

Research article

Development of a Pencak Silat Learning Media Based on Articulate Storyline for Elementary Physical Education

Sonya Nelson ^{1,2*}, Ade Zalindro ¹, Septri ¹, Nurul Ihsan ¹, Ridho Bahtra ¹, Alnedral ¹, Yovhandra Ockta ², Juanda Putra ¹ and Desi Novita Sari ¹

Citation: Nelson S., Zalindro A., Septri, Ihsan N., Bahtra R., Alnedral, Ockta Y., Putra J., Sari D.N. – Development of a Pencak Silat Learning Media Based on Articulate Storyline for Elementary Physical Education
Balneo and PRM Research Journal 2025, 16(4): 923

Academic Editor(s):
Constantin Munteanu

Reviewer Officer:
Viorela Bembea

Production Officer:
Camil Filimon

Received: 05.11.2025
Published: 30.12.2025

Reviewers:
Mariana Rotariu
Mihai Hotetetu

Publisher's Note: Balneo and PRM Research Journal stays neutral with regard to jurisdictional claims in published maps and institutional affiliations.



Copyright: © 2025 by the authors. Submitted for open-access publication under the terms and conditions of the Creative Commons Attribution (CC BY) license (<https://creativecommons.org/licenses/by/4.0/>).

1. Faculty of Sports Science, Universitas Negeri Padang, Indonesia;
2. Doctoral Sport Sciences Programe, Faculty of Sports Science, Universitas Negeri Padang, Indonesia;
3. Faculty of Health Sciences, Universitas Teuku Umar, Indonesia

* Correspondence: sonyanelson@fik.unp.ac.id

Abstract: This study aims to develop and validate an interactive digital learning media for Pencak Silat instruction using the Articulate Storyline platform. The research employed the Research and Development (R&D) method based on the Borg and Gall model, integrated with the Multimedia Development Life Cycle (MDLC) framework consisting of six stages: concept, design, material collection, assembly, testing, and distribution. Data were collected through expert validation, teacher practicality assessment, and student response questionnaires. The validation results showed an average score of 92.63%, categorized as very valid, while the practicality test obtained an average score of 91.13%, classified as excellent. These findings indicate that the developed media effectively integrates cultural elements, interactive features, and pedagogical accuracy. The multimedia—comprising text, animation, narration, and video—successfully enhanced student motivation, engagement, and psychomotor understanding in performing Pencak Silat movements. This research contributes to digital transformation in Physical Education by providing accessible, culturally grounded, and sustainable learning innovations that align with SDG 4 (Quality Education) and SDG 11 (Sustainable Cities and Communities). The Articulate Storyline-based media offers an effective model for developing interactive learning resources that preserve cultural heritage while enhancing 21st-century competencies.

Keywords: Articulate Storyline, Pencak Silat, Interactive Learning Media, Physical Education, Martial Arts

1. Introduction

The rapid development of information and communication technology (ICT) in the era of Industrial Revolution 4.0 and Society 5.0 has profoundly reshaped educational paradigms [1], [2], [3]. Institutions are now urged to embed digital innovation in pedagogy to nurture creative, adaptive, and technology-literate learners [4]. Learning media have thus become strategic elements in promoting student engagement and conceptual understanding [5], [6], [7]. In Physical Education (PE), traditionally dependent on demonstration and direct physical interaction, digital transformation provides visualization, feedback, and flexibility that conventional methods cannot easily offer [8]. Consequently, innovation in PE learning media is essential to align with global educational reforms emphasizing inclusivity, technological competence, and lifelong learning.

Pencak Silat conveys discipline, respect, cooperation, and cultural identity [9]. Within the school curriculum, it contributes to students' psychomotor, cognitive, and affective development [10], [11], [12]. However, Pencak Silat instruction in elementary education often remains limited to printed materials and verbal explanation. Such con-

ventional approaches fail to visualize complex movement patterns effectively or stimulate active learning [13]. Teachers also face difficulties accessing or designing modern, interactive media suited to elementary-school learners' needs. As a result, lessons frequently lack motivational appeal and cultural depth, and students become passive recipients rather than active participants.

