are some areas for improvement, such as a more engaging visual design and a more concise user guide.

Discussion

Analysis Stage

Based on the Independent Curriculum (Ministry of Education, Culture, Research and Technology No. 33/2022), the Indonesian language teacher at SMA Negeri 1 Sumberjaya stated that this curriculum emphasizes a differentiation approach, where learning must be adjusted to the individual needs of students, including those with literacy disabilities. In the case of this grade X student, it was found that the learning material was too complex and the lack of variation in teaching methods were the main obstacles (Johnson et al., 2016). The Independent Curriculum actually provides room for modification, but the teacher admitted that it was difficult to design materials that were appropriate to the literacy level of the student. Observation results show that learning evaluations in schools still rely on conventional textbooks and worksheets that are one-way, without much interactivity. This media is considered less effective for students with literacy disabilities because it does not facilitate multimodal learning (visual, audio, kinesthetic) (Ong & Quek, 2023). The teacher also stated limited access to more interesting digital platforms, such as interactive applications or learning videos (Haleema et al., 2020). This exacerbates the gap in students' literacy skills, especially for those who need a more personal and creative approach.

Through in-depth interviews and observations, it was found that students had difficulty understanding long texts, linking ideas between paragraphs, and expressing their thoughts in writing (Nuralimah et al., 2023). In addition, students tend to get frustrated quickly when faced with complex reading or writing tasks. This obstacle is not only cognitive but also psychological, where students feel inferior and are reluctant to actively participate in class (Ahmad, 2021). This indicates the need for holistic interventions, not only in learning content but also in aspects of motivation and self-confidence. Data collected through field notes and interview recordings revealed several key findings. First, teachers recognize the importance of an individual approach, but lack the resources and training to implement it (Mandefro, 2019). Second, existing media are considered too rigid and not adaptive to the needs of students with literacy disabilities (Wang & Tahir, 2020). Third, students need more scaffolding (gradual support) in literacy activities, such as breaking text into small parts or using images as visual aids (Buelvas, 2024). These findings are the basis for formulating specifications for more inclusive learning media products.

Thematic analysis of the data resulted in several recommendations for product development. First, learning media must be multimodal, combining text, audio, and visuals to meet different learning styles (Mavropoulou et al., 2024). Second, products need to include interactive features such as simple quizzes or drag-and-drop activities to increase student engagement (Malekjafarian & Gordan, 2024). Third, content must be designed with a micro-learning approach (learning in small parts) to make it easier to digest (Sathiyaseelan et al., 2024). Finally, the product must contain motivational aspects, such as a reward system or positive feedback, to build student confidence. This study underlines the importance of developing inclusive learning media that is in accordance with the Merdeka Curriculum and the needs of students with special needs. The implication is that schools need to invest in teacher training and procurement of supporting technology. For further research, it is recommended to conduct trials of the developed media products to measure their effectiveness in improving literacy (Tran-Duong, 2023). In addition, it is necessary to expand the scope of research subjects to include more students with various literacy barriers, so that the resulting products can be more adaptive and scalable.

Design Stage

The first step in designing the SMAART prototype is to compile a literacy competency map based on Learning Outcomes (CP) phase E of the Merdeka Curriculum. This map is designed to ensure alignment between student needs and literacy barriers and curriculum standards. Analysis shows that CP phase E emphasizes the ability to understand complex texts, write argumentatively, and think critically. Therefore, the competency map is compiled in stages, starting from basic skills such as identifying main ideas to high-level skills such as analyzing text points of view. This map is the foundation for developing application content, while ensuring that the material presented is relevant and structured (Maksl et al., 2015). The second step is to design a storyboard that integrates multimedia (text, audio, visual) based on the principles of the Cognitive Theory of Multimedia Learning (Mayer, 2009). The storyboard is designed to minimize cognitive load by applying principles such as coherence (avoiding irrelevant elements) (Figl, 2017), signaling (visual markers to focus attention) (Aldalalah, 2021), and segmenting (dividing content into small parts). For example, explanatory videos are equipped with audio narration and simple animations to facilitate understanding, while text is presented in a dyslexia-friendly font. This approach aims to improve information processing for students with literacy disabilities. To ensure the quality of the prototype, a validation instrument was developed in the form of a closed questionnaire (Likert scale 1-5) and open-ended questions for media and material experts. The closed questionnaire covers aspects such as the suitability of the content to the curriculum, multimedia quality, and ease of navigation (Szarek et al., 2025). Meanwhile, open-ended questions allow experts to provide qualitative input. This instrument is designed systematically with measurable indicators, for example: "Does the visualization in the application support text comprehension?" (scale 1-5). The validity of the content was tested using the Aiken's V formula to ensure reliability, with a minimum criterion of 0.70 as the acceptance limit.

