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Research Article

Development of Virtual Classroom–Based Learning Media to Improve Learning Achievement in Thai Folk Dance

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Abstract: This study aimed to (1) develop and determine the efficiency of virtual classroom-based learning media for Thai folk dance according to the 80/80 criterion; (2) compare students' learning achievement before and after using the media; and (3) examine students' satisfaction with the media. The sample comprised 38 Grade 8 students in Class 2/3 at Triam Udom Suksa Pattanakarn Pathum Thani School, selected through cluster random sampling. The intervention and data collection were conducted over a 4-week period (totaling 12 instructional hours) during the first semester of the 2025 academic year. The media were developed using the ADDIE model, with the Technological Pedagogical Content Knowledge (TPACK) framework and social constructivist principles informing the integration of content, pedagogy, technology, and learner interaction. The research instruments comprised the virtual classroom-based learning media, a media-quality evaluation form, pretest and posttest achievement tests, and a student-satisfaction questionnaire. Data were analyzed using percentages, means, standard deviations, and a dependent-samples t-test. The media achieved an efficiency index of 81.05/90.25, exceeding the predetermined 80/80 criterion. The mean achievement score increased from 8.24 (SD = 3.20) before the intervention to 18.05 (SD = 1.47) afterward, with a statistically significant difference reported at the .05 level. Overall student satisfaction was at the highest level (M = 4.51, SD = 0.61). These findings indicate that the media met the specified efficiency criterion and were associated with higher post-intervention achievement scores and favorable student evaluations. However, the one-group pretest–posttest design without a control group limits causal interpretation; therefore, the observed improvement cannot be attributed solely to the media. Further research using comparison groups and direct assessments of practical dance performance is recommended.

Keywords: Virtual Classroom Learning Media, Thai Folk Dance, learning achievement, student satisfaction, instructional design

Introduction

Contemporary society is characterized by continuous learning and rapid change. Technology has become integral to social, economic, and educational life, transforming education beyond conventional classroom-based provision. Online instruction represents an educational innovation that employs technology to facilitate learner-centered learning.

Students no longer depend exclusively on classroom teachers for knowledge; contemporary learning resources include families, communities, peers, nature, the environment, and modern technologies. Online education, together with supporting websites and applications, has consequently evolved to provide flexible and convenient teaching and learning opportunities (Chaopho, Sermsong, Wongchan, & Lertsapung, 2020).

Rapid technological development and the continuous transformation of knowledge require teachers to adapt to emerging learning environments. Instruction must move beyond lecture-dominated approaches toward active participation, authentic performance, and practices aligned with changing learner behaviors. Modern technologies can serve as tools for stimulating learning (Medhaakkharakiat & Siriwong, 2019). Augmented reality (AR), for example, integrates virtual content with the physical world by superimposing digital images on real environments through tablets, smartphones, and other display devices. Its applications span medicine, tourism, business, education, and publishing. In educational contexts, AR can engage visual, auditory, and tactile perception while enabling novel forms of response and interaction. When pedagogically integrated, it can increase interest, reduce boredom, strengthen motivation and curiosity, enrich learning experiences, and improve students' comprehension (Hirankerd, Kittisunthonnphisarn, & Sooksai, 2025).

Thai dance is included in basic education to enable students to study national culture and to provide a foundation for advanced study. It constitutes Strand 3 of the Arts Learning Area under Thailand's 2008 Basic Education Core Curriculum, implemented in schools from the 2009 academic year onward (Udchan, Krataithong, & Duangwiset, 2019). Technology and instructional innovation have increasingly been incorporated into dance education to improve achievement and desirable learning behaviors. Nevertheless, commonly used resources remain largely limited to books and videos, despite the subject's integration of theoretical knowledge and embodied movement. Students may therefore perceive dance content and movement sequences as difficult to remember, which can lead to boredom, unfavorable attitudes, and achievement below instructional targets. Conventional practice typically relies on teacher explanation and demonstration followed by repeated imitation. Students with prior experience may progress readily, whereas those who do not observe carefully or practice consistently may fall behind and regard the movements as excessively difficult (Jintalai & Pattayanon, 2018). Specifically for Grade 8 students, educational survey reports and curriculum evaluations indicate that many learners struggle with lower-secondary Thai dance modules due to the abstract nature of memorizing spatial formations, intricate hand gestures (Na-Tat), and rhythm patterns from periodic classroom demonstrations alone. Conventional face-to-face instruction often fails to provide sufficient individualized review time outside class hours, resulting in inconsistent skill retention, diminished learning engagement, and overall performance scores falling below standard benchmark criteria. Learner-centered and experiential approaches offer an alternative by engaging students in cycles of experience, reflection, conceptualization, and action. Through active participation, learners identify problems, consider solutions, adapt their understanding, and apply knowledge in new situations (Dewey, 1997; Kolb, 1984). New knowledge, skills, and attitudes are constructed by connecting prior experience with critical reflection, analysis, synthesis, and evaluation, with teachers facilitating rather than simply transmitting knowledge (Evans, 1994). As students increasingly devote attention to mobile phones, computers, and internet-based environments, digital resources offer accessible and timely opportunities for inquiry. Accordingly, the present study developed virtual classroom-based learning media on Thai folk dance for secondary students, aligned with Arts Standard A 3.2 of the 2008 Basic Education Core Curriculum. Grounded in the Technological Pedagogical Content Knowledge (TPACK) framework and social