In response to these challenges, digital-based innovations—multimedia, augmented reality (AR), and virtual reality (VR)—have been widely explored to enhance sport and martial-arts learning [14]. These technologies improve learners' spatial understanding and motor-sequence recognition but remain costly and technically demanding for primary-school contexts [15]. Hence, a lightweight and accessible platform is required—one that teachers can operate without specialized programming skills. Articulate Storyline emerges as a promising authoring tool that enables the creation of interactive multimedia lessons integrating text, audio, video, animation, and quizzes [16]. Studies have demonstrated its effectiveness in fostering self-regulated learning and engagement across various subjects [17]. Its intuitive interface resembles PowerPoint but adds dynamic features such as triggers, layers, and timelines, making it ideal for producing movement-based learning content like Pencak Silat. Pedagogically, the adoption of Articulate Storyline aligns with the constructivist theory of learning, emphasizing learner-centered exploration, experimentation, and reflection. Interactive multimedia encourages students to build knowledge through active manipulation and feedback—an approach essential for mastering psychomotor skills [17]. Interactive digital media offer valuable support in Pencak Silat education by helping students understand motion patterns through visualizations, animations, and immediate feedback. Such features also enable the integration of cultural elements—traditional music, narratives, and symbolism—so that learning simultaneously strengthens motor skills and cultural appreciation.

Although previous studies have explored AR- and VR-based martial-arts instruction at university or training-center levels, there remains a lack of culturally responsive and developmentally appropriate media for elementary-school learners. This study addresses that gap by developing Pencak Silat learning media using Articulate Storyline, a platform that provides accessible, HTML5-based digital simulations aligned with traditional pedagogical principles. The study supports SDG 4 (Quality Education) by offering inclusive and culturally relevant digital resources that enhance students' competencies while helping preserve Indonesia's intangible cultural heritage. Overall, the Articulate Storyline application serves as a bridge between traditional Pencak Silat learning and modern educational needs. This study develops an Articulate Storyline-based Pencak Silat learning medium designed specifically for elementary-school students, addressing a gap in existing research that typically focuses on AR or VR tools, which are often not developmentally appropriate or accessible for young learners. Unlike immersive AR/VR systems, which prioritize full-body simulation and advanced performance replication, this digital tool emphasizes guided, step-by-step movement breakdowns with age-appropriate interactivity. It combines traditional pedagogical methods with modern digital design, offering a scaffolded learning experience that integrates cultural elements such as traditional music and narratives into the instructional content. This approach not only supports skill development but also strengthens cultural appreciation, making it a more accessible, pedagogically sound alternative to AR/VR for younger audiences.

2. Materials and methods

This study employed a Research and Development (R&D) approach following the Borg and Gall (2003) model, aiming to design, validate, and evaluate a digital learning tool for Pencak Silat using the Articulate Storyline platform. The process followed the Multimedia Development Life Cycle (MDLC) framework (Sugiarto, 2018), encompassing six phases: concept, design, material collection, assembly, testing, and distribution. In the concept phase, a needs analysis was conducted with PE teachers

from elementary schools in Padang Utara District, identifying gaps such as limited visualization tools, low student engagement, and underuse of technology in Pencak Silat instruction. The design phase focused on mapping learning content to the PE curriculum, ensuring alignment with psychomotor, cognitive, and affective objectives. Teachers, selected based on their experience in teaching Pencak Silat at the elementary level, and students aged 8 to 12, were the primary participants. A validation rubric, developed by subject matter experts and instructional designers, assessed the content's accuracy, pedagogical relevance, and usability. After development, the media underwent field testing, with revisions made based on feedback to improve its effectiveness and usability.

In the material collection phase, researchers gathered multimedia assets such as motion videos, photographs, narration, and traditional music reflecting the cultural context of Pencak Silat. These materials were then integrated during the assembly phase, where the media was developed using Articulate Storyline. The resulting prototype allowed learners to explore fundamental stances, strikes, and defenses interactively, supported by animations and audio-visual cues. The testing phase comprised two stages: expert validation and user trials. Three experts—specialists in Pencak Silat, educational technology, and instructional design—evaluated the media's content validity, interface design, and pedagogical appropriateness using structured assessment sheets. Practicality testing was conducted with PE teachers to assess usability, accessibility, and classroom integration, while student responses were collected to measure motivation and engagement. Quantitative data from validation and practicality questionnaires were analyzed descriptively using means and percentages, categorized as “very valid,” “valid,” or “practical” based on established criteria. The instruments of this research can be seen in the table below:

