

Developing A Narrative Visual Framework to Adapt Javanese Fables into Education for Sustainable Development Aligned Animated Content

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Abstract

This study develops a narrative-visual framework to adapt the collection of animal fables from Pura Pakualaman (a Javanese royal heritage) into short animated films that support Education for Sustainable Development (ESD), particularly cultural sustainability. By analyzing five fables through a single case study, this research uses Propp's narrative morphology, van Leeuwen's semiotic transformation framework, and ESD competency mapping. The findings show three things. First, all five fables have a consistent narrative structure: initial situation, conflict, development, resolution, and moral coda. This structure fits the three-act film format while maintaining *sêstradi* teachings (21 virtues and 21 vices unique to Pakualaman). Second, the visual transformation framework translates Javanese aesthetic codes (wayang movement, batik motifs, color symbolism: gold=wisdom, red=danger, black=arrogance) into animation designs with pedagogical functions. Third, the implementation model links each teaching (*sura*/courage, *ladak*/perseverance, *luwas*/humility) with UNESCO ESD competencies (ethical citizenship, resilience, responsible consumption). Unlike previous studies that focused on Western fairy tales without ESD, this study provides a culture-based framework for heritage digital literacy. Its practical implications for animators, educators, and cultural practitioners are notable, although empirical validation with the target audience is still needed.

Introduction

Indonesia's archipelago encompasses over 1,300 ethnic groups, each sustaining oral traditions that transmit intergenerational knowledge, ethical frameworks, and local ecological wisdom (Indah & Rohmah, 2021). Among these, Javanese animal fables (*dongeng binatang*) constitute a distinctive genre that employs non-human protagonists to encode moral philosophy, social critique, and character education (Halimah et al., 2020). However, rapid digitalization and shifting childhood media ecologies have placed these oral heritage forms at risk of attrition. As children increasingly engage with globally distributed animated content, predominantly Western or Japanese in origin locally grounded moral narratives risk marginalization (Anisimova, 2020; Martzoukou, 2022).

This challenge intersects with a broader imperative articulated by UNESCO's (2017) Education for Sustainable Development (ESD) framework, which identifies *cultural sustainability*—the preservation and transmission of heritage knowledge—as a core pillar alongside environmental and economic dimensions. ESD Goal 4.7 explicitly calls for education that "values cultural diversity" and "builds competencies for sustainable lifestyles" (UNESCO, 2017, p. 12). Digital storytelling, particularly animated film, offers a promising medium for cultural sustainability, as it can preserve ephemeral oral narratives in durable, distributable formats while adapting them to contemporary children's media consumption patterns (Dai et al., 2020; Martzoukou, 2022). Yet, adapting oral heritage for digital media entails significant risks: oversimplification, loss of moral nuance, cultural inauthenticity, or the subordination of pedagogical intent to entertainment metrics.

The Pura Pakualaman fable collection presents a uniquely suitable case for investigating this adaptation challenge. Unlike generalized folklore collections, these manuscripts originated in a palace scriptorium during the reign of Paku Alam II, functioning as a systematic vehicle for *sêstradi*—a structured character education framework comprising twenty-one virtuous and twenty-one vicious traits (Rahmat, 2025). Philological studies confirm that these fables were not informal folk narratives but deliberately crafted pedagogical instruments, making them particularly appropriate for ESD-aligned adaptation (Soenjoto, 2022; Rahmat, 2025).

Despite growing scholarly interest in folklore-to-animation adaptation, four significant gaps persist. First, existing studies disproportionately focus on Western fairy tales (e.g., Propp-based analyses of Grimm or Andersen), with limited attention to non-Western, particularly Southeast Asian, palace-generated fables (Angelaki, 2024; Purnomo et al., 2022). Second, prior adaptation frameworks rarely integrate philologically validated source texts, instead working with generic or informally collected folklore, which compromises fidelity to original moral structures. Third, while animation design studies acknowledge cultural aesthetics (e.g., Hidayat & Supendi, 2025; Maulana & Karyono, 2024), few provide systematic, replicable frameworks for translating traditional visual codes (color symbolism, movement patterns, textile motifs) into animation design choices with explicit pedagogical rationales. Fourth, and most critically, no prior study has explicitly operationalized folklore-to-animation adaptation for ESD competencies, particularly cultural sustainability and heritage education. The dominant paradigm treats adapted animations as entertainment or generic moral instruction, without linking narrative values to specific sustainability outcomes (Lafifa & Rosana, 2023; Rahiem, 2021).

This study addresses these gaps by asking three research questions: (1) What narrative structures in the Pura Pakualaman animal fables enable adaptation into animated short films while preserving their *piwulang sastra* (moral teachings)?, (2) How can Javanese traditional aesthetics specifically *wayang* movement principles, batik patterns, and color symbolism be systematically translated into animation design choices that reinforce moral messaging?, (3) How can the adapted animated content be implemented as digital literacy material that supports specific ESD competencies (cultural sustainability, ethical citizenship, intergenerational value transmission)?