constructivist principles, the environment was designed to permit access at any time and place, support the development of twenty-first-century competencies, broaden learning opportunities, and promote the preservation and continuation of Thai cultural heritage.

Research Objective

1. To develop and evaluate the efficiency of virtual classroom–based learning media for Thai folk dance in accordance with the 80/80 efficiency criterion.
2. To compare students' learning achievement before and after learning through the virtual classroom–based learning media for Thai folk dance.
3. To examine students' satisfaction with the use of the virtual classroom–based learning media for Thai folk dance.

Research Hypothesis

H1: The virtual classroom learning media on regional Thai folk dance will achieve the predetermined efficiency criterion of 80/80.

H2: Students who learn through the virtual classroom learning media on Thai folk dance will demonstrate significantly higher posttest achievement scores than their pretest scores at the .05 significance level.

H3: Students' overall satisfaction with the virtual classroom learning media on Thai folk dance will be at a high level or above.

Conceptual Framework

The conceptual framework of this study integrates three components: the ADDIE model, Technological Pedagogical Content Knowledge (TPACK), and social constructivism. ADDIE provides a systematic development process comprising five phases: analysis, design, development, implementation, and evaluation. TPACK guides the alignment of Thai folk dance content, pedagogical approaches, and the technological capabilities of the virtual classroom. Social constructivism informs the design of learner interactions through discussion, collaborative interpretation, peer exchange, and teacher scaffolding. These three components are operationalized through virtual classroom–based learning media incorporating text, images, audio, video, and interactive features. This learning environment is expected to facilitate students' access to content, review of learning materials, interaction, and engagement, thereby contributing to the efficiency of the learning media, students' learning achievement, and their satisfaction.