Table 1. Expert Validation Questionnaire Structure (Content, Instructional Design

No	Construct / Aspect	Example Assessment Items	Likert Scale
1	Content Relevance	The material aligns with the elementary school curriculum	1–5
2	Accuracy of Techniques	Terms such as stance, attack, and defense are used correctly	1–5
3	Clarity of Explanation	The explanation of movements is easy for students to understand	1–5
4	Completeness of Material	The material covers core competencies and basics	1–5
5	Character Values	The material reflects values such as discipline, respect, and cooperation	1–5

Table 2. Instructional Design Expert Validation Questionnaire

No	Construct / Aspect	Example Assessment Items	Likert Scale
1	Quality of Learning Content	Learning objectives are clearly presented	1–5
2	Learning Flow	The learning sequence is organized from simple to complex	1–5
3	Interactivity	Interactions support student engagement	1–5
4	Cognitive Load	Information is appropriate and not overwhelming for elementary students	1–5
5	Assessment	Quizzes/exercises align with learning objectives	1–5

Table 3. Media Expert Validation Questionnaire

No	Construct / Aspect	Example Assessment Items	Likert Scale
1	Program Quality	Navigation buttons (Next, Back, Home) function properly	1–5
2	Visual Design	Color selection and contrast are appropriate for students	1–5
3	Readability	Font size and type are easy to read	1–5
4	Media Synchroniza-tion	Audio, video, and animation are properly synchronized	1–5
5	Video Quality	Demonstration videos are clear and easy to follow	1–5

Table 4. Practicality Questionnaire Structure (Teachers and Students)

No	Construct / Aspect	Example Assessment Items	Likert Scale
1	Ease of Use	The media is easy to use without teacher assistance	1–5
2	Clarity of Material	The explanations are easy to understand	1–5
3	Interactivity	Interactive buttons and features work well	1–5
4	Attractiveness	Animations and visuals make learning more interesting	1–5
5	Learning Benefit	The media helps understand Pencak Silat movements	1–5

Table 5. Likert Scale Interpretation

Score	Category
1	Strongly Disagree / Very Poor
2	Disagree / Poor
3	Neutral / Fair
4	Agree / Good
5	Strongly Agree / Very Good

3. Results

The study adopted the Research and Development (R&D) approach to design, develop, validate, and implement an interactive digital learning media for Pencak Silat instruction. The model used was adapted from Borg and Gall (2003), which emphasizes a systematic and iterative process of product creation, validation, and testing. The development was further operationalized using the Multimedia Development Life Cycle (MDLC) model, consisting of six interconnected stages: concept, design, material collection, assembly, testing, and distribution.

A. Identifying Potentials and Problems

The process began with a needs analysis conducted through interviews and observations of elementary school Physical Education (PE) teachers in Padang Utara District. It was identified that existing Pencak Silat learning resources were limited to printed materials and verbal demonstrations, which made it difficult for students to visualize movements accurately. Teachers also expressed challenges in using digital learning tools due to limited training and infrastructure. This phase established the urgency to create a digital-based instructional media that is interactive, accessible, and aligned with the PE curriculum.

B. Data Collection and Requirement Analysis

Supporting data were collected through literature review and curriculum document analysis related to the Pencak Silat subject in elementary schools. The goal was to map the essential competencies—stances (*kuda-kuda*), attacks (*serangan*), and defenses (*tangkisan*)—and define the learning objectives. Simultaneously, multimedia resource requirements were determined, including video footage, graphics, traditional background music, and narration scripts to ensure that the final product would integrate cultural authenticity and pedagogical accuracy.

C. Product Design and Product Development

The product design phase of this research was conducted systematically using Articulate Storyline 360 as the development platform. The process followed nine main steps to ensure that the final product met both pedagogical and technical standards. During this phase, a storyboard was created to visualize the flow of learning activities within the Articulate Storyline platform. Each scene in the storyboard represented a learning unit containing instructional text, animation, and interactive assessment tasks. The design incorporated navigation buttons (Next, Back, and Home) to facilitate user control, while color schemes and background images were selected to reflect Indonesian cultural motifs. The user interface was designed to be simple, intuitive, and suitable for young learners to navigate independently.

