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The Development of Metaverse on Thai Herbs Using the ADDIE Model

Mayuree Phitthayasenee[1*], Paramin Wongkhamsing [1], Pongporn Punpeng [2] and Chamaiporn Karnjanapan[3]

[1]Computer Program, Faculty of Education, Lampang Rajabhat University, Muang, Lampang 52100, Thailand
[2]Information Technology Program, Faculty of Science, Lampang Rajabhat University, Muang, Lampang 52100, Thailand
[3]Business Computer Program, Faculty of Management Science, Lampang Rajabhat University, Muang, Lampang 52100, Thailand
*Corresponding author, e-mail: mayureejantapan@gmail.com
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Abstract

Local wisdom embodies knowledge, skills and practices passed down through generations to address challenges in the lives of people in local communities. In Thailand, the preservation of local wisdom serves as cultural social capital but faces the risk of decline because of an ageing population. This research develops the metaverse of Thai herbs using the analysis, design, development, implementation and evaluation (ADDIE) model in Mae Tha District, Lampang Province, Thailand, imparting herbal knowledge to future generations. This research follows five phases-learner analysis, design, development, implementation and evaluation-employing a mixed-methods approach. The qualitative study involved document analysis to identify community needs related to Thai herbs, which informed the development of the metaverse incorporating static images, three-dimensional (3D) images using augmented reality (AR) technology, and videos. The targeted learners accessed the metaverse through an avatar. A quantitative study examined how the ADDIE-based metaverse enhanced students' learning processes. The target group comprised 30 junior high school students from Thippala Vithayanu Sorn School. Research instruments consisted of structured interview forms, learning record forms, the metaverse quality assessments and pre and post-learning achievement tests. Statistical analyses applied percentages, means and standard deviations (SDs). The findings revealed that experts rated the metaverse quality at 4.54, indicating a very high standard. Post-learning achievement scores (mean = 13.37, 66.83%) significantly exceeded pre-learning scores (mean = 6.93, 34.67%), marking a 32.16% improvement (SD = 0.94). These results demonstrate that the ADDIE-based metaverse effectively supports the preservation of local wisdom for future generations. The metaverse proved to be an effective tool to enhance students' learning and preserve herbal wisdom.

Keywords: Metaverse, Thai herbs, ADDIE model, Local wisdom

Introduction

The objective of this article is to study the local wisdom encompassing knowledge that develops skills and practices passed down through generations to address issues within communities effectively (Teryola *et al.*, 2024). The promotion of local wisdom is deemed a cultural social capital derived from the elders, which faces the risk of vanishing. In Lampang Province, 198,510 elderly individuals-approximately 28.01% of the total population - highlight the region's aging demographic (Department of older persons (DOP), 2024). Interviews with Mr. Somboon Pochaiah regarding elderly residents revealed a lack of knowledge transfer about Thai herbal wisdom to younger generations, resulting in this traditional wisdom being at risk of disappearing along with the aging population. This is consistent with research on the Huasua

Sub-district contains various herbal recipes, suggesting a need for broader research across multiple districts to preserve and integrate essential herbs into daily life (Buppunhasamai, 2023).

The use of Thai herbs for healing is a long-standing communal wisdom comprising practical self-care methods (Jariksakulchai *et al.,* 2022). Thai herbs include various plant components traditionally used to alleviate ailments. Their application relies on five initial factors: shape, color, scent, taste and name. These aspects help ensure accurate usage, enhancing the effectiveness of Thai herbal medicine, which can be comparable to modern pharmaceuticals. Proper use requires selecting the correct herb for the specific ailment, ensuring the right species, the accurate dosage, the appropriate method of use and the correct parts of the plant (Department for Development of Thai Traditional and Alternative Medicine, 2016). However, online platforms engage students in herbal medicine and community botany, supporting teachers in introducing the scientific aspects of herbal medicine (Straus & Chudler, 2016). This is consistent with the Metaverse, which is a fully immersive online learning environment where learners can interact through avatars to demonstrate the potential for collaborative and participatory learning among students (Darda *et al.*, 2024)

Metaverse allows users to engage in various activities, including learning, working and interactive communication, which enhances engagement and the learning experience, representing a new, innovative strategy in education (Vanegas & Moreno, 2024). Furthermore, AR virtual environments have extended from primary to higher education, fostering learning in languages, sciences and mathematics, significantly enhancing student engagement and understanding through mixed reality (Bakim & Hanid, 2024). The Metaverse is therefore suitable for compiling Thai herbal knowledge, allowing future generations to access engaging, multi-modal learning experiences (e.g., AR 3D imagery and videos). These interactive resources support meaningful education, fostering lifelong learning and engagement among secondary education students. This study focuses on a target group of 30 junior high school students from Thippala Vithayanu Sorn School in Huasua Sub-district, Mae Tha District, Lampang Province, Thailand.