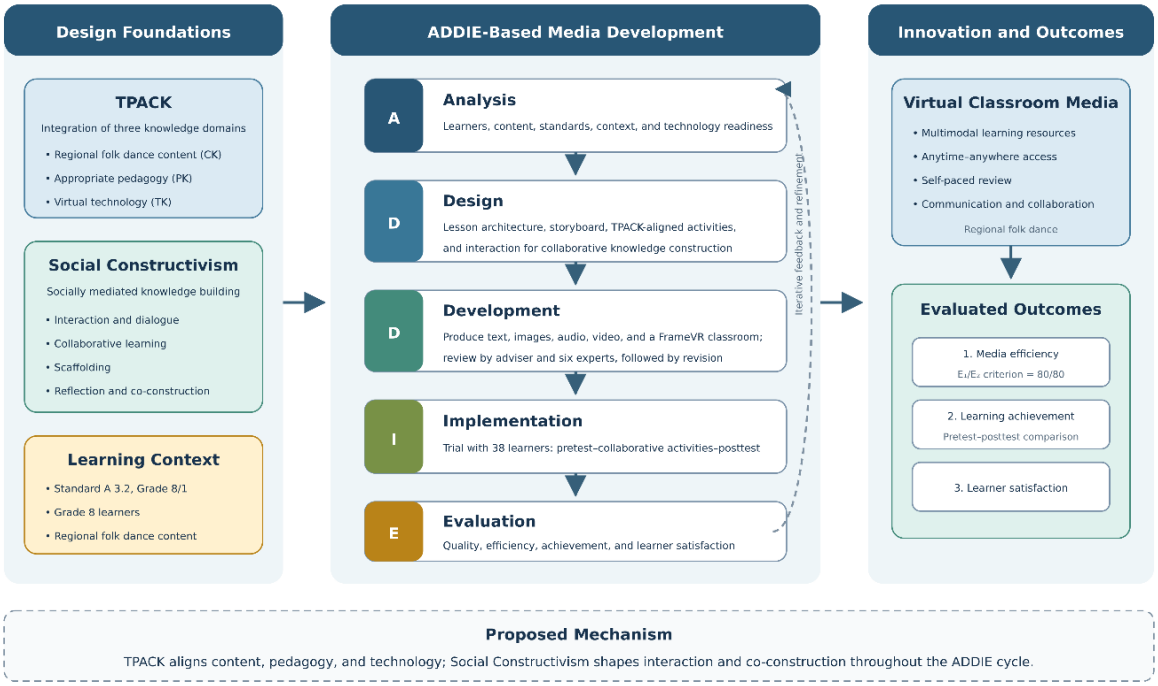


Figure 1 Conceptual Framework

Literature Review

The Transition to Digital Learning and Virtual Classrooms

Technological change has extended learning from physical classrooms into digital environments in which learners can access content, media, and interaction across temporal and spatial boundaries. Online learning is the broadest of these concepts and refers to learning activities delivered through digital networks, including access to instructional content, communication, interaction, and assessment. A virtual classroom represents a more specific form of online learning in which teaching and learning activities are organized within a structured digital environment that enables teacher–learner communication, content presentation, discussion, collaboration, and other forms of instructional interaction. Thus, a virtual classroom is more than an online information-delivery channel; it is an integrated learning environment that combines multimodal resources, teacher-learner communication, and participatory activities.

Virtual Reality (VR) should be distinguished from a virtual classroom because VR refers primarily to a technology for creating computer-generated, three-dimensional environments in which users can interact with virtual objects or spaces, often through specialized devices such as head-mounted displays. Immersive learning, in contrast, refers more broadly to a learning experience in which learners are highly engaged with a simulated, virtual, or interactive environment. VR can therefore be used to support immersive learning, but immersive learning is not synonymous with VR, and neither concept is equivalent to a virtual classroom. This distinction is important for the present study because the research focuses on the development and evaluation of virtual classroom-based learning media, rather than on the effects of VR technology or immersive learning as independent instructional interventions.

In Thailand, online platforms have increased instructional flexibility and supported students' roles as seekers and constructors of knowledge rather than passive recipients of lectures (Medhaakkharakiat & Siriwong, 2019; Chaopho, Sermsong, Wongchan, & Lertsapung, 2020). International evidence suggests that immersive technologies can

strengthen engagement, presence, and experiential learning. Learning, however, does not arise automatically from technological realism. The Cognitive Affective Model of Immersive Learning proposes that immersion, representational fidelity, and learner control influence presence and agency, which subsequently affect motivation, attention, cognitive load, self-regulation, and knowledge outcomes (Makransky & Petersen, 2021). A meta-analysis of primary-level learners likewise reported an overall positive effect of virtual reality on learning, while identifying activity design, duration, and technology type as important moderators (Villena-Taranilla et al., 2022). Virtual classrooms should therefore be grounded in instructional design rather than technological novelty alone.

The Potential of Virtual Media for Learning Thai Folk Dance

Thai folk dance integrates movement, music, costume, place, geography, history, and community identity. Lectures or static images alone may therefore be insufficient for understanding the relationship between performance forms and their cultural contexts. Virtual classroom media can present text, images, sound, and video within a unified environment, allowing learners to explore content sequentially, review it as needed, and connect performance details with the contexts that give them meaning. This capacity accords with multimedia-learning principles, which hold that learners develop deeper understanding when verbal and visual information is appropriately selected, organized, and integrated without imposing unnecessary cognitive load (Mayer, 2024) . Within cultural-heritage education, virtual reality and three-dimensional environments provide access to distant objects, places, and narratives while fostering contextual and emotional connections. Educational value nevertheless depends on maintaining content accuracy, enabling interpretation and dialogue, and avoiding the reduction of culture to a mere exhibit (Scavarelli, Arya, & Teather, 2021) . For Thai folk dance, this entails integrating movement, performance style, music, costume, and community background while enabling students to explain, compare, question, and collaboratively construct cultural meaning.

ADDIE as a Systematic Media-Development Process

ADDIE comprises Analysis, Design, Development, Implementation, and Evaluation and provides a process framework connecting learner needs, learning objectives, content, pedagogy, technology, and assessment (Branch, 2009) . Analysis addresses curriculum standards, learner characteristics, dance content, and access to devices. Design specifies lesson structure, storyboards, interaction, and assessment. Development involves producing and validating text, images, audio, video, and the virtual environment. Implementation organizes pre-learning, during-learning, and post-learning experiences. Evaluation encompasses media quality, efficiency, achievement, and satisfaction, with feedback informing improvement throughout the process. Thai studies support the use of ADDIE for digital media and online lessons, which tend to meet quality criteria and correspond with increased post-instruction achievement (Junwandee, Gumjadphai, & Kunpaibutr, 2018; Namyotha, 2022) . ADDIE, however, manages the development process without fully specifying how content, pedagogy, and technology should be integrated or how learners should interact to construct knowledge. TPACK and social constructivism address these theoretical requirements.