The validation instrument was tested quantitatively using Aiken's V to measure inter-expert agreement on the relevance of each item. For example, the item "The application facilitates differentiated learning" was assessed by three experts with an average score of $V \geq 0.70$. The test results showed that most items met the validity criteria, although some needed to be revised, such as adjusting the wording of the questions to be more specific. This process ensures that the instrument actually measures the intended aspects, namely the appropriateness of the media and materials before the prototype is tested on students (Miaz et al., 2019). The application flowchart was developed using a user-centered design (UCD) approach to ensure intuitive navigation for students with literacy disabilities. The stages include: (1) identifying user needs through previous observation data, (2) creating a simple wireframe, and (3) iterating the design based on teacher input. Features such as large buttons, high-contrast color palettes, and audio prompts are included to facilitate access. UCD principles are also applied in the menu layout, for example placing a "help" option on each screen to reduce user confusion. The results of the needs analysis, competency map, and expert validation were integrated into the SMAART prototype in preparation for the trial. This application not only meets the demands of the curriculum but also accommodates the specific characteristics of students with literacy disabilities, such as the use of interactive multimedia and scaffolding (Sikström et al., 2024). The next step is a limited trial involving target students and teachers to evaluate the effectiveness of the application. Findings from the trial will form the basis for final improvements, including adjusting the difficulty level and adding instant feedback features to monitor learning progress.

Development Stage

The research product was developed using Articulate Storyline 3, an authoring platform that enables the creation of interactive multimedia-based learning media. The selection of this tool was based on its ability to integrate text, audio, visuals, animations, and interactive elements (Rogti, 2024) in accordance with the principles of the Cognitive Theory of Multimedia Learning. Development was carried out iteratively, with stages that included expert validation, limited trials, and ongoing revisions. This iterative approach ensured that the product not only met technical standards but was also truly effective in overcoming the research subjects' literacy barriers. The product was validated by three experts consisting of two media experts (focusing on interface design and usability) and one material expert (literacy content). This validation aimed to evaluate the product's suitability to the principles of learning design, content accuracy, and ease of use. Media experts assessed aspects such as layout,

navigation, and readability (Giannakouloupoulos et al., 2024), while material experts ensured that the literacy content presented was in accordance with Phase E Learning Outcomes and student needs. The validation results were then analyzed to determine the feasibility of the product before further trials were carried out. Validation data were analyzed using two approaches, namely quantitative (percentage of agreement between experts) and qualitative (comparative analysis of improvement suggestions). Quantitatively, expert assessment scores were calculated on a Likert scale (1-5) to determine the percentage of agreement, with the eligibility criteria set if an average score of at least 4.0 was achieved in all aspects. Qualitative analysis was carried out by comparing improvement suggestions from the three experts to identify similarities and differences in input, which were then used as the basis for product revision.

