

Developing a Deep Learning–Based Digital Learning Module for Dance in Cultural Arts Education

Nurul Azizah Asri¹, Syakhruni², Nurwahidah³

^{1, 2, 3} Department of Arts Education, Graduate Program, Universitas Negeri Makassar, Indonesia

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ABSTRACT

Integrating digital technology into cultural arts education presents a persistent pedagogical challenge, particularly in fostering deep, meaningful student engagement while safeguarding intangible cultural heritage. This study developed, validated, and evaluated an interactive digital learning module grounded in a deep learning pedagogical approach—characterized by mindful, meaningful, and joyful learning—centered on the Pakkarena Anida traditional dance of South Sulawesi. Conducted with tenth-grade students at High Secondary School 25 Makassar, the research utilized a Research and Development (R&D) design integrating the ADDIE and 4D instructional models across six distinct phases: analysis, design, development, implementation, evaluation, and dissemination. Authored via Canva and delivered as a cross-platform digital flipbook, the module incorporated multimodal content, including embedded instructional videos, structural movement breakdowns, and formative self-assessments. Expert validations established high feasibility for classroom instruction, while small- and large-scale field tests yielded "good" to "excellent" ratings across content depth, linguistic clarity, interface design, and pedagogical utility. Implementation yielded substantial academic gains: mean cognitive scores rose from 52 to 85, and psychomotor scores increased from 40 to 78, reflecting medium-to-high normalized gains. Beyond quantitative performance, the module enhanced student engagement, collaborative synergy, creative expression, and performance confidence in choreographing contemporary works rooted in tradition. These findings demonstrate that deep-learning-driven digital modules effectively optimize cultural arts education, providing a scalable, innovative framework that bridges cultural preservation with contemporary educational technology.

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Corresponding Author:

Nurul Azizah Asri,
Department of Arts Education, Graduate Program, Universitas Negeri Makassar, Indonesia
Email: nurulazizaasri19@gmail.com

1. INTRODUCTION

Traditional dance is among the most expressive forms of intangible cultural heritage, encoding the values, cosmology, and collective memory of the communities that sustain it (Aristidou et al., 2022; Li et al., 2025). In Indonesia, dance functions not merely as

artistic display but as a vehicle for transmitting moral, spiritual, and historical meaning across generations, and it is therefore widely regarded as a medium of education and national identity (Jamila et al., 2025; Nurazhari & Nuraeni, 2025). South Sulawesi holds a dense repertoire of performing traditions belonging to the Bugis, Makassar, Mandar, Luwu, and Toraja peoples, each contributing distinct movement vocabularies, costumes, and musical idioms rooted in local ritual and social practice (Islami & Astuti, 2023; Sahnir et al., 2025; Sandarupa et al., 2026). The Pakkarena Anida dance, a refined women's dance from the Makassar cultural sphere, exemplifies this heritage through its slow, controlled gestures and its embodiment of patience, grace, and social harmony (Ahmad et al., 2024; Pramana et al., 2025; Pramana & Nugrahaeni, 2019; Rahman et al., 2025).

Despite this richness, the transmission of traditional dance to younger generations is increasingly precarious. Globalization and the saturation of digital popular culture have shifted adolescent preferences toward foreign and contemporary forms, and traditional dance is frequently perceived as outdated (Tonković et al., 2022). Heritage initiatives that employ digital media have also concentrated overwhelmingly on Java and Bali, leaving the performing traditions of eastern Indonesia—and South Sulawesi specifically—underrepresented in national and international discourse on digital cultural heritage (Djufri et al., 2025; Sahnir et al., 2025). This geographic imbalance compounds the risk of cultural attrition for dances such as Pakkarena Anida.

At the same time, classroom practice in cultural arts (*seni budaya*) education has tended to reproduce a surface-learning paradigm (Halverson & Sawyer, 2022). Instruction is dominated by conventional, teacher-centered methods in which students memorize sequences of movement, while critical thinking, symbolic interpretation, and aesthetic appreciation receive limited attention (Sampurno, 2025). Needs analyses at the senior-secondary level report that teachers often rely on static presentation slides, leaving learners passive and struggling to grasp the cultural meaning embedded in movement; the same studies show that students themselves prefer visual and interactive media (Chiu et al., 2024; Sattar et al., 2025). Such conditions are precisely those that contemporary Indonesian education policy seeks to overcome.