This study is positioned at the intersection of three scholarly domains: (1) *narrative adaptation theory*, extending Hutcheon's (2006) concept of adaptation as creative reinterpretation preserving the "spirit" of source texts, while incorporating Jenkins' (2006) transmedia storytelling framework for digital distribution; (2) *cultural semiotics and heritage education*, drawing on UNESCO's (2017) ESD framework and Rieckmann's (2018) competency model; and (3) *multimodal pedagogy*, following Wells' (1998) theorization of animation as a distinct pedagogical medium capable of making abstract moral values tangible through visual exaggeration and symbolic coding.

Unlike prior work that treats animation adaptation as a purely technical or aesthetic exercise, we conceptualize it as a *pedagogical translation* process: each narrative and visual choice must be justified not merely by entertainment value or cultural authenticity, but by its contribution to moral clarity and sustainability competency development. This framing distinguishes our study from generic "folklore preservation" projects and positions it within the evidence-informed tradition of ESD intervention design.

Methodology

This study employs a qualitative, document-based research design operationalized as a single embedded case study (Yin, 2018). The *case* is the *Pura Pakualaman* animal fable collection as a bounded cultural-pedagogical system. The *embedded units* of analysis are five individual fables selected for analysis. The case study design is methodologically justified because the Pakualaman fables represent a unique, historically documented corpus with formal pedagogical intent, requiring in-depth, context-sensitive analysis rather than statistical generalization (Yin, 2018). The study does not aim to produce population-generalizable claims but rather a *transferable framework* that other researchers and practitioners can adapt to similar heritage contexts.

The research design integrates three analytical strands: (1) *narrative analysis* of fable texts using a Propp-derived coding scheme, (2) *visual semiotic analysis* of Javanese traditional aesthetics, and (3) *framework synthesis* integrating narrative and visual elements into an ESD-aligned implementation model. Primary data consist of five animal fable manuscripts from the Pura Pakualaman collection, selected based on (a) their representativeness of the full range of *piwulang* values identified in Rahmat's (2025) philological study, and (b) their narrative diversity (encompassing bet-based conflicts, physical fights, quest narratives, and experimental demonstrations). The five fables are:

Table 1
Five Fables Pura Pakualaman Collection

Fable Title	English Translation	Primary Lesson
<i>Lemut lan Gajah Delikan</i>	Mosquito and Elephant Hide-and-Seek	<i>Kibir</i> (arrogance)
<i>Tikus lan Gajah Totohan</i>	Mouse and Elephant Betting	<i>Sura</i> (courage), <i>lenggak</i> (cleverness)
<i>Adigang Adigung Adiguna</i>	Power, Might, and Skill (Elephant-Snake-Deer)	<i>Lojok</i> (arrogance), <i>lunjak</i> (greed)
<i>Cantrik lan Manuk Prenjak</i>	Apprentice and the Prenjak Bird	<i>Luwas</i> (humility), <i>lumuh</i> (reluctance to listen)
<i>Watak Dasar Kucing</i>	Basic Character of the Cat	<i>Ngadeg</i> (innate character)

All manuscripts are held in the Pura Pakualaman manuscript collection (catalog numbers as per Soenjoto, 2022). Access was granted by palace authorities for research purposes. Each fable consists of 4–22 stanzas of *tembang* (sung poetry) with explicit moral conclusions.

Secondary data include: (a) philological studies of Pakualaman manuscripts (Rahmat, 2025; Soenjoto, 2022), (b) documentation of Javanese visual aesthetics (*wayang* manuals, batik pattern encyclopedias, color symbolism guides), (c) scholarly literature on animation adaptation and ESD, and (d) technical guidelines for animation production (frame rates, resolution standards, audio specifications).

Analysis proceeded through four sequential stages.

1. Narrative Structure Analysis (RQ1). Each fable was coded for Proppian functions, using a simplified five-function scheme adapted from Propp (1968): (F1) Initial situation (character introduction, setting), (F2) Violation/Transgression (conflict initiation, rule-breaking, bet), (F3) Struggle/Contest (direct confrontation, competition), (F4) Trickery/Deception (cleverness, outsmarting, reversal), (F5) Resolution with Moral Coda (outcome, explicit *piwulang* statement). Two researchers independently coded all five fables; inter-coder reliability was calculated at 89% agreement (Cohen's $\kappa = 0.84$, substantial agreement per Landis & Koch, 1977).
2. Piwulang-to-ESD Mapping (RQ3). Each identified *piwulang* value was mapped to UNESCO (2017) ESD competencies using a two-step protocol: (a) definitional matching—comparing the *piwulang* description in Rahmat (2025) with ESD competency descriptors; (b) deliberative consensus—the three researchers independently proposed mappings, then resolved discrepancies through discussion. The output is a mapping table linking each fable to specific, measurable sustainability outcomes.
3. Visual Aesthetic Analysis (RQ2). Javanese aesthetic elements were cataloged from three sources: (a) *wayang* performance manuals documenting character design principles (Soedarsono, 1999), (b) batik encyclopedias documenting pattern symbolism (Maulana & Karyono, 2024), and (c) color symbolism guides from Javanese cultural studies (Mahardhika & Prihadi, 2020). For each aesthetic element, we identified (a) its traditional meaning/semiotic value, (b) its potential translation into animation design (character posture, background texture, transition effect), and (c) its pedagogical function (how it reinforces moral clarity for young audiences).
4. Framework Synthesis. The outputs of Stages 1–3 were integrated into a unified adaptation framework comprising: (a) narrative transformation guidelines (how to translate fable structure into three-act film format), (b) visual transformation guidelines (how to render traditional aesthetics in animation), (c) ESD integration guidelines (how to embed sustainability competencies in each episode), and (d) implementation specifications (technical standards, distribution platforms, supporting activities).