1) Application Installation

The process began by downloading and installing Articulate Storyline 360 from its official website. After installation, the application was configured and tested to ensure compatibility and readiness for the design process. A trial version was initially used before activating the full license. Langkah awal adalah mengunduh aplikasi Articulate Storyline 360 melalui situs resmi <https://articulate.com>.



Figure 1. Articulate Storyline 360 App

2) Creating a New Project and Scene Structure

A new project file was created within the software, followed by the establishment of several scenes to serve as the main storyline framework. Each scene represented a unit of learning—such as introduction, stance techniques, attack techniques, and defense movements—ensuring a modular and logical instructional flow.

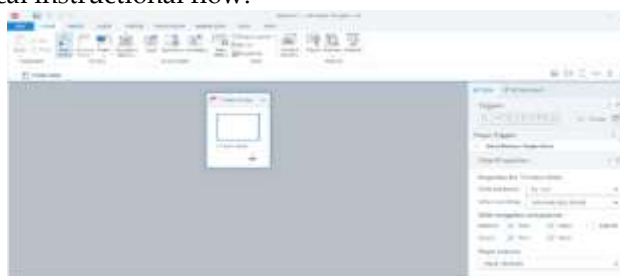


Figure 2. New Project and Scene Structure

3) Adding Slides for Each Learning Segment

Each scene was populated with slides containing instructional content. Slides were organized sequentially from basic concepts to applied practice. Layouts were arranged for clarity, balancing text, visuals, and navigation icons.

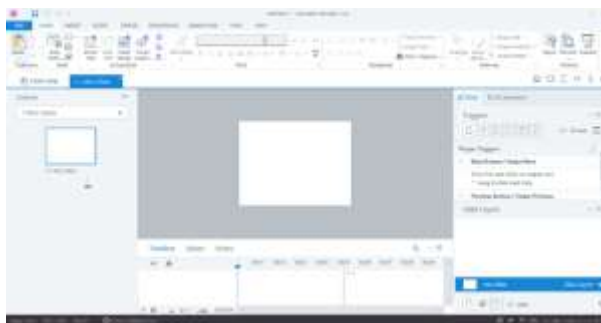


Figure 3. Slides for Each Learning Segment

4) Designing Background and Visual Themes

Relevant backgrounds were selected for each slide to enhance engagement and contextual understanding. Images reflected Pencak Silat settings—training halls, motion silhouettes, and cultural motifs—to maintain authenticity while creating a visually appealing environment for learners.



Figure 4. Design Background

5) Integrating Navigation Buttons

To support interactivity, navigation buttons such as Next, Back, and Home were embedded. These buttons allowed learners to control their progress, revisit earlier sections, or return to the main menu, fostering self-paced learning.



Figure 5. Adding Navigation Buttons

6) Composing Text and Learning Material

Concise, age-appropriate texts were added to explain movement sequences and values of Pencak Silat. The written material was designed to be informative yet engaging, combining technical explanations with motivational elements that promote discipline, respect, and cooperation.



Figure 6. Composing Text

7) Applying Animations and Transitions

Animations were applied to text, icons, and images to attract attention and emphasize important learning points. Transitions were designed to visualize movement dynamics, helping students mentally connect theoretical descriptions with actual physical actions.



Figure 7. Applying Animations

8) Setting Interactive Triggers

Triggers—interactive commands that respond to user actions—were configured to control navigation and multimedia playback. For example, clicking a “Start” button activated a video or transitioned to the next task. This created a responsive and immersive learning experience.



Figure 8. Applying Animations

9) Embedding Video and Audio Media

Instructional videos demonstrating Pencak Silat techniques were inserted, featuring certified athletes to ensure accuracy. Narration explained each step, and traditional background music was added to enhance cultural ambiance. Users could control playback (play/pause/repeat), supporting individual exploration and repetition for mastery.