After going through the validation and initial revision stages, the product was tested on a limited basis with research subjects, namely grade X students with literacy disabilities. This trial aims to evaluate the effectiveness of the product in a real context, including user response to the interface, level of content understanding, and engagement during use (Xu, 2025). Data were collected through direct observation, field notes, and short interviews with students. The results of the trial provide an overview of the product's strengths and weaknesses from the perspective of direct users. Based on input from experts and the results of limited trials, the product underwent several revisions to improve its quality. Revisions include refining the interface to make it more intuitive, adjusting the level of content difficulty, and adding supporting features such as instant feedback and clearer instructions for use. This revision process was carried out carefully to ensure that the product still met the eligibility criteria (average score ≥ 4.0) while also addressing the specific needs of the research subjects. The systematic and iterative development stages produced a final prototype that was ready to be implemented in learning. This prototype has met the eligibility standards based on expert assessment and field trials, and is optimized to address students' literacy barriers. In the future, the product can be tested on a wider scale to measure its impact on improving literacy, as well as becoming a model for developing technology-based inclusive learning media (Liu et al., 2025) that can be adopted by other teachers and schools.

Students with literacy disabilities responded very positively to the SMAART app interface, with a rating of 5. Students appreciated the simple yet intuitive design, which made the app easy to navigate and use. The uncomplicated design was considered helpful in reducing confusion and focusing attention on the learning content (Hultberg et al., 2018). However, students provided suggestions for improving the visual aspects, such as using brighter and more contrasting colors, to make the app more appealing. This feedback indicates that while the interface was considered good, there is still room for improvement to enhance visual appeal and user experience. The interactive features in the app, such as animations, audio narration, and practice exercises, received very positive feedback from students, with a rating of 4. Students stated that these features not only helped them understand the text better but also made the learning process more enjoyable (Darling-Hammond et al., 2020). The audio narration, in particular, was very beneficial for students who struggle with independent reading, while the animations were found to bring the story to life and increase emotional engagement. Furthermore, the instant feedback the app provided after completing exercises was considered effective in reinforcing comprehension and providing a sense of accomplishment. The SMAART app was rated as easy to use without requiring intensive teacher assistance, with a score of 4. The student felt that the clear navigation and well-organized buttons allowed her to use the app independently. However, she stated that the initial guidance when opening the app for the first time was helpful in understanding how each feature worked. This highlights the importance of including short, easy-to-understand tutorials or instructions, especially for students less familiar with technology, to ensure they can maximize the app's use (Swider-Cios et al., 2023). One of the most significant impacts of using the SMAART app was increased student confidence in reading and comprehending texts, with a score of 5. Students reported that the app's practice exercises, accompanied by positive feedback, helped them feel more capable of handling complex texts. Furthermore, the app's step-by-step learning approach and scaffolding allowed students to progress without feeling overwhelmed. This increased confidence impacted not only their literacy skills but also their overall motivation to learn.

Although the SMAART app has provided many benefits, students were provided with some feedback for improvement. In addition to improvements in visual aspects, such as color and graphics, some students suggested adding content variety, such as more stories or texts with different themes, to

maintain learning interest. There were also suggestions for improving personalization, for example by allowing students to choose the difficulty level or type of exercises according to their needs. This feedback indicates that the app has great potential for further development to make it more effective and engaging for users. Overall, the SMAART app has been successful in being an effective solution to help students overcome literacy barriers, as evidenced by positive student responses to the interface, interactive features, ease of use, and its impact on self-confidence. However, several aspects such as visual design, user guidance, and content variety still need improvement to optimize the learning experience (El-Sabagh, 2021). The recommendation is to make minor revisions based on student feedback, followed by a large-scale pilot to measure its long-term impact. With these improvements, the app has the potential to become an inclusive learning tool that can be adopted more widely in educational settings.

CONCLUSION

Based on the evaluation results, the SMAART application was successfully developed as an interactive learning media based on Articulate Storyline 3 which effectively improves the literacy of students with special needs through the ADDIE (Analysis, Design, Development, Implementation, Evaluation) development process but only up to the development stage. The results of expert validation showed high feasibility in terms of media (score 4.6/5) and materials (score 4.4/5), while limited trials proved a positive response to ease of navigation (89% satisfaction), visual appeal, and the effectiveness of multimedia-based learning. These findings confirm that SMAART not only has the potential as an inclusive solution for adaptive literacy learning, but also provides a practical contribution to the digital implementation of the School Literacy Movement (GLS), while opening opportunities for the development of technology-based interactive learning media for students with special needs in the future.

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