To ensure trustworthiness, we employed four strategies recommended by Lincoln and Guba (1985) for qualitative research: (a) *prolonged engagement*, the lead researcher spent six months familiarizing with the Pakualaman corpus, including consultation with palace manuscript custodians; (b) *peer debriefing*, the analytical framework was reviewed by two animation scholars and one ESD researcher external to the study team; (c) *negative case analysis*, we actively searched for fables that did not fit the Proppian coding scheme (none were found among the five, though we acknowledge this as a limitation of sample scope); and (d) *audit trail*, all coding decisions, analytical memos, and framework revisions were documented in a research log.

Researcher positionality is acknowledged. The lead researcher has training in Javanese philology and prior experience with *Pakualaman* manuscripts; this informs aesthetic interpretations but also introduces potential bias toward preservationist rather than transformative adaptation. To mitigate bias, visual transformation decisions were validated against external criteria: (a) consultation with two Javanese cultural practitioners (a *dalang* puppeteer and a batik

artist), and (b) explicit documentation of the pedagogical rationale for each design choice, ensuring decisions are justified by educational outcomes rather than personal aesthetic preference.

This study has three principal limitations. First, it does not include empirical validation with target audiences (children, teachers, parents). The adaptation framework is proposed theoretically, based on prior literature and expert consultation, but its effectiveness in improving moral comprehension, cultural knowledge, or ESD competencies remains untested. Second, the sample is limited to five fables from a single manuscript collection; while these were selected for representativeness, the framework's transferability to other Javanese or Indonesian oral traditions requires further research. Third, the study does not address production feasibility (cost, technical capacity, distribution infrastructure), which may constrain implementation in resource-limited educational settings. These limitations are addressed in the conclusion as directions for future research.

Results

This section presents the research findings based on the analysis of five Pura Pakualaman animal fables according to the three formulated research questions. The findings are presented in three interrelated sub-sections. Sub-section 4.1 answers the first research question (RQ1) regarding the narrative structure of these fables and how the structure allows adaptation into a shorts animated film format. Narrative analysis using a simplified Propp coding scheme reveals patterns of consistency as well as variation among the fables. Sub-section 4.2 answers the third research question (RQ3) about mapping the *piwulang* values into UNESCO ESD competencies. This mapping is important to ensure that the animation content not only preserves cultural heritage but also explicitly supports sustainable education goals. Subsection 4.3 addresses the second research question (RQ2) regarding the transformation of traditional Javanese aesthetics particularly the principles of *wayang* posture, movement vocabulary, color symbolism, and batik motifs into animation design choices with explicit pedagogical functions. Overall, these three subsections are integrated into a narrative-visual adaptation framework, which constitutes the main contribution of this study. A summary of key findings is presented at the end of the section.

4.1 Narrative Structure Analysis (RQ1)

The five fables were analyzed using a simplified Propp coding scheme. Unlike the original Propp scheme, which has 31 functions, this study only used five core functions relevant to the basic structure of animal fables: (F1) initial situation, (F2) violation/transgression, (F3) struggle/conflict, (F4) deceit/cunning, and (F5) resolution with an explicit moral coda. Two researchers coded independently, with an inter-coder agreement rate of 89% (Cohen's $\kappa = 0.84$), indicating substantial agreement.

Table 2
Narrative Structure Analysis of Five Pakualaman Fables

Fable	F1: Initial Situation	F2: Violation/Transgression	F3: Struggle/Contest	F4: Trickery/Deception	F5: Resolution with Moral
<i>Lemut lan Gajah Delikan</i>	Mosquito and elephant introduce hide-and-seek bet	Mosquito's arrogance (<i>kibir</i>) in hiding too close	Elephant ruins trees in frustration; mosquito cannot find elephant	Mosquito admits defeat when elephant hides cleverly	Explicit moral: "Do not be arrogant in winning; luck is a blessing"
<i>Tikus lan Gajah Totohan</i>	Mouse and elephant bet on who humans consider "biggest"	Elephant's assumption that size determines value	Mouse positioned as "bigger" through human perception	Mouse's clever framing of "bigness" as social rather than physical	Elephant defeated; moral: courage and cleverness (<i>sura, lenggak</i>) triumph over size
<i>Adigang Adigung Adiguna</i>	Elephant, snake, and deer each claim dominance	Elephant's arrogance of size, snake's arrogance of venom, deer's opportunistic greed	Elephant and snake kill each other; deer becomes trapped in elephant carcass	Ki Jayamurka (greedy woodcutter) returns for second tusk, dies	Moral: arrogance, misused power, and greed end in vain
<i>Cantrik lan Manuk Prenjak</i>	Apprentice seeks talisman in forest	Apprentice captures talking bird; bird offers wishes	Bird gives three pieces of advice; apprentice disbelieves	Bird claims diamond on head; apprentice leaps into ravine	Apprentice injured, remorseful; moral: avoid greed, listen to advice
<i>Watak Dasar Kucing</i>	King and minister debate: basic character vs. training	King trains cat to behave like human; minister skeptical	Minister releases mouse; cat reverts to chasing	Cat's innate behavior proves minister's position	Moral: basic character (<i>ngadeg</i>) is stronger than training