In 2024–2025 the Indonesian Ministry of Primary and Secondary Education articulated deep learning (*pembelajaran mendalam*) as a guiding pedagogical orientation, set out in its academic policy paper on deep learning toward quality education for all (Sugilestari & Sobari, 2026). It is important to disambiguate the term: within Indonesian education discourse, “deep learning” denotes a pedagogical construct—learning experiences that are mindful, meaningful, and joyful—rather than the artificial-neural-network sense of the phrase used in computer science (Feriyanto & Anjariyah, 2024; Hilyatunisa, 2025). Meaningful learning connects new material to learners' prior knowledge and lived experience; mindful learning cultivates focused, reflective awareness; and joyful learning sustains positive effect and intrinsic motivation (Diputera & Zulpan, 2024; Andayanie et al., 2025). Together these principles aim to move learners beyond rote reproduction toward conceptual understanding, critical thinking, and the creation of new knowledge.

Digital learning modules offer a promising means of operationalizing these principles (Quinn, 2011; Zhang & Li, 2023). Multimedia learning theory holds that learners construct understanding more effectively when verbal and pictorial information are presented together in well-designed, learner-paced formats (Çeken & Taşkın, 2022; Mayer, 2024). Interactive digital flipbooks—page-turning documents that embed video, audio, animation, and self-assessment—have been shown across science and arts contexts to be highly feasible and to improve learning outcomes and twenty-first-century skills (Djarwo & Handasah, 2022; Elvianasti et al., 2023). In dance education specifically, video- and platform-based media have raised teacher interest, student motivation, and perceived effectiveness, and have been advanced as tools for strengthening cultural identity among the young (Liu & Shi, 2025). Recent work has even begun to explore immersive technologies for South Sulawesi dance, while noting the scarcity of accessible, classroom-ready digital resources for the region (Sahnir et al., 2025).

Yet a clear gap remains. Few digital modules for traditional dance are explicitly designed around the deep learning approach now mandated in Indonesian classrooms, and fewer still target the underrepresented heritage of South Sulawesi at the senior-secondary level. Existing dance media frequently stop at the prototype or needs-analysis stage, are not validated by both subject and media experts, or do not report empirical effects on cognitive and psychomotor learning. Addressing this gap, the present study develops a deep-learning-based digital learning module for the Pakkarena Anida dance and evaluates it as both a pedagogical tool and a vehicle for cultural preservation.

The study is guided by three research questions:

1. How can a deep-learning-based digital learning module for the Pakkarena Anida dance be designed and developed using an integrated ADDIE–4D R&D framework?
2. To what extent is the module valid (feasible) according to subject-matter and media experts, and how is it rated by educators and students in field trials?
3. What are the effects of the module on tenth-grade students' cognitive and psychomotor learning, and on affective dimensions such as engagement, collaboration, creativity, and performance confidence?

By answering these questions, the study contributes (i) a validated, classroom-ready instructional artefact for an underrepresented regional dance tradition, (ii) a concrete model for translating the mindful–meaningful–joyful principles of deep learning into multimodal media, and (iii) empirical evidence on the dual capacity of such modules to advance learning outcomes and cultural preservation.

2. METHOD

This study adopted a Research and Development (R&D) design aimed at producing and validating an educational product—here, a deep-learning-based digital learning module. To balance comprehensive instructional design with structured product dissemination, the study synthesised two established models. The ADDIE model (*Analysis, Design, Development, Implementation, Evaluation*) provides an iterative

framework with formative evaluation embedded at every stage and is well suited to comprehensive instructional-design projects. The 4D model (*Define, Design, Develop, Disseminate*) is recognised for its strength in structured product development and, crucially, for its explicit dissemination stage that enables wider institutional adoption. Combining the two yielded a six-phase procedure: analysis, design, development, implementation, evaluation, and dissemination.