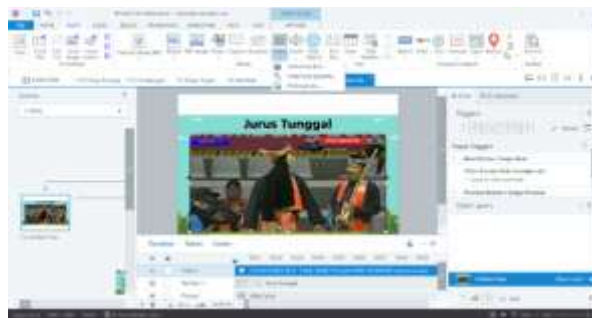


Figure 9. Embedding Video

D. Expert Validation (Content, Design, and Media Evaluation)

The developed prototype underwent expert validation involving three specialists: a Pencak Silat material expert, an instructional design expert, and a media technology expert. They evaluated the product using structured questionnaires assessing aspects such as content accuracy, instructional flow, interface design, and overall functionality. Hasil penelitian menunjukkan validitas rata-rata 92.63%, dikategorikan sangat valid, dengan skor yang sangat tinggi dengan penilaian dari ahli materi 95.68, ahli instruksional 90.55 dan ahli media 91.66%. The experts concluded that the learning media was accurate, pedagogically relevant, and visually engaging. For more details, please see the table 1.

Table 1. Validation Results by Experts

Expert Category	Assessment Aspect	Max Score	Obtained Score	Percentage (%)	Category
Material Expert	Content Aspect	20	19	95.00	Very Good
	Material Accuracy	55	53	96.36	Very Good
Average				95.68	Very Good
Instructional Design Expert	Media Content Quality	30	27	90.00	Very Good
	Media Display	45	41	91.11	Very Good
Average				90.55	Very Good
Media Expert	Program Quality	30	27	90.00	Very Good
	Media Design	15	14	93.33	Very Good
	Material Presentation	30	28	90.00	Very Good
Average				91.66	Very Good
Overall Expert Mean Score				92.63	Very Valid

E. Product Revision (Based on Expert Feedback)

Revisions were made according to the experts' suggestions, which included refining text readability, improving navigation button placement, and adjusting the pacing of video playback to better match the narration. Minor adjustments were also applied to background colors and font contrasts to enhance visual comfort for younger learners. For more details, see table 2.

Table 2. Revision from the Expert

Trial Type	Number of Respondents	Average Score (%)	Category
Small-Scale Trial	15	89.44	Very Practical
Large-Scale Trial	30	91.13	Excellent

F. Small-Group Trial and Large Scale Trial

After validation, a small-scale trial was conducted involving 15 respondents (PE teachers and students). The participants used the media independently and filled out a practicality questionnaire. The results showed a mean score of 89.44%, categorized as very practical. Users reported that the media was easy to operate, the content was clear, and the animations increased motivation and comprehension. Teachers stated that the digital format allowed them to demonstrate complex motions more efficiently than traditional explanations. A broader implementation was carried out with 30 students and teachers from various elementary schools. The evaluation results indicated an average practicality of 91.13%, classified as excellent. The participants agreed that the integration of text, audio, and motion improved learning outcomes, particularly in understanding movement sequences. Students showed higher enthusiasm, better retention, and improved coordination when performing Pencak Silat movements after using the application. For more details, see Table 3.

Table 3. Small and Large Scale Trial Results

Expert Type	Focus of Evaluation	Key Suggestions / Revisions Made
Material Expert	Accuracy of <i>Pencak Silat</i> content and curriculum alignment	- Refined terminology of techniques (stance, attack, defense). - Simplified explanations for elementary learners. - Added moral values (discipline, respect, cooperation).
Instructional Design Expert	Learning flow and navigation logic	- Reorganized slide sequence from general to specific. - Standardized button positions and layouts. - Reduced redundant text to lower cognitive load.
Media Expert	Visual design, animation, and interactivity	- Improved font contrast and readability. - Adjusted background color harmony. - Synced narration with animation timing. - Optimized video playback and added sound cues for interaction.

9. Product Revision and Finalization

Following the field trial, final refinements were applied, including optimizing video loading speed, adding feedback sounds to navigation buttons, and embedding a short interactive quiz at the end of each learning unit. The finalized product demonstrated strong validity, practicality, and effectiveness—making it suitable for classroom implementation and self-paced learning.



Figure 10. Pencak Silat Learning Media

4. Discussion

The development of *Articulate Storyline*-based *Pencak Silat* learning media represents a timely and necessary response to the evolving demands of digital education in the 21st century. The importance of this research lies in its ability to bridge a significant pedagogical gap—combining Indonesia’s cultural heritage with modern instructional technology to improve both learning quality and cultural continuity. In the current era of *Society 5.0*, the education sector is challenged to promote digital literacy while preserving local wisdom. Physical Education (PE), often perceived as traditional and non-technological, requires innovative approaches to remain relevant to today’s learners. Therefore, this study is crucial because it not only enhances psychomotor and cognitive skills through multimedia but also contributes to character formation and cultural identity preservation.