From Table 2, it can be seen that the first four fables (*Lemut lan Gajah Delikan*, *Tikus lan Gajah Totohan*, *Adigang Adigung Adiguna*, *Cantrik lan Manuk Prenjak*) follow the five Propp functions completely: starting from the initial situation, then a violation/transgression that triggers the conflict, followed by struggle, deception as the turning point, and ending with a resolution with an explicit moral coda. This pattern is structurally almost identical to the three-act film format (setup → confrontation → resolution), making these four fables very suitable for direct adaptation into a 10–12 minutes short animation format. The presence of an explicit moral coda—a characteristic of Javanese fables according to Danandjaja (1984) is actually an advantage because it provides a ready-made moment for framing ESD competencies.

However, one fable shows an important variation. The Character of the Cat lacks a trickery function (F4); the story resolution arises from an experimental demonstration (giving a mouse to a trained cat to observe whether its basic nature will reemerge). This finding suggests that proof-based fables like the Character of the Cat have a narrative structure different from traditional conflict fables. The adaptation implication: episodes for this fable are more suitable to be framed as a science experiment or character study (like a hypothesis test) rather than a conventional narrative with an enemy and trickery. The second

key finding is that all fables rely on a dyadic conflict structure (two opposing parties: mosquito vs. elephant, mouse vs. elephant, elephant vs. snake vs. deer, student vs. bird, king vs. minister).

This dyadic structure facilitates adaptation because children can easily identify the "right" and "wrong" parties (or at least the parties that need to be reflected upon) without having to track complex multiparty alliances. Thus, the answer to RQ1 is: the narrative structure of Pakualaman fables consistently follows Propp's five-function pattern, which can be directly mapped to the three-act film structure, with an explicit moral coda as a valuable distinguishing feature for ESD integration, although proof-type fables like *Watak Dasar Kucing* require a different adaptation approach.

4.2 Piwulang-to-ESD Competency Mapping (RQ3)

Table 3 presents the systematic mapping of each fable's *piwulang* values to UNESCO (2017) ESD competencies. This mapping is the study's primary theoretical contribution, providing a replicable protocol for heritage-based ESD intervention design.

Table 3 Piwulang-to-ESD Competency Mapping					
Fable	Primary Lesson (Javanese Piwulang)	English Translation	ESD Competency (UNESCO, 2017)	Specific Sustainability Outcome	Pedagogical A
Lemut lan Gajah Delikan	Kibir (negated: "do not be arrogant")	Arrogance (prohibited)	Normative competence (reflecting on values) + Ethical citizenship	Humility as conflict reduction; recognizing luck/privilege as unearned	Post-episode d "When have yo underestimate smaller/weake
Tikus lan Gajah Totohan	Sura (courage), lenggak (cleverness)	Courage, strategic intelligence	Anticipatory competence (evaluating strategies) + Resilience	Overcoming physical disadvantage through non-material resources	Activity: "What when you are t smallest/slowe
Adigang Adigung Adiguna	Lojok (arrogance), lunjak (greed)	Pride, excess/greed	Normative competence (recognizing limits) + Responsible consumption	Anti-greed as sustainability ethic; finite resources	Sustainability c earth's resourc elephant's tusk more than need everyone"
Cantrik lan Manuk Prenjak	Luwas (humility), lumuh (reluctance to listen)	Humility, openness to advice	Intergenerational competence (valuing elder/wiser knowledge) + Systems thinking	Listening to diverse knowledge sources (including traditional ecological knowledge)	Role-play: Child adult as "appre reversing expe
Watak Dasar Kucing	Ngadeg (innate character)	Basic character/inclination	Self-awareness competence (understanding one's own values/impulses)	Recognizing that behavior change requires working with not against basic tendencies	Activity: "What naturally to you you have to pre

Three important findings emerged from this mapping. First, every *piwulang* value can be mapped to at least one ESD competence, and some—such as in *Adigang Adigung Adiguna*, map to two competences simultaneously (normative competence and responsible consumption). This indicates that the fables of *Pakualaman* are not only relevant for general character education (as has long been assumed) but also for specific and measurable sustainability education goals. This is a significant finding as it opens up opportunities to integrate cultural heritage into ESD curricula, which has so far been dominated by examples from Western contexts.

Second, the granularity of the *sêstradi* framework (21 virtues and 21 vices) allows for much more precise mapping compared to folklore that only uses the generic dichotomy of "good vs evil." For example, the fable *Tikus lan Gajah Totohan* not only teaches "courage" in the abstract, but teaches *sura* (courage accompanied by strategic cleverness) as opposed to foolish courage that lacks calculation. This specificity enables educators to design sharper achievement indicators.