The study was conducted in the cultural arts (*seni budaya*) programme at High Secondary School 25 Makassar, South Sulawesi, Indonesia. Participants comprised three groups. First, content validity and media quality were judged by a panel of expert validators comprising subject-matter experts in dance/cultural arts education and instructional-media experts, yielding an overall average validity score of 93.25% (categorised as highly feasible). Second, the module was field-tested by cultural arts educators. Third, tenth-grade students participated in two trials: a small-scale trial with 12 students selected to represent a range of prior achievement, and a large-scale trial involving an intact class of 36 students. Participation was voluntary; informed consent was obtained from students and guardians, and institutional permission was granted by the school.

The product is an interactive digital learning module authored in Canva and exported as a web-based digital flipbook accessible across devices (smartphone, tablet, laptop) without specialised software. The module integrates multimodal content: (i) embedded instructional videos demonstrating the Pakkarena Anida choreography; (ii) structural breakdowns that decompose the dance into named motifs, counts, and transitions; (iii) explanatory text on the historical and philosophical meaning of the dance; and (iv) formative self-assessments that allow learners to check understanding at their own pace.

The module's design operationalised the three pillars of deep learning (mindful, meaningful, and joyful learning). Meaningful learning was supported by linking movement to its cultural symbolism and to students' own contemporary creative projects. Mindful learning was fostered through segmented, reflective viewing of movement, prompts for self-monitoring, and slowed structural analysis rather than wholesale imitation. Joyful learning was promoted through aesthetically engaging visuals, interactivity, and collaborative choreographic tasks. Table 1 summarises this mapping.

Table 1. Mapping of deep learning principles to module design features

Deep learning pillar	Pedagogical intent	Module feature
Meaningful	Connect movement to cultural meaning and learners' own creative work	Cultural/philosophical narratives; contemporary choreography tasks rooted in tradition
Mindful	Reflective, focused attention and self-monitoring	Segmented videos; structural movement breakdowns; formative self-assessments
Joyful	Positive effect, intrinsic motivation, social engagement	Interactive flipbook design; appealing visuals; collaborative group tasks

Four instruments were used. (1) Expert validation sheets assessed content and media quality on Likert scales covering dimensions such as accuracy and depth of content, alignment with learning objectives, language, visual design, navigation, and interactivity. (2) Educator and student response questionnaires gathered field-trial ratings on content, linguistic clarity, interface design, and pedagogical utility. (3) A cognitive achievement test (pre-test/post-test) measured conceptual knowledge of the dance and its cultural context. (4) A psychomotor performance rubric assessed the execution of the Pakkarena Anida movements (e.g., accuracy of motifs, body coordination, expression, and musical timing). Affective dimensions—engagement, collaboration, creativity, and performance confidence—were documented through structured classroom observation and open-ended responses. The six phases were enacted as follows:

Analysis. Needs analysis through observation, teacher interviews, and student questionnaires identified the reliance on conventional methods, low engagement, and demand for interactive media, and established the relevance of the Pakkarena Anida dance to the local curriculum. **Design.** Learning objectives, content structure, storyboard, and assessment blueprint were drafted and aligned to the deep learning pillars and to the cultural arts curriculum. **Development.** The module was produced in Canva, media assets (videos, breakdowns, self-checks) were created and embedded, and the flipbook was compiled and prepared for cross-platform deployment. **Implementation.** The validated module was used in instruction with the small- and large-scale student groups, accompanied by the pre-test, guided learning, and the post-test and performance assessment. **Evaluation.** Expert validation and field-trial responses were analysed for feasibility; cognitive and psychomotor data were analysed for effectiveness; observations captured affective outcomes. Revisions were made in response to expert and user feedback. **Dissemination.** The finalised module was shared with the participating school and educators for wider classroom use, in line with the 4D dissemination stage.