TPACK and the Alignment of Content, Pedagogy, and Technology

The TPACK framework explains that effective technology-enhanced teaching depends on the interaction of content knowledge (CK), pedagogical knowledge (PK), and technological knowledge (TK), including the intersections among these domains (Mishra & Koehler, 2006) . For Thai folk dance, CK includes meaning, history, geographical

context, performance styles, costumes, and music; PK includes demonstration, questioning, comparison, review, and collaborative learning; and TK includes the affordances of virtual classroom platforms, video, audio, images, and discussion channels. TPACK-based design should therefore begin not with the newest technology but with what learners must understand or perform, followed by selection of pedagogical approaches and technological features that support those outcomes. Video can facilitate observation of movement sequences, audio can illuminate rhythm and music, detailed images can support costume analysis, and discussion spaces can enable shared interpretation. Such alignment reduces the risk of a virtual classroom becoming merely a media repository and enables technology to function as a cognitive and social tool.

Social Constructivism and the Co-construction of Knowledge

Social constructivism views knowledge as emerging from the relationship between individual cognition and sociocultural contexts. Learning is promoted through language, dialogue, collaborative problem-solving, scaffolding, and the negotiation of meaning (Palincsar, 1998) . This perspective is particularly relevant to Thai folk dance, which involves not only factual knowledge and movement skills but also cultural meanings that learners connect with prior experience and the perspectives of others. In a virtual classroom, social constructivism can be operationalized through collaborative observation of performances, discussion of relationships between stylistic features and regions, comparison of costumes and music, peer explanation, and feedback from teachers and group members. The teacher consequently becomes a designer and facilitator who poses questions, scaffolds learning, and provides resources for the collaborative construction of knowledge. Research on VR and AR in social learning spaces similarly indicates that co-presence, communication, and collaborative activity are crucial to learning outcomes, beyond visual immersion alone (Scavarelli, Arya, & Teather, 2021).

Integrating ADDIE, TPACK, and Social Constructivism

In this study, the ADDIE model provides a systematic process for analysing learner needs and curriculum requirements, designing lessons, developing learning media, implementing the instructional innovation, and evaluating outcomes. The Technological Pedagogical Content Knowledge (TPACK) framework informs decisions about aligning standard Thai circle dance (Ram Wong Matra Than) or Thai folk dance content with pedagogical approaches and the technological features of the virtual classroom. Social constructivism, in turn, guides the design of interaction, discussion, and the interpretation of cultural content within the learning environment.

These frameworks therefore serve complementary rather than interchangeable functions. ADDIE structures the development process, TPACK guides the integration of content, pedagogy, and technology, and social constructivism informs the design of learning interactions. Together, they provide the conceptual foundation for developing the virtual classroom–based learning media evaluated in this study.

Methodology

Research Design and Participants

This study employed a one-group pretest–posttest design to examine changes in students' learning achievement following the use of virtual classroom–based learning media for Thai folk dance education. This design was selected because the study was conducted in a regular classroom within an authentic school setting. The participants were Mathayom Suksa 2 (Grade 8) students in Class 2/3 at Triam Udom Suksa Pattanakarn

Pathum Thani School during the first semester of the 2025 academic year, selected through cluster random sampling.

Before the intervention, all students completed a pretest. They then engaged in learning activities using the developed virtual classroom–based learning media. Upon completion of the learning process, they completed a posttest and a satisfaction questionnaire. As the study employed a single-group design without a comparison group, changes in pretest and posttest scores may have been influenced by other factors, including maturation, testing effects, or additional learning experiences during the intervention period. The findings were therefore interpreted as evidence of an association between the use of the learning media and changes in students' learning achievement, rather than as confirmation of a direct causal effect attributable to the media.

Research Instruments

1. Virtual classroom-based learning media for Thai folk dance
2. A quality-evaluation form for the virtual classroom-based learning media
3. A Thai folk dance learning achievement test used as both the pretest and posttest.
4. A satisfaction questionnaire for Grade 8 students learning through the virtual classroom-based learning media on Thai folk dance

Instrument Development Procedures

1. Relevant documents, textbooks, information resources, virtual classroom media, and previous research were reviewed to inform the development of the virtual classroom-based learning media.

2. The media were developed through the ADDIE model, integrated with the TPACK framework and social constructivist theory, as described below.

Stage 1: Analysis

1) Content analysis was conducted in accordance with indicator A 3. 2, Grade 8/1, of the 2008 Basic Education Core Curriculum. Documents and textbooks were reviewed to define the content scope: meaning, historical background, geographical characteristics, performance styles, costumes, and accompanying musical instruments.

2) The target group was analyzed in relation to the curriculum indicator and core content concerning Thai folk dance.

Stage 2: Design

Following a review of virtual classroom development approaches, the researchers designed the environment as a linear programmed lesson.

1) Content and lesson-design information were synthesized from relevant documents, textbooks, and research.

2) A storyboard was prepared to specify the format and sequence of each lesson topic. TPACK-informed activities comprised a pretest, lesson introduction, content presentation, reinforcement of understanding, lesson summary, posttest, and collaborative interaction. Learners could communicate through the virtual environment, which incorporated text, audio, images, and video to sustain attention, reinforce understanding, and support review. Content could be revisited as often as required and accessed at any time and place.