Third, the "Pedagogical Application" column in Table 3 provides concrete examples of how each competence can be activated in teaching and learning activities. For instance, for the fable *Lemut lan Gajah Delikan*, the post-episode discussion focuses on children's personal experiences of underestimating someone smaller/weaker—this activates normative competence because children are invited to reflect on their own values. For the fable *Cantrik lan Manuk Prenjak*, role-playing activities by reversing authority (children as advisors, adults as receivers) activate intergenerational competence in a non-patronizing way. Thus, the *sêstradi* framework in the *Pakualaman* fables provides a sufficiently granular taxonomy of values to be systematically mapped to UNESCO's ESD competences, and this mapping can be operationalized through specific post-broadcast pedagogical activities.

4.3 Visual Transformation Framework (RQ2)

This research catalogs aesthetic elements from three sources: (1) a *wayang* performance manual that documents character design principles (Soedarsono, 1999), (2) a batik encyclopedia that documents pattern symbolism (Maulana & Karyono, 2024), and (3) a guide to color symbolism from Javanese cultural studies (Mahardhika & Prihadi, 2020). For each aesthetic element, three aspects are identified: (i) its traditional meaning/semiotic value, (ii) its potential translation into animation design, and (iii) its pedagogical function (how the element reinforces moral clarity for a child audience). Table 4 presents the resulting visual transformation framework.

Table 4
Visual Transformation Framework: From Traditional Aesthetics to Animation Design

Aesthetic Domain	Traditional Javanese Element	Semiotic Meaning	Animation Implementation	Pedagogical Function
Character posture (arrogant figures)	Stiff, upright posture (<i>dedege kaku</i>), chin elevated	Indexes pride, refusal to bend	3D rigging with limited spine flexibility; static poses held longer (12 + frames)	Visual anchor: "Stiff = pride = fall" — children can predict outcome from posture
Character posture (clever figures)	Dynamic, twisted posture (<i>mbiyak</i>), asymmetrical	Indexes adaptability, cunning	Flexible rigging with spine twisting; rapid pose changes (every 4–6 frames)	Visual anchor: "Twisted = clever = resourceful"
Color symbolism (gold)	Gold (<i>mas</i>) associated with deities, nobility	Wisdom, divinity, legitimate authority	Character accents (bird's feathers, king's accessories) in RGB (255,215,0)	Signals: "This character speaks truth / gives good advice"
Color symbolism (red)	Red (<i>abang</i>) in wayang for angry/aggressive characters	Danger, anger, uncontrolled emotion	Threat elements (snake tongue, angry eyes) in bright red (RGB 255,0,0)	Danger cue: even pre-literate children recognize red = caution
Color symbolism (black/dark brown)	Black (<i>ireng</i>) for strong but ambivalent characters	Power, strength, potential for arrogance	Elephant, arrogant characters in dark brown/black palette	Signals moral ambivalence: not evil, but flawed
Color symbolism (white/light)	White (<i>putih</i>) for purity, truth	Purity, honesty, moral clarity	Resolution scenes, moral-coda moments bathed in warm white light	Visual reward: moral understanding = bright, clear world
Movement vocabulary	<i>Ayun-ayun</i> (hanging/floating)	Deliberate, contemplative action	Slow-motion (0.5x speed) for reflective moments	Pacing cue: slow = think, fast = impulsive
Movement vocabulary	<i>Sembur</i> (rushing)	Impulsive, uncontrolled action	Motion blur, speed lines, 24→12 fps drop	Pacing cue: rushed = mistake
Background: Batik motifs	<i>Parang</i> (diagonal knife)	Perseverance, continuity, struggle	Transition wipe between scenes; background texture for protagonist journey	Subconscious messaging: continuity of effort
Background: Batik motifs	<i>Kawung</i> (palm fruit cross-section)	Justice, self-reflection, balance	Background for moral-coda scenes, discussion prompts	Subconscious messaging: reflection time
Background: Batik motifs	<i>Mega mendung</i> (clouds)	Patience, emotional regulation	Background for moments requiring delayed gratification (e.g., cat resisting mouse)	Subconscious messaging: patience = cloud-like calm
Lighting	Soft, long-shadowed (<i>wayang</i> screen effect)	Mystical, moral ambiguity (shadows = gray areas)	Rim lighting with warm (amber) key light, cool (blue) fill	Moral complexity: not binary good/evil
Composition	Symmetrical for resolution scenes	Harmony, balance restored	Centered framing, horizontal lines, balanced color weights	Visual closure: resolution = order

Javanese aesthetics are not merely decorative, as if they were just 'ornaments' that can be replaced with other aesthetics without losing meaning. On the contrary, this finding shows that Javanese aesthetics is a pedagogical semiotic system in which every visual element carries specific cultural meaning that actively reinforces the moral message of the story. For example, a stiff and upright posture for an arrogant character (*dedege kaku*) gives a visual cue to children that 'arrogance = stiffness = will fall,' even before dialogue is spoken or resolution occurs. Similarly, the use of the *parang* batik motif as a background or transition sends a subconscious message about the continuity of struggle, while *kawung* appears at moments of resolution to indicate balance and self-reflection.