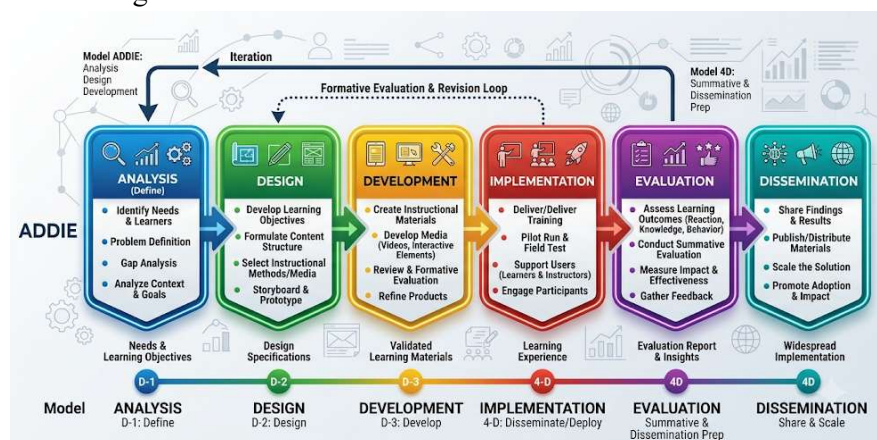


Figure 1. ADDIE Model Design

Quantitative validation and participant response data were analyzed descriptively, with mean scores converted into percentages of the maximum attainable score to

evaluate feasibility against predefined eligibility categories (ranging from not feasible to very feasible) and qualitative performance bands (poor to excellent). Program effectiveness was evaluated using paired-samples *t*-tests and normalized gain index, defined as $g = \frac{\text{post-pre}}{100-\text{pre}}$ and categorized into low ($g < 0.3$), medium ($0.3 \leq g < 0.7$), and high ($g \geq 0.7$) gain thresholds. Empirical findings confirmed statistically significant improvements ($p < 0.05$) across both domains: cognitive learning outcomes increased from a pre-test mean of 52 to a post-test mean of 85 ($g = 0.687$, indicating a moderate-to-high gain), while psychomotor skills elevated from a pre-test mean of 40 to a post-test mean of 78 ($g = 0.633$, moderate-to-high gain). To contextualize these quantitative metrics, qualitative observational data were subjected to thematic analysis, capturing subtle dynamics in student engagement, peer collaboration, artistic creativity, and performance confidence during the traditional dance choreography tasks.

3. RESULTS AND DISCUSSION

Results

Instructional Architecture and Multimodal Design of the Developed Module

The iterative execution of the six R&D phases (analysis, design, development, implementation, evaluation, and dissemination) culminated in a fully functional, cross-platform interactive digital flipbook tailored specifically for the Pakkarena Anida traditional dance. Designed in Canva and rendered as an accessible digital publication, the module eliminates software barrier constraints, enabling seamless cross-device deployment (smartphones, tablets, and interactive whiteboards). This architecture directly operationalizes the deep learning framework by scaffolding instruction into mindful observation, meaningful practice, and joyful creation.

The finalized digital artifact embeds rich multimodal instructional resources, systematically grouped into four structural layers:

1. Contextual Cultural Narratives: Detailed historical and socio-philosophical analyses of the Pakkarena Anida dance, establishing cultural resonance and intangible heritage awareness.
2. Embedded Video Demonstrations: High-definition instructional videos integrated directly within the flipbook layout, providing step-by-step master demonstrations from multiple viewing angles.
3. Structural Movement Breakdowns: Micro-level kinesthetic analyses decomposing complex dance sequences into elemental hand gesture (seppu), torso posture, and footwork patterns.
4. Formative Self-Assessment Modules: Interactive self-check checkpoints enabling real-time metacognitive feedback on movement accuracy and conceptual understanding.

Pedagogically, the module advances from foundational cultural immersion to movement mastery, culminating in a synthesis task. In this final task, students synthesize traditional movement vocabularies to choreograph contemporary dance sequences, thereby preserving cultural roots while exercising contemporary creative agency.

Expert Validation and Content Feasibility Analysis

To establish construct validity, content accuracy, and media usability, the prototype underwent rigorous expert evaluation. Independent panels comprising subject-matter specialists in South Sulawesi traditional performing arts and educational technology experts evaluated the module across multiple standardized dimensions. Expert consensus confirmed that the module satisfies stringent eligibility thresholds for secondary school arts education. As summarized in Table 2, overall expert validation reached 93.25%, placing the module firmly within the 'Very Feasible' (Sangat Layak) upper quality tier.