Stage 3: Development

1) The designed components, including text, images, and video, were produced.

2) The virtual classroom-based learning media were created using FrameVR.

3) The media were reviewed by the research advisor and revised accordingly.

4) Six experts evaluated the accuracy and appropriateness of the content and media; revisions were subsequently made in response to their recommendations.

Stage 4: Implementation

1) The completed media, following quality evaluation and revision, were implemented with the Grade 8 sample at Triam Udom Suksa Pattanakarn Pathum Thani School. TPACK guided the selection and application of technology, while social constructivism informed activities emphasizing learners' co-construction of knowledge.

Stage 5: Evaluation

1) After using the media, learners completed a satisfaction questionnaire to determine their satisfaction with the virtual classroom-based learning media on Thai folk dance.

Development of Thai Folk Dance Learning Achievement Test

A learning achievement test on Thai folk dance was developed to assess students' knowledge and understanding before and after the use of virtual classroom–based learning media. The test comprised 20 multiple-choice items, each with four response options. Each correct answer was awarded one point, yielding a maximum score of 20. The test covered four main content domains: (1) the meaning and historical background of Thai folk dance; (2) its characteristics and components; (3) dance movements, rhythms, costumes, and accompanying musical instruments; and (4) its cultural significance and appropriate application.

The items were developed based on the learning objectives, curriculum content, and instructional content presented through the virtual classroom–based learning media. A test blueprint was constructed to ensure adequate coverage of the specified content and learning objectives. The same test was administered before and after the intervention to measure changes in students' learning achievement.

Content validity was examined by six experts, who evaluated the alignment of each item with the specified learning objectives. The Index of Item–Objective Congruence (IOC) was calculated for each item. Items with IOC values of 0.50 or above were considered acceptable according to the predefined criterion, whereas items that did not meet this criterion were revised in accordance with the experts' recommendations.

Following content validation, the revised test was piloted with students whose characteristics were similar to those of the study sample but who did not participate in the main study. Item analysis was then conducted to determine the difficulty index (p) and discrimination index (r) of each item. Items with difficulty indices ranging from 0.20 to 0.80 and discrimination indices of 0.20 or above were considered suitable for inclusion in the final test. Items that did not meet these criteria were revised or removed.

The internal consistency reliability of the achievement test was assessed using the Kuder–Richardson Formula 20 (KR-20), as the items were scored dichotomously as correct or incorrect. The final reliability coefficient was 0.86, indicating good internal consistency. The final 20-item test was subsequently administered to the study participants as a pretest before the intervention and as a posttest upon completion of the four-week instructional period.

The quality-evaluation form for content and media experts was developed through the following procedures.

1. Relevant documents, textbooks, information resources, and studies on learning-media evaluation were reviewed.
2. The evaluation framework was established and divided into content and media dimensions.

3. A five-point rating-scale quality-evaluation form was constructed for content and media experts.

4. The research advisor reviewed the instrument, which was then revised.

5. Six experts examined the congruence and appropriateness of the evaluation form. The index of item-objective congruence (IOC) was calculated, with values of .50 or higher considered acceptable.

6. Expert feedback was used to finalize the quality-evaluation form before implementation.

7. The form was pilot-tested, and reliability was assessed using Cronbach's alpha coefficient.

Data Collection

1. The researchers coordinated with the participating institution, explained the study objectives, and requested cooperation in data collection.

2. Participants received instructions regarding the procedures and use of the virtual classroom-based learning media.

3. Before the intervention, participants completed the Thai folk dance achievement pretest.

4. The sample then received instruction through the virtual classroom-based learning media.

5. After the intervention, participants completed the achievement posttest.

6. Participants completed the questionnaire assessing their satisfaction with the media.

7. Pretest, posttest, and satisfaction data were subjected to statistical analysis.

Data Analysis

The collected data were analysed using descriptive and inferential statistics to evaluate the efficiency of the developed virtual classroom-based learning media, changes in students' learning achievement, and student satisfaction.

1. Efficiency of the Developed Virtual Classroom-Based Learning Media

The efficiency of the developed virtual classroom–based learning media was assessed using the E1/E2 efficiency index, representing process efficiency (E1) and outcome efficiency (E2), respectively. The efficiency criterion was set at 80/80. E1 was calculated from students' performance during the learning process, whereas E2 was calculated from their learning achievement upon completion of the learning activities. The resulting E1/E2 values were compared with the predefined 80/80 criterion to determine whether the developed learning media met the expected level of efficiency. This approach is consistent with Brahmawong's (2013) framework for evaluating instructional media efficiency, which considers both students' performance throughout the learning process and their final learning outcomes.

2. Comparison of Pretest and Posttest Learning Achievement

Students' pretest and posttest achievement scores were analysed using a paired-samples *t*-test to determine whether learning achievement differed significantly before and after learning through the virtual classroom–based learning media. The significance level was set at .05.