These findings challenge the common assumption in some heritage preservation projects that 'authenticity' requires literal reproduction of traditional forms—for example, using puppets without alteration or recording wayang performances directly. Instead, this framework suggests that semiotic principles (postures indexing characters, colors signaling moral values) can be translated across mediums, while execution techniques (3D rigging, digital color grading, motion blur effects) can adapt to contemporary children's visual expectations without losing cultural meaning. This aligns with UNESCO's 'living heritage' approach, which prioritizes continuity of meaning over static forms.

his framework reveals a critical design tension between cultural authenticity and cross-cultural legibility. Traditional Javanese color symbolism—gold for wisdom, red for danger, black for ambivalent power, white for truth—is highly effective for audiences already familiar with Javanese culture. However, for international distribution or for non-Javanese audiences within Indonesia itself (for example, children in Papua or Sumatra who have no exposure to Javanese culture), some symbols may not be immediately recognized. To address this tension, this study recommends a redundancy strategy: continue using authentic color symbolism, but add verbal reinforcement through subtitles, dubbing, or narrator commentary.

For example, when a wise character appears with a golden accent, the narrator or another character can explicitly say, "Notice the golden color—that is a sign that he is wise and his words can be trusted." Thus, the traditional Javanese aesthetics of wayang posture, batik motifs, and color symbolism can be systematically translated into animation design choices through a transformation framework that preserves their original semiotic and pedagogical functions, while adjusting the execution techniques to the digital medium and, if necessary, adding verbal redundancy for cross-cultural audiences.

The findings from the three analyses above indicate that the animal fables of Pura Pakualaman have three characteristics that make them highly suitable for adaptation into ESD animation: (1) a narrative structure that is consistent and compatible with the three-act film format, (2) a granular value taxonomy that can be directly mapped to UNESCO ESD competencies, and (3) a richness in traditional aesthetics that is inherently pedagogical and can be translated into digital media.

5. Implementation Model for ESD-Aligned Digital Literacy

This section presents an implementation model for adapting Pakualaman fables into ESD-based digital literacy content. The model is proposed (theoretically suggested) because empirical validation with the target audience is still ongoing further research. The implementation model comprises four components: (1) standard animated episode structure, (2) technical production specifications, (3) distribution strategy and supporting resources, and (4) explicit framing protocol for the "Sustainability Corner".

5.1 Animated Episode Structure

Each fable is adapted as a short animated episode with a duration of 10–12 minutes. This duration was chosen based on three considerations. First, the attention span of children aged 5–9 (the main target audience) usually does not exceed 15 minutes for uninterrupted narrative content. Second, a duration of 10–12 minutes is sufficient to complete Propp's five functions (F1-F5) without rushing or dragging. Third, this duration aligns with the standards for "short-form content" on platforms like YouTube and online learning services, which allows for viewing in a single teaching-learning session.

All episodes follow a standardized pedagogical structure consisting of eight segments, as detailed in Table 5.

Table 5
Animated Episode Structure

Segment	Duration	Content	ESD Integration Point
Opening (title + recap)	30 sec	Title card, "Previously..." (for episodes 2–5)	N/A
Introduction	1.5 min	Character introduction, setting, initial situation (F1)	N/A
Conflict initiation	2 min	Violation/transgression (F2)	Pause point: "What would you do?" prompt
Struggle/development	3 min	Struggle (F3), trickery (F4)	Character internal voiceover of moral dilemma
Climax	1.5 min	Turning point, reversal of fortune	Slow-motion moment for emotional impact
Resolution + Moral coda	1.5 min	Outcome (F5), explicit piwulang statement	Direct address: "The lesson here is..." (character breaks fourth wall)
Sustainability Corner	30 sec	Linking piwulang to ESD competency	Explicit framing: "This connects to taking care of our world because..."
Closing (credits + prompt)	30 sec	Credits, "Next time..."	Discussion prompt overlay

Some segments have pedagogical features specifically designed. First, the pause point in the Conflict Initiation segment is a moment when the animation stops briefly (2–3 seconds) and a question appears on the screen: "What would you do if you were [character]?" Teachers can pause the presentation at this point for a class discussion before continuing. This feature activates anticipatory competence because children are invited to predict the consequences of different choices.

Second, the character's internal voiceover in the Struggle/Development segment is a technique in which the audience hears the character's inner thoughts (for example, the mouse thinks: "I am smaller, but maybe I can use my intelligence..."). This helps children access the character's moral reasoning process, not just see external actions. This technique is very important for fables like Mouse and Elephant Totohan, where the mouse's victory depends on cognitive strategy rather than physical strength.

Third, direct address in the Resolution + Moral Coda segment is a moment where the character (usually a wise character or narrator) looks directly at the camera and states the lesson explicitly. This is different from conventional animated films which tend to avoid "breaking the fourth wall." In the context of Javanese fable pedagogy, direct address is actually in line with the oral teaching tradition where the storyteller directly conveys the message to the audience. So, this is not a violation of cinematic convention, but rather a faithful adaptation to the source genre. Fourth, the Sustainability Corner is a 30-second segment at the end that explicitly connects the fable's lesson to ESD competencies (see Subsection 5.4 for a script example). The existence of this separate segment is important because research shows that early childhood children need explicit framing to transfer learning from one context (fable story) to another context (real life and sustainability issues). Without this segment, children may understand the moral of the fable ("don't be arrogant") but not automatically connect it to sustainability issues such as overconsumption or intergenerational justice.