The findings reveal that the *Articulate Storyline* platform effectively supports interactive learning in elementary *Pencak Silat* education. Validation and testing results—showing expert agreement above 92%, and user practicality above 90%—demonstrate that digital learning media can serve as an engaging and pedagogically valid tool. These outcomes align with the broader educational reform agenda emphasizing the integration of technology to enhance student-centered learning. The study’s results confirm that interactive media with audiovisual elements can significantly improve learner engagement and understanding, especially for subjects requiring visualization of movement and rhythm, such as martial arts.

This finding is consistent with prior research conducted by [18] who found that *Articulate Storyline*-based interactive learning improved student motivation and self-regulation across multiple disciplines. Similarly, [19] emphasized that multimedia integration in Physical Education fosters better retention and psychomotor coordination, especially when learners can manipulate visual and auditory cues independently. Furthermore, a study by [20] on the use of digital media in martial arts instruction demonstrated that interactive simulations significantly enhance learners’ ability to replicate complex movements by providing step-by-step visualization. The present study extends these findings by situating the technology within an elementary education context and embedding cultural dimensions, offering an inclusive and culturally responsive model of digital pedagogy.

The integration of *Articulate Storyline* also supports Mayer’s *Cognitive Theory of Multimedia Learning*, which argues that learning is more effective when information is presented through both visual and auditory channels. The multimedia features—animation, narration, and interactive triggers—enabled dual coding that reinforced memory and comprehension. Students were able to observe, imitate, and internalize *Pencak Silat* techniques more effectively than through traditional verbal instruction. Teachers also reported that the application reduced instructional time while maintaining student enthusiasm, confirming that technology can complement rather than replace direct physical training.

From a cultural and sustainability perspective, this research contributes to the realization of SDG 4 (Quality Education). By digitizing *Pencak Silat*, the study safeguards Indonesia’s intangible heritage while promoting accessible, equitable, and engaging education. The digital media ensures that *Pencak Silat* remains relevant to modern learners, integrating cultural values into an interactive, technology-driven platform. The combination of traditional content and modern design demonstrates how cultural education can evolve without losing authenticity, positioning this research as both pedagogically and socially significant.

The implications of this study are multifaceted. First, for educators, the findings highlight that *Articulate Storyline* can be a practical solution for developing digital lessons without requiring advanced programming skills. Teachers can adapt

this model to other cultural or sports subjects, thereby fostering innovation in classroom practices. Second, for schools and policymakers, this study underscores the importance of investing in accessible digital learning infrastructure to support hybrid or blended learning in Physical Education. Third, at the theoretical level, the research reinforces constructivist and multimedia learning theories, demonstrating how learner interaction with multimedia objects leads to deeper understanding and higher engagement. Lastly, for cultural preservation, it provides a model for digitizing heritage-based subjects, ensuring that younger generations engage with national traditions in meaningful ways.

Despite its contributions, this study has several limitations. The implementation was conducted primarily in a limited number of elementary schools within the Padang Utara district, which may restrict the generalizability of results to other regions with different technological access or cultural backgrounds. Moreover, the evaluation focused mainly on content validity and practicality rather than long-term learning outcomes or psychomotor performance improvements. The study also did not employ experimental comparisons (e.g., control versus treatment groups) that could quantitatively measure the effectiveness of the media in improving specific skills. Additionally, internet connectivity and hardware limitations in some schools may have affected the consistency of user experiences.

Future studies should aim to expand the sample size and include diverse demographic contexts to test the scalability of the learning media. Experimental or quasi-experimental designs could be employed to measure the media's impact on students' performance, retention, and motor skill acquisition more rigorously. Researchers are also encouraged to integrate adaptive learning analytics to track student interactions and performance in real time, providing deeper insights into personalized learning pathways. Furthermore, collaboration with software developers could enhance the gamification aspect—adding performance tracking, rewards, and progress indicators—to further increase motivation. Lastly, comparative studies across different martial arts or physical education disciplines could determine whether the *Articulate Storyline* approach can serve as a universal model for interactive sports education.