Digital learning resources for students emphasise the importance of digital media in improving learning processes. Also, digital learning enhances computer literacy skills, encouraging responsible work management, which is critical in modern learning environments (Khairova & Gabdullina, 2020). Research indicates that presenting digital learning materials in 3D and AR formats helps clarify complex concepts, reduces learning time and improves student comprehension (Sathyapriya *et al*., 2024). The metaverse environment can enhance the educational process by facilitating interactive engagement, allowing students to access continuous multimedia content that enriches personal learning experiences and student participation, fostering a deeper understanding.

Developing the metaverse for learning and preserving local herbal wisdom necessitates the ADDIE model developed by Gustafson & Branch (2002), a five-step framework for instructional material development consisting of learner analysis, design, development, implementation and evaluation (Mutmainnah *et al.*, 2024). Each step must comprehensively identify challenges and community needs related to Thai herbs, guiding the creation of the metaverse enriched with static images, AR 3D imagery and videos. These resources enhance the learning process for targeted learners, providing a realistic study of herbal knowledge. This is consistent with Latip (2022) studied the application of the ADDIE model in developing multimedia learning based on scientific knowledge, consisting of 5 steps: (1) Analysis: comprising problem analysis, content analysis, curriculum analysis, and multimedia objectives analysis; (2) Design: comprising the creation of flowcharts and storyboards; (3) Development: the stage of creating multimedia and validating accuracy by expert teams and teachers; (4) Implementation: the stage of limited trial use in

science classrooms; and (5) Evaluation: the stage of receiving feedback about the multimedia from experts, teachers, and students. The research findings showed that the application of the ADDIE model can effectively lead to the development of science learning multimedia. Moreover, the virtual world integrating digital technologies, often called the Metaverse, denotes an environment where people can interact while performing learning tasks.

Based on the importance mentioned above, the researcher is interested in studying the development of the metaverse for Thai herbs using the ADDIE Model. The model follows five steps: analysis, design, development, implementation and evaluation. The analysis phase identifies needs and gathers knowledge about Thai herbs to inform the development of the metaverse. The design phase involves planning instructional materials and structuring learning activities, whereas the development phase entails creating tangible learning materials. In the implementation phase, small-group trials with students collect feedback on functionality and effectiveness before broader application. Finally, the evaluation phase assesses the learning material's effectiveness based on student and instructor feedback. Following the ADDIE model ensures the creation of comprehensive and practical mobile learning applications tailored to learners' specific needs (Mutmainnah *et al.*, 2024).

Objectives

1. To develop the metaverse of Thai herbs using the ADDIE Model.
2. To compare learning achievement scores before and after organizing learning activities using metaverse of Thai herbs through the ADDIE Model.

Research Methodology

Research Design: The research design employed in this study was a one-group pretest-posttest design, as described by using Srisaard 's 2010**.**

Population and Sample: The target group comprises 30 junior high school students from Thippala Vithayanu Sorn School. The study employed non-probability sampling, known as purposive selection in quantitative research was used to select the target group by purposive sampling. This is because this school is only in the research area, the only secondary school in Wang Ngern sub-district, Hua Sue sub-district and Don Fai sub-district, Lampang, Thailand.

Scope of content: Learning content on at least 20 essential Thai herbs and 11 methods of herbal preparation, showcasing various traditional remedies.

Research instrument: Regarding the research instruments, prior to primary data collection, the researcher validated their quality through evaluation by five educational technology experts to assess the validity of all tools. These instruments consisted of structured interview forms, learning record forms, the metaverse quality assessment form and academic achievement tests.

Data Collection: This research employed a mixed-methods approach, integrating qualitative research through interviews with local wisdom holders to analyze problems and needs related to the properties and formulas of Thai herbs. The collected data was then used to conduct focus group discussions to identify genuine needs for learning design in developing metaverse about Thai herbs. The quantitative research evaluated the metaverses' quality and assessed its effectiveness in enhancing students' learning through the ADDIE model. The research and development were conducted following the ADDIE framework (Mutmainnah *et al.*, 2024; Phitthayasenee, 2015). The research methodology consisted of five phases:

(1) Analysis, (2) Design, (3) Development, (4) Implementation and (5) Evaluation. All details of the ADDIE framework are depicted in Figure 1.

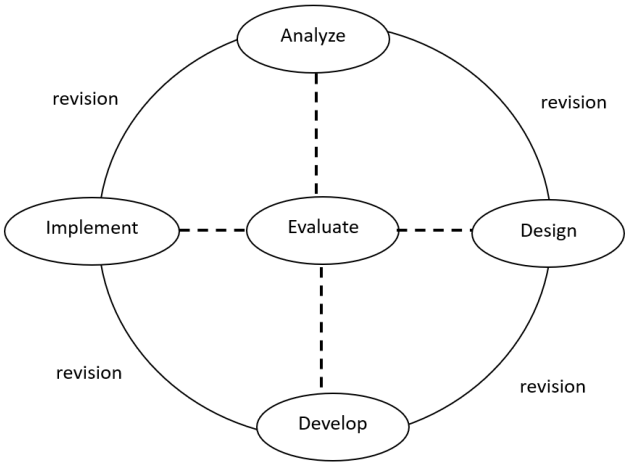


Figure 1 The research methodology using the ADDIE Model.
(Gustafson & Branch, 2002)

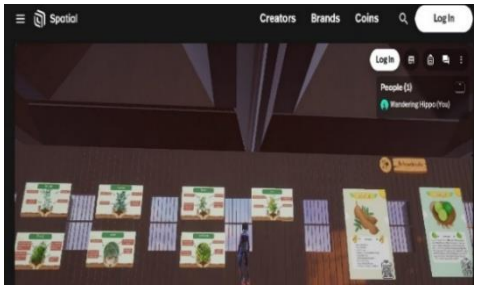
Data Analysis: Statistical analyses applied percentages, means and standard deviations (SDs).