3. Analysis of Student Satisfaction

Students' satisfaction with the virtual classroom–based learning media was analysed using means (M) and standard deviations (SD). The mean scores were interpreted according to the predefined criteria for the five-point satisfaction scale.

4. Analysis of Expert Evaluation Results

Experts' ratings of the quality of the developed virtual classroom–based learning media were analysed using means (M) and standard deviations (SD). The mean scores were interpreted according to the predefined criteria for the five-point rating scale.

Ethical Considerations

Although formal institutional review board (IRB) approval was not required for this study due to its minimal-risk educational/ creative nature, all procedures were performed in strict accordance with the ethical standards of the Declaration of Helsinki. Prior to data collection, all participants were fully informed about the purpose, procedures, and scope of the study. Written informed consent was obtained from each individual participant included in the study. All participation was voluntary, and the anonymity and confidentiality of the participants' personal data have been completely maintained throughout the research and publication process.

Results

1. The virtual classroom-based learning media presented content on Thai folk dance and included a microphone, broadcast control, camera toggle, seat control, reaction stickers, movement controls, settings, widescreen display, and other supplementary functions. Learners could select topics, revisit previous material, and pursue additional study according to their needs. Content was presented through multiple formats, including text, images, audio, and video.

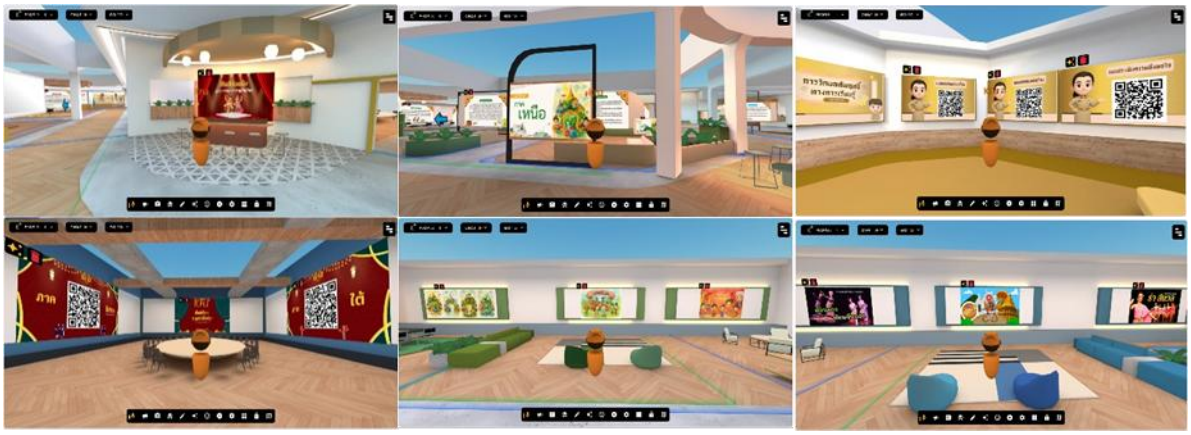


Figure 2 Virtual classroom-based learning media for Thai folk dance

Table 1 Efficiency of the virtual classroom-based learning media for Thai folk dance

Assessment	Maximum score	M	Percentage	Criterion	E_1/E_2
Formative scores	40	32.42	81.05	80	81.05
Posttest scores	20	18.05	90.25	80	90.25

As shown in Table 1, The efficacy assessment of the virtual classroom learning media for indigenous dance revealed that the students achieved a mean score of 32.42 (81.05%) during the learning process and a mean post-test score of 18.05 (90.25%). Consequently, the process and outcome efficiency ratios (E_1/E_2) of the instruction utilizing the virtual classroom reached 81.05/90.25, satisfying the established 80/80 efficiency threshold.

2. Comparison of achievement before and after learning through the virtual classroom-based learning media on Thai folk dance

Table 2 Comparison of pretest and posttest achievement scores

Assessment	Maximum score	M	S.D.	t	p (one-tailed)
Pretest	20	8.24	3.20	16.20	.001*
Posttest	20	18.05	1.47		

*p < .05

As shown in Table 2, The comparison of academic achievement before and after learning through virtual classroom learning media on traditional performing arts revealed that the pre-test mean score was M = 8.24, S.D = 3.20, whereas the post-test mean score was M = 18.05, S.D. = 1.47. The comparison between pre- and post-test scores demonstrated that learning achievement following the implementation of virtual classroom media was significantly higher than prior to the instruction at the .05 significance level (p < .05).