5.2 Technical Specifications

The technical specifications for animation production need to be established from the beginning to ensure consistency between episodes and compatibility with various distribution platforms. Table 6 summarizes the recommended technical parameters along with their pedagogical rationale.

Table 6
Technical Specifications

Parameter	Specification	Rationale
Resolution	1920×1080 (Full HD), 16:9 aspect ratio	Standard for educational platforms, compatible with classroom projectors
Frame rate	24 fps (cinematic), drop to 12 fps for comedic/speed sequences	24 fps signals "quality content"; 12 fps signals exaggeration (pedagogical pacing cue)
Audio	Dolby Digital 5.1, stereo mix for classroom	Spatial audio for immersive engagement
Language	Javanese dialogue (original <i>tembang</i> preserved where possible), Indonesian and English subtitles	Preserves linguistic heritage; enables wider distribution
Music	Electronic gamelan (sampled instruments + synthetic layers)	Traditional timbre, contemporary production

The decision to use 24 fps as a baseline with a drop to 12 fps for certain scenes was based on the pedagogical function of pacing. In conventional cinema, 24 fps creates smooth and "serious" motion. In educational animation for children, deliberately lowering the frame rate (for example, when an arrogant character moves hurriedly) creates an "unnatural movement" effect that subconsciously signals that something is wrong. This is a translation of the concept of *sembur* (hurried, uncontrolled movement) in the vocabulary of *wayang* motion (see Table 4).

The decision to retain the original *tembang* in Javanese dialogue, rather than translating everything into Indonesian, was based on the consideration that the melody and rhyme of the *tembang* are an integral part of the mnemonic structure of the fable (Danandjaja, 1984). Removing the *tembang* will reduce the child's memory of the teachings. For non-Javanese audiences, subtitles serve as a bridge without eliminating the original aesthetic-linguistic elements.

5.3 Distribution and Supporting Resources

The distribution model is designed to reach three audience groups: (1) children who access independently through online video platforms, (2) teachers who integrate episodes into classroom learning, and (3) parents who accompany children at home. Primary distribution includes three channels:

1. A dedicated YouTube channel named "Piwulang Digital" or "Pakualaman Fables." Episodes are released weekly on a regular schedule to build viewing habits and anticipation. Each episode includes a description listing the main *piwulang*, related ESD competencies, and discussion questions. YouTube is chosen because of its very high penetration among Indonesian children (more than 85% of children aged 6–11 access YouTube at least once a week) as well as automatic subtitle features that facilitate accessibility.
2. A mobile application for Android and iOS that provides: (a) offline viewing (download episodes to watch without an internet connection), (b) interactive quizzes with a points and badges system, (c) digital trading cards ("character cards" with facts about *piwulang* and sustainability tips), and (d) a "parent/teacher" mode that hides quizzes until the child finishes watching the episode. The mobile application is important to reach areas with unstable internet connections.
3. Integration with Indonesian educational platforms such as Rumah Belajar (Ministry of Education, Culture, Research, and Technology), Sekolahmu, and Ruangguru. This integration allows teachers to: (a) assign episodes as homework, (b) track students' viewing progress (if the platform supports it), and (c) access episodes directly from the learning interface they are already using, without needing to open YouTube or a separate application.

Support resources for educators include four components: *First*, episode-specific teacher guides (PDF format, 4–6 pages per episode) containing: (a) learning objectives (cognitive: identifying morals; affective: reflecting on personal experiences; psychomotor: demonstrating related behaviors), (b) pre-viewing and post-viewing discussion questions, (c) clear ESD competency mapping along with achievement indicators, (d) adaptations for different age levels (5–6 years, 7–8 years, 9+ years). *Second*, printable worksheets in three variants: (a) matching characters with traits (for children 5–6 years old), (b) drawing alternative story endings (for children 7–8 years old), (c) writing mini fables with their own morals (for children 9+ years old). The worksheets are designed so teachers can photocopy them without licensing fees. *Third*, interactive gamified quizzes that can be accessed via mobile apps or browsers. Point systems, badges, and leaderboards for class teams are used to motivate participation, with a warning that the leaderboard should be arranged per class (not nationally) to avoid demotivation for slower students. *Fourth*, offline activity kits for learning without digital devices: (a) a guide for simple paper animation workshops (stop-motion using the teacher's phone), (b) templates for paper puppets of fable characters, (c) drawing competition rubrics with assessment criteria that prioritize understanding of moral lessons (*piwulang*) rather than artistic talent.

Discussion

This research provides three main interrelated contributions to the literature on cultural heritage adaptation, animation design, and ESD. The first contribution is a validated narrative transformation protocol for Javanese palace fables. This study shows that the five Pakualaman fables have a consistent Proppian structure and can be directly mapped to a three-act film format, with an explicit moral coda that serves as a ready-to-use ESD framing moment. Unlike previous studies that treated folklore as generic source material, these findings affirm that fables originating from a palace environment with formal pedagogical intent—particularly the *sêstradi* framework—have superior suitability for ESD adaptation due to their explicit and granular moral taxonomy.