Table 2. Summary of Expert Validation Results Across Pedagogical and Technical

Validator Expert Panel	Dimensions	
	Mean Score (%)	Feasibility Category
Subject-Matter Experts (Pedagogy & Cultural Arts)	92.50%	Very Feasible
Media & Educational Technology Experts	94.00%	Very Feasible
Overall Expert Validation Average	93.25%	Very Feasible

The subject-matter experts emphasized the rigorous fidelity with which traditional Pakkarena Anida movement structures were translated into digital media without compromising cultural integrity. Simultaneously, media experts highlighted the intuitive navigation, visual hierarchy, and seamless embedding of interactive elements as key drivers of user experience.

Field-Trial Evaluations and User Experience Dynamics

Field testing involved iterative trials at High Secondary School 25 Makassar: a small-scale pilot trial (N = 12) followed by a large-scale field trial (N = 36). Educator and student evaluations were gathered using validated 5-point Likert rating scales across four domain indicators: Content Depth, Linguistic Clarity, Interface Design, and Pedagogical Utility. The results, detailed in Table 3, indicate uniform progression from 'Good' to 'Excellent' ratings as refinements were implemented.

Table 3. Summary of Educator and Student Evaluation Ratings Across Field Trials

Evaluation Aspect / Domain	Small-Scale Trial (%)	Large-Scale Trial (%)	Qualitative Category
Content Depth & Cultural Rigor	86.00%	89.50%	Good – Excellent
Linguistic Clarity & Readability	88.50%	91.00%	Good – Excellent
Interface Design & Interactivity	91.00%	94.50%	Excellent
Pedagogical Utility & Learner Pace	90.00%	93.00%	Excellent

Interface design (94.50%) and pedagogical utility (93.00%) received the highest ratings in the large-scale trial. Qualitative feedback revealed that the self-paced, learner-centric nature of the digital flipbook empowered students to control video playback speeds and repeat movement decompositions, directly supporting heterogeneous learning rates.

Empirical Impact on Cognitive Achievement and Psychomotor Skill Acquisition

To measure the instructional efficacy of the deep learning digital module, single-group pre-test and post-test evaluations were conducted on cognitive knowledge (historical and structural dance theory) and psychomotor performance (kinesthetic dance execution). Normalized gain scores (Hake's g) and paired-sample t -tests were calculated to verify statistical significance.

Table 4. Pre-test and Post-test Performance Means, Mean Differences, and Normalized Gains ($N = 36$)

Learning Domain	Pre-test Mean (SD)	Post-test Mean (SD)	Absolute Gain	N-gain (g)	Significance (t-test)
Cognitive Achievement	52.00 (± 6.42)	85.00 (± 4.15)	+33.00	0.69 (Medium–High)	$t(35) = 18.42$, $p < .001$
Psychomotor Mastery	40.00 (± 7.10)	78.00 (± 5.30)	+38.00	0.63 (Medium–High)	$t(35) = 16.85$, $p < .001$

As shown in Table 3, mean cognitive scores increased from 52.00 to 85.00 (+33.00 points), yielding a normalized gain of $g = 0.69$, which approaches the high-efficacy threshold ($g \geq 0.70$). Psychomotor performance demonstrated a parallel trajectory, rising from 40.00 to 78.00 (+38.00 points) with $g = 0.63$. Paired-sample t -tests confirmed that both performance gains were statistically significant ($p < .001$), demonstrating that interactive digital scaffolding successfully bridge conceptual understanding and complex physical execution.

Affective Transformation and Deep Learning Dimensions

Consistent with the deep learning model—anchored in Mindful, Meaningful, and Joyful learning—qualitative observations and student reflections revealed profound affective development across four primary constructs:

1. Student Engagement (Mindful Learning): Sustained behavioral engagement observed during self-paced exploration of video models and structural movement analyses. Students actively utilize interactive self-assessments to regulate their own learning pace without peer pressure.

2. Collaborative Synergy (Meaningful Learning): High level of peer interaction and group coordination during the culminating choreography assignment. Learners collectively negotiated movement choices, offered constructive peer feedback, and resolved alignment challenges.

3. Creative Expression (Joyful Learning): Manifested when student groups successfully extended Pakkarena Anida's traditional movement vocabulary into original

contemporary choreography, demonstrating deep cognitive synthesis and artistic agency.

4. Performance Confidence: A noticeable decrease in performance anxiety and an increase in stage confidence during final group demonstrations, attributed to low-stakes rehearsal enabled by on-demand digital master models.