In conclusion, this study demonstrates that developing culturally rooted, interactive learning media using *Articulate Storyline* is both feasible and impactful. It not only enhances teaching and learning in Physical Education but also contributes to the preservation of Indonesia's cultural identity in the digital era.

5. Conclusions

The development of Articulate Storyline-based Pencak Silat learning media has proven to be valid, practical, and pedagogically effective for elementary school contexts. The validation results, with an overall mean score of 92.63%, indicate that the product meets high standards of content accuracy, instructional design, and media quality. Similarly, practicality scores exceeding 90% confirm that the digital media is user-friendly, engaging, and applicable for classroom use. The integration of interactive multimedia—text, audio, video, and animation—successfully enhanced students' motivation, understanding, and psychomotor coordination in performing Pencak Silat techniques.

This study demonstrates that Articulate Storyline can serve as a powerful yet accessible tool for developing culturally grounded digital learning materials without requiring advanced technical skills. The combination of traditional martial arts pedagogy and modern multimedia design bridges the gap between cultural heritage and 21st-century education. Beyond its educational benefits, this innovation supports the United Nations Sustainable Development Goals (SDG 4 and bSDG 9) by promoting inclusive, technology-driven, and culturally sustainable learning.

Overall, the research concludes that digital transformation in Physical Education, when implemented thoughtfully, can enhance both learning quality and cultural preservation. The Articulate Storyline Pencak Silat media provides a model for future educational innovations that are contextually relevant, interactive, and aligned with global sustainability goals.

6. Acknowledgement

The authors would like to thank the Lembaga Penelitian dan Pengabdian Masyarakat (LPPM) Universitas Negeri Padang for providing financial support for this research under contract number 1716/UN35.25/LT/2025. This funding made the completion of the study and the development of the digital Pencak Silat learning media possible. The authors deeply appreciate the institution's continuous commitment to fostering innovation and research excellence in education and cultural preservation.

Author Contributions: Conceptualization: S.N. and A.Z.; Methodology: A.Z.; Software: S.N, JP, DNS and Y.O.; Validation: A.Z. and S.N.; Formal Analysis: S. JP, and DNS; Investigation: Y.O.; Resources: S.N. and N.I.; Data Curation: Y.O. and R.B.; Writing—Original Draft: A.Z.; Writing—Review & Editing: A.Z. and S.; Visualization: Y.O. and A.Z; Supervision: S.N.; Project Administration: S.N.; Funding Acquisition: S.N.