The second contribution is a systematic visual transformation framework that connects Javanese aesthetics with animation pedagogy. This study operationalizes how the codes of *wayang* postures, the symbolism of batik motifs, and the meanings of Javanese colors can be translated into animation design choices with explicit pedagogical rationale. This goes beyond previous studies on cultural aesthetics in animation that merely describe traditional elements without providing a replicable translation protocol. The resulting framework determines which traditional elements are mapped to which animation choices, with what pedagogical function, thereby enabling other cultural heritage practitioners to adapt this protocol to their respective cultural contexts.

The third contribution is a protocol for mapping piwulang competencies to ESD. This study maps the piwulang values from each fable—such as *sura* (courage) and *luwas* (humility)—to specific UNESCO ESD competencies, such as ethical citizenship, resilience, responsible consumption, and intergenerational competence. These findings address a significant gap in the ESD literature, which has long called for the development of culture-based competencies but has provided few operational examples. This mapping protocol enables cultural heritage educators to answer the question: 'This traditional story teaches X — which sustainability competence does it support?'

These findings not only align with previous research but also surpass it. Consistent with Rahiem (2021) and Purnama et al. (2022), this study found that locally based digital storytelling enhances cultural knowledge and moral engagement. However, whereas those studies only evaluated 'character education' outcomes in general, this research provides a mapping of specific ESD competencies, allowing integration into the sustainability curriculum rather than merely standalone moral instruction. Similarly, in line with Hutcheon (2006), who treats adaptation as a creative reinterpretation, this study expands adaptation theory by specifying pedagogical criteria for adaptation decisions: every transformation—whether an addition, deletion, or substitution—must be justified not only by media affordances but also by educational outcomes. This pedagogical adaptation framework has never been articulated before in the adaptation study literature, which tends to focus more on aesthetic or commercial criteria.

Furthermore, these findings challenge deeply rooted assumptions in some heritage preservation literature that 'authenticity' requires literal reproduction of traditional forms, for example using wayang puppets without alteration. This study shows that principles, such as postures that index character or colors that signal value, can be translated across media, while execution, such as 3D rigging or digital color grading, adapts to contemporary visual expectations. This aligns with UNESCO's 'living heritage' approach, which prioritizes continuity of meaning over stagnation of form.

Although the case study design allows for in-depth analysis of this specific corpus, it limits generalization. However, the developed protocol—narrative coding scheme, mapping of teachings to ESD, and the visual transformation framework—can be transferred to other heritage contexts. A researcher working with Sundanese fables or Balinese wayang narratives can apply the same stages of analysis: identifying Proppian structures, extracting explicit moral values, mapping them to ESD competencies, translating traditional aesthetics using semiotic principles, and implementing them as structured episodes.

For practitioners, these findings offer concrete guidance. Animators and media producers can use the visual transformation framework as a replicable template for culturally authentic animation design, with the key insight that authenticity does not reject digital techniques, but rather translates traditional semiotic principles into digital execution. Educators and curriculum developers can utilize the teaching-to-ESD mapping to integrate heritage storytelling into the sustainability curriculum, with a "Sustainability Corner" in each episode providing a structured moment for framing explicit competencies. Cultural heritage practitioners receive a demonstration of the pathway from manuscript preservation to active digital transmission: the Pakualaman fables are not museum artifacts locked in archives, but living pedagogical resources. Digitization combined with pedagogical adaptation allows heritage to function as education for cultural sustainability, not merely education about cultural sustainability.

Conclusion

This study develops a narrative-visual framework to adapt the animal fables of Pura Pakualaman into short animated films that align with Education for Sustainable Development (ESD). Analysis of five fables reveals three main contributions. First, the five fables have a consistent narrative architecture (initial situation-conflict-development-resolution with a moral coda) that can be directly mapped onto a three-act film structure, while also preserving literary teachings and the *sêstradi* framework (21 virtues and 21 vices). Second, the resulting visual transformation framework translates Javanese aesthetic codes (*wayang*, *batik*, color symbolism) into animation design choices with explicit pedagogical functions. Third, the mapping of piwulang to UNESCO ESD competencies provides a repeatable protocol for sustainability education based on cultural heritage. This study has not been empirically validated with the target audience, is limited to five fables, and does not address production feasibility in resource-limited environments. Further research is needed to: (1) empirically test the effectiveness on moral understanding and ESD competencies, (2) conduct comparative studies with other heritage corpora, (3) investigate implementation in real curricula, (4) conduct longitudinal studies on long-term impacts, and (5) critically examine the unintended consequences of heritage digitalization.

Declarations

Funding: No funding was received for this study.

Ethics approval and consent to participate: Not applicable. This study does not involve human participants, animal subjects, or clinical trials.

Consent for publication: Not applicable.

Data Availability: The data supporting the findings in this study come from a collection of animal fable manuscripts from Pura Pakualaman, Yogyakarta, which had been philologically documented by a research team previously. The primary data, in the form of transcriptions and translations of the five fables from Pura Pakualaman. The datasets generated and/or analysed during the current study are not publicly available due to intellectual property restrictions from the Pura Pakualaman authorities and cultural heritage protection policies. However, they are available from the corresponding author on reasonable request. Requests must include a letter of recommendation from the Pura Pakualaman palace authorities or an affiliated research institution. Access will be granted for non-commercial, academic research purposes only upon approval.

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