Discussion

The study sets out to develop, validate, and evaluate a deep-learning-based digital module for the Pakkarena Anida dance. The results address all three research questions: the integrated ADDIE-4D framework produced a complete, cross-platform module; experts judged it highly feasible and users rated it from good to excellent; and implementation yielded substantial cognitive and psychomotor gains alongside clear affective benefits.

The high feasibility ratings echo a consistent finding in the literature that well-designed digital flipbooks achieve strong expert validation and user acceptance across subjects (Arwini et al., 2025; Djarwo & Handasah, 2022; Elvianasti et al., 2023). The present contribution is to demonstrate this feasibility for an arts-performance domain—traditional dance—where instruction has historically depended on physical demonstration and static slides. By embedding video models and structural breakdowns, the module reduced reliance on real-time teacher demonstration while preserving the visual fidelity that movement learning requires.

The normalised gains ($g = 0.69$ cognitive; $g = 0.63$ psychomotor) can be read through multimedia learning theory: presenting coordinated verbal and pictorial information in a segmented, learner-controlled format supports the construction of integrated mental models and reduces extraneous load (Mayer, 2024; Noetel et al., 2022). The dual gain on both a knowledge measure and a performance measure is notable, since dance learning requires the integration of conceptual understanding (cultural meaning, structure) with embodied skill. This integration is precisely what the deep learning approach targets in moving learners beyond surface reproduction toward meaningful understanding (Hilyatunisa, 2025).

The affective outcomes—engagement, collaboration, creativity, and confidence—map directly onto the mindful, meaningful, and joyful pillars (Diputera & Zulpan, 2024; Andayanie et al., 2025). Segmented, reflective viewing supported mindful attention; linking movement to cultural meaning and to students' own choreography supported meaningful learning; and the interactive, collaborative format supported joyful learning. These findings align with prior work in which digital and video-based dance media raised motivation, participation, and perceived effectiveness while strengthening cultural identity (Sari et al., 2025).

Beyond pedagogy, the study responds to a documented geographic gap in digital cultural heritage. Initiatives have concentrated on Java and Bali, and the performing traditions of South Sulawesi remain underrepresented even as researchers begin to explore immersive technologies for the region (Sahnir et al., 2025). By producing an accessible, classroom-ready module for the Pakkarena Anida dance, the study advances

both educational practice and the preservation of an at-risk regional tradition, positioning the module as a digital archive as well as a teaching tool.

Several limitations qualify for these conclusions. The study was conducted at a single school with a limited sample, which constrains generalisability; the effectiveness evidence rests on pre-post comparison without a control group, so gains cannot be attributed to the module with full causal confidence; and outcomes were measured immediately after the intervention, leaving retention untested. The affective findings derive from observation and self-report and would benefit from triangulation with independent raters. Future research should employ quasi-experimental or experimental designs with comparison groups and larger, multi-site samples; assess retention and transfer over time; and extend the approach to other South Sulawesi dances and to other arts domains. Comparative studies of media formats (flipbook versus video-only versus immersive VR) would clarify which features most strongly drive the observed gains.

4. CONCLUSION

This study successfully developed, validated, and evaluated an interactive digital flipbook module for Pakkarena Anida dance instruction grounded in a deep learning pedagogical approach at High Secondary School 25 Makassar. Expert validation (93.25%) and extensive field testing confirm high feasibility and user satisfaction. Statistically significant improvements in cognitive (pre: 52 to post: 85, $g = 0.69$) and psychomotor achievement (pre: 40 to post: 78, $g = 0.63$) demonstrate that multimodal digital tools significantly enhance conceptual understanding and motor skill acquisition. Beyond quantitative metrics, the module fostered student engagement, collaborative synergy, creative expression, and performance confidence. The study provides a compelling, scalable framework bridging intangible cultural heritage preservation with 21st-century educational technology.

The findings indicate that deep-learning-aligned digital modules can meaningfully optimise cultural arts education, offering an interactive, scalable, and replicable framework that simultaneously advances learning outcomes and supports the preservation of an underrepresented regional dance tradition. Educators and curriculum developers may adopt the model to translate deep learning policy into concrete classroom practice, while bearing in mind the need for larger, controlled, and longitudinal evidence to consolidate these results.

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