3. Students' satisfaction with the virtual classroom-based learning media on Thai folk dance

Table 3 Students' satisfaction with the virtual classroom-based learning media

Evaluation item	M	S.D.	Satisfaction level
Content dimension			
The lesson content was clearly explained and easy to understand.	4.34	0.53	High
The level of content difficulty was appropriate for the learners.	4.47	0.51	High
The media increased learners' knowledge and understanding of the content.	4.63	0.49	Highest
Sum	**4.48**	**0.52**	**High**
Media dimension			
Instructions for using the media were clear and easy to understand.	4.32	0.47	High
The media design was attractive, novel, and engaging.	4.53	0.51	Highest
The media supported self-directed study.	4.39	0.53	High
The media were contemporary.	4.76	0.43	Highest
The media enabled enjoyable learning.	4.53	0.56	Highest
The media were easy and convenient to use.	4.61	0.55	Highest
The media were appropriate for instructional use.	4.47	0.51	High
Sum	**4.52**	**0.64**	**Highest**
Overall Mean	**4.51**	**0.61**	**Highest**

As shown in Table 3, The indicates that overall satisfaction was at the highest level (M = 4.51, S.D. = 0.61). Satisfaction with the content dimension was high (M = 4.48, S.D. = 0.52), while satisfaction with the media dimension was at the highest level (M = 4.52, S.D. = 0.64). The highest-rated item was the modernity of the media (M = 4.76, S.D. = 0.43), followed by increased knowledge and understanding (M = 4.63, S.D. = 0.49).

Discussion

The development of virtual classroom learning media to enhance knowledge of regional Thai performing arts followed the ADDIE Model across five distinct phases: 1) Analysis, 2) Design, 3) Development, 4) Implementation, and 5) Evaluation. Efficiency analysis revealed that students achieved an average formative assessment score during learning of 32.42 (81.05%) and an average post-learning achievement score of 18.05 (90.25%). The resulting process/outcome efficiency index (E_1/E_2) of 81.05/90.25 successfully surpassed the benchmark criteria of 80/80. These findings align with Junwandee, Gumjadphai, and Kunpaibutr (2018), who developed learning activities integrating the ADDIE Model with Backward Design. Their results demonstrated an efficiency rating (E_1/E_2) of 81.58/78.60 against a 75/75 baseline, a statistically significant increase in post-test academic achievement ($p < .01$), and the highest level of student satisfaction. Similarly, Namyotha (2022) developed an ADDIE-based online instructional module for home economics (vegetable cultivation) for Grade 9 students at Phrayuen Wittayakharn School, comprising five key components: entry portal, orientation, core content, student showcase, and learning achievement assessment. The module achieved an E_1/E_2 efficiency of 84.76/83.68 (exceeding the 80/80 threshold), an effectiveness index (E.I.) of 71.77, significant post-test learning gains ($p < .01$), and high student satisfaction. Furthermore, the outcome accords with Rittibul et al. (2025), who investigated virtual classroom learning media focused on prominent figures in Thai dance, detailing their biographies and artistic achievements via the ADDIE framework. Their intervention achieved an efficiency ratio of 80.89/90.71, comfortably exceeding the established 80/80 criterion.

The comparison of academic achievement before and after learning with the virtual classroom media on the topic of Folk Dance, analyzed using the dependent samples t-test, revealed that the mean pre-test score was M = 8.24, S.D. = 3.20, while the mean post-test score was M = 18.05, S.D. = 1.47. The results demonstrated that the academic achievement of students taught via the virtual classroom media was significantly higher after instruction than before instruction at the .05 significance level ($p < .05$). This finding aligns with Changpetch (2022), who developed interactive virtual learning media using digital technology to enhance computational thinking skills in algorithms for Grade 8 students; the study reported a mean pre-test score of 13.68 (45.60%) and a significantly higher post-test score of 26.40 (88.00%), with t-test analysis confirming a statistically significant difference at the .05 level. Furthermore, these results are consistent with Niyomsutjarit and Srichailard (2024), who investigated the development of online instructional media combined with blended learning to enhance 21st-century professional teaching skills among undergraduate students, finding an efficiency score of 80.66/84.67 (exceeding the standard 80/80 criterion) and significantly higher post-test achievement at the .05 level. The current findings are also supported by Rittibul et al. (2025), whose study on The Development of Virtual Classroom Learning Media for Enhancing Learning Achievements on the Topic of Important People in Thai Dance similarly indicated a statistically significant increase in post-test achievement compared to pre-test scores at the .05 level.

The findings of the present study are consistent with those of Martin et al. (2021), who reported that synchronous online learning can yield positive cognitive learning outcomes under appropriate instructional conditions. Although the present study employed a virtual classroom learning environment rather than a synchronous online course, its findings similarly suggest that digital learning environments may support learning when their technological features are aligned with instructional objectives, learning activities, and learners' needs. Martin et al. (2021) also emphasised that the effects of online learning

vary according to pedagogical and contextual factors. This supports the view that the improvements observed in the present study should not be attributed solely to technology.