Conflicts of Interest: The authors declare no conflict of interest

References

1. I. Imaniah, "The Synergy of Educational Technology Advancement and Human Capabilities in the Era," E3S Web Conf., vol. 10, no. June 2016, 2023.
2. C. Pârvu, D. A. Szabo, B. C. Ungurean, A. R. Puni, and S. C. Silișteanu, "Optimising physical education classes in schools using technology: The use of mobile apps for active participation of medically exempt students with a focus on skill development and medical rehabilitation," *Balneo PRM Res. J.*, vol. 14, no. 4, 2023, doi: 10.12680/balneo.2023.604.
3. C. Pârvu, B. C. Ungurean, C. G. Zamfir, Z. B. Khamraeva, and D. G. Alistar, "The Impact of Technology on Improving the Learning Process in Physical Education Lessons for Medically-Exempt Pupils," *Balneo PRM Res. J.*, vol. 14, no. 2, pp. 1–12, 2023, doi: 10.12680/balneo.2023.551.
4. N. O. Gold and H. Coovadia, "Critical thinking development in a Quality Matters-based online learning : student insights from a South African higher education context," *Front. Educ.*, vol. 2019, no. August, pp. 1–19, 2025, doi: 10.3389/educ.2025.1642266.
5. A. Suharta, D. Endriani, R. Dewi, and A. Supriadi, "Development of Volleyball Game Model Using Learning Media," *Kinestetik J. Ilm. Pendidik. Jasm.*, vol. 6, no. 2, pp. 271–278, 2022, doi: 10.33369/jk.v6i2.21636.
6. M. Komaro, A. D. Minghat, R. H. Putra, A. Suherman, Ana, and A. M. Pradana, "Development of Android-based Multimedia to Improve Student Learning Outcome in Crystal Structure Subject of Engineering Materials Course," *J. Eng. Educ. Transform.*, vol. 35, no. Special Issue 2, pp. 171–176, 2022.
7. C. Leukel and K. Loibl, "Problem-solving prior to instructional explanations when learning javelin throwing in primary school," *Instr. Sci.*, 2025, doi: 10.1007/s11251-024-09700-9.
8. D. Xie, B. Chen, H. Li, and Q. Huang, "Enhancing table tennis performance and physical fitness through digital technology : a quasi-experimental study based on the TPACK framework," *Front. Sport. Act. Living*, vol. 7, no. May, pp. 1–13, 2025, doi: 10.3389/fspor.2025.1595455.
9. O. Sukmana, G. R. Sumedi, R. Kristiono, D. Susilo, and F. H. Syahmahita, "Reconstructing masculinity : the role of traditional sports in shaping gender identities in Indonesia Reconstruyendo la masculinidad : el papel de los deportes tradicionales en la formación de las identidades de género en Indonesia Authors How to cite in ," *Retos*, vol. 2025, pp. 485–502, 2025.
10. Y. Kiram, A. Komaini, Y. Ockta, M. S. Rifki, Padli, and Gusril, "Development of Virtual Reality for Enhancing Motor Skills and Physical Activity in Children with Intellectual Disabilities," *Ann. Appl. Sport Sci.*, vol. 2025, no. Special Issue, 2025.
11. M. Saputra et al., "The influence of leg muscle power, waist flexibility and self-confidence on soccer long passing ability," *Retos*, vol. 62, pp. 335–340, 2025, doi: 10.47197/retos.v62.109072.
12. Umar, Y. Ockta, and P. Mardesia, "A Correlational Study: Pedagogical and professional competence of physical education teachers in relation to the implementation of the Merdeka curriculum," *J. Phys. Educ. Sport*, vol. 23, no. 12, pp. 3325–3331, 2023, doi: 10.7752/jpes.2023.12380.
13. W. Burleson et al., "Active Learning Environments with Robotic Tangibles : Children ' s Physical and Virtual Spatial Programming Experiences," *IEEE Access*, vol. 1382, no. c, pp. 1–11, 2017, doi: 10.1109/TLT.2017.2724031.

14. S. Nelson et al., "The effectiveness of learning media based on digital augmented reality (AR) technology on the learning outcomes of martial arts La eficacia de los medios de aprendizaje basados en tecnología de realidad aumentada digital (AR) en los resultados del apr," *Retos*, vol. 2025, pp. 878–885, 2025.
15. A. A. Supli and Y. Xiaojing, "Exploring the effectiveness of augmented reality in enhancing spatial reasoning skills: A study on mental rotation, spatial orientation, and spatial visualization in primary school students," *Educ. Inf. Technol.*, no. November 2023, 2024, doi: 10.1007/s10639-023-12255-w.
16. Z. Saeedi and M. Najjarpour, "Social Sciences & Humanities Open Enhancing technical vocabulary acquisition in ESP context through virtual content development with Articulate Storyline," *Soc. Sci. Humanit. Open*, vol. 11, no. May, p. 101539, 2025, doi: 10.1016/j.ssaho.2025.101539.
17. H. S. Rad, "Reinforcing L2 reading comprehension through artificial intelligence intervention : refining engagement to foster self - regulated learning," *Smart Learn. Environ.*, 2025, doi: 10.1186/s40561-025-00377-2.
18. L. Heliawati, L. Lidiawati, and I. D. Pursitasari, "Articulate Storyline 3 multimedia based on gamification to improve critical thinking skills and self-regulated learning," *Int. J. Eval. Res. Educ.*, vol. 11, no. 3, 2022, doi: 10.11591/ijere.v11i3.22168.
19. A. Woll and I. Wagner, "Video-based visual feedback to enhance motor learning in physical education — a systematic review," *Ger. J. Exerc. Sport Res.*, no. October 2021, pp. 447–460, 2022, doi: 10.1007/s12662-021-00782-y.
20. A. Hassan and R. Id, "Reflections on augmented reality codes for teaching fundamental defensive techniques to boxing beginners," *PLoS One*, pp. 1–27, 2024, doi: 10.1371/journal.pone.0301728.