The satisfaction evaluation survey of students toward learning management using virtual classroom media on the topic of Folk Dance revealed that overall student satisfaction was at the highest level M = 4.51, S.D. = 0.61. Considering each specific aspect, satisfaction with the content aspect was at a high level M = 4.48, S.D. = 0.52, whereas satisfaction with the media aspect was at the highest level M = 4.52, S.D. = 0.64. The implementation of virtual classroom learning media fostered increased student engagement and enthusiasm in learning. These findings align with Saenphaeng (2019), who investigated student satisfaction with instructional technology among lower secondary school students in the Phu Phan Thong Network Center under the Sakon Nakhon Primary Educational Service Area Office 1. Their study indicated a statistically significant difference in satisfaction based on gender at the .05 level, whereas no significant difference was observed across grade levels. The results are also consistent with Kespanich et al. (2023), who examined satisfaction with virtual classrooms for computer hardware topics and found that learners expressed a good level of satisfaction with virtual classroom usability, yielding an average score of 3.85. Furthermore, the findings concur with Rittibul et al. (2025), who developed virtual classroom media to enhance learning achievements regarding key figures in Thai dance; their post-intervention evaluation demonstrated student satisfaction at the highest level M = 4.79, S.D. = 0.39.

Limitations of the Study

This study employed a one-group pretest–posttest design without a comparison group. Although this design allows changes in learning achievement to be examined before and after the intervention, it cannot rule out alternative explanations, such as maturation, testing effects, or other learning experiences during the intervention period. Causal inferences regarding the effects of the learning media should therefore be made with caution.

The sample comprised 38 students from a single class at one school. Consequently, the findings may not be generalisable to students in other schools or grade levels, or to those with different levels of experience in digital learning and Thai folk dance.

This study primarily assessed learning achievement and student satisfaction. Given the practical nature of Thai folk dance, achievement test scores cannot fully capture students' performance abilities, including movement accuracy, timing, coordination, expressive quality, and cultural interpretation. Future studies should therefore incorporate direct assessments of practical performance using validated assessment rubrics, video-based assessment, or peer and self-assessment.

Recommendations

Recommendations for Practice

1. Teachers should receive preparation in both pedagogical practices and the technological features of the virtual classroom system. This preparation should develop their understanding of activity implementation, content presentation, assignment allocation, monitoring of student learning, and basic troubleshooting of issues that may arise during use.

2. Students should receive an orientation before participating in the learning activities. This orientation should clarify the learning objectives, procedures for accessing the virtual classroom, methods of accessing learning materials and activities, and expectations for participation and assignment submission.

3. Schools should ensure adequate infrastructure, particularly access devices and internet connectivity appropriate to the number of students. The effectiveness of virtual classroom learning depends partly on technological readiness. Insufficient devices or unstable internet connections may disrupt access to learning materials and participation in learning activities.

4. Virtual classrooms should be used to support and supplement dance education rather than replace practical training. Learning dance requires physical practice, body control, rhythmic accuracy, mastery of dance movements, precision of execution, and emotional expression. Learning activities should therefore enable students to acquire knowledge and review dance movements through the virtual classroom while engaging in practical training under teacher guidance. This approach can strengthen the connection between learning through digital media and the development of practical dance skills.

5. A teacher toolkit and implementation guidelines should be developed to facilitate adoption of the instructional model by other teachers. These resources may include an instructional guide, activity plans, a system user manual, guidelines for preparing learning materials and activities, assessment criteria, technical troubleshooting guidance, and sample activities adaptable to students with varying prior knowledge and levels of technological readiness.

Recommendations for Future Research

1. Future studies should employ a quasi-experimental design with intervention and comparison groups, or a research design that provides greater control over potential confounding variables. Such designs would help address the limitations of the one-group pretest–posttest design and support more credible interpretations of the effects of the instructional intervention.

2. Learning retention should be examined by administering a delayed posttest at a specified interval in addition to the immediate posttest. This would allow researchers to assess the extent to which students retain and apply their dance-related knowledge over time.

3. Future research should incorporate assessments of practical dance skills, as learning achievement alone may not comprehensively reflect students' ability to perform dance movements. These assessments should examine performance components such as movement accuracy, rhythm and movement execution, bodily coordination, and the ability to express and apply dance knowledge through performance.

4. A range of assessment tools appropriate to the practical nature of dance education should be developed. These may include performance rubrics for systematic assessment, video recordings as evidence of performance, and peer and self-assessment. These approaches would provide opportunities for students to reflect on their learning and continuously develop their skills.

5. The intervention should be implemented across a broader range of schools and student groups with varying institutional contexts, group sizes, prior dance experience, and levels of technological readiness. This would enable researchers to examine the applicability of the instructional model across different contexts and the consistency of findings across diverse learner groups, thereby strengthening the generalisability of the findings and supporting wider adoption of the model.

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