In the analysis phase, this involves interviewing about problems and needs regarding the use of Thai herbs, including the properties of local Thai herbs and methods for preparing Thai herbal medicine formulations. After that, the data obtained from the interviews was brought to a focus group discussion to identify the actual needs, which consist of static images, 3D images using AR technology of Thai herbs in areas where Thai medicinal plants grow, as well as important properties of no fewer than 20 types of Thai herbs, and video clips of Thai herbal medicine preparation for 11 formulations, including: Phrai oil, herbal compress balls, Phet Matum tea, urinary system tonic, Thai herbal shampoo, Si Ton remedy, Wan Nga Chang cream, Maha Chakra oil, herbal inhaler, mouthwash, and herbal balm. The research instruments used are structured interview forms and learning record forms.

In the design phase, involves taking the data obtained from the analysis phase to design the components of the metaverse for Thai herbs using behaviorism and cognitivism learning theories. This includes the front-end of the metaverse, which consists of learning objectives, lesson usage instructions, control buttons, and additional learning resources such as YouTube. The back end of the metaverse includes lesson content in the form of static images, 3D images using AR technology, video clips of Thai herbal medicine preparation, and assessments. Storyboard illustrations structured the arrangement of visually appropriate materials across various screens, including slide sequences, backgrounds, graphics, sound, video and navigational links. The study provided examples of screen layouts depicting the exterior and interior sections of a house, featuring still images of Thai herbs, 3D images using AR technology and videos.

In the development phase, a graphic user interface was created to log in to the metaverse, using the Spatial programme according to the design specifications. The log-in page is presented in Figure 2.

Figure 2 A graphic user interface was created to log in to the metaverse.



(A) Static image

(B) 3D image using AR technology

(C) Video clip

Figure 3 Personalised metaverse of Thai medicinal herbs.

After creating the metaverse for Thai herbs, a quality assessment of the metaverse was conducted by 5 experts. The expert assessment revealed an outstanding mean quality score of 4.54. Moreover, the pre-test and post-test were validated by content and evaluation experts. The analysis of the Index of Item-Objective Congruence (IOC) for each item yielded values greater than 0.67, which is considered acceptable according to research standards. Subsequently, efficiency testing of the Thai herb metaverse was conducted through 3 trials to meet the 80/80 criterion, namely: one-on-one group, small group, and field group, with revisions made according to expert recommendations using Brahmawong's 2013 formula (see Table 1, Table 2 and Table 3). The first pilot test was a one-on-one group administered to three junior high school students. The second pilot test was a small group administered to nine junior high school students. The third pilot test was a field group assessment administered to 21 junior high school students.

The research instruments used include a quality assessment form for the Thai herb metaverse and an efficiency test.

In the implementation stage, the study applied the developed metaverse of Thai herbs in learning activities with the 30 target students. The process follows three steps; conducting pre-learning tests, enabling students to access the metaverse using computer devices with at least 16 GB of random-access memory (RAM) and a central processing unit (CPU) comparable to an Intel Core i7 processor or a compatible mobile phone. The last step is administering post-learning assessments.

(A) The students are about to study the metaverse (B) Students view still images in the metaverse

Figure 4 Learning activities using the metaverse of Thai herbs

In the evaluation phase, the study compared students' learning achievements before and after the learning activities to evaluate the objectives met. The study also administered the pre- and post-learning achievement tests to measure learning outcomes.

Analysis Phase: exploring issues and needs related to Thai herbs using interviews and focus group discussions.

⇩

Design phase: developing lesson components and storyboards.

⇩

Development phase: creating the metaverse using the Spatial programme according to the design specifications.

⇩

Quality assessment: five experts evaluated the metaverse's effectiveness and functionality.

⇩

Pilot study: trying out the developed metaverse.

⇩

Implementation phase: applying the developed metaverse of Thai herbs in learning activities with the 30 target students.

⇩

Evaluation phase, comparing students' learning achievements before and after the learning activities to evaluate the objectives met.

Figure 5 A workflow of the methodology for the development of the metaverse.

Results

1. Developed the metaverse of Thai herbs: The study developed a metaverse of Thai herbs using the ADDIE model, focusing on Wang Seua Fai Sub-district, Mae Tha District, Lampang Province, Thailand. The research findings are divided into 2 issues: (1) results of quality assessment of the Thai herb metaverse using the ADDIE model, and (2) results of efficiency testing of the Thai herb metaverse using the ADDIE model. Five experts evaluated and assessed the metaverse's quality. All details were shown as the following: The quality assessment yielded an average score of 4.54, indicating a very high rating. The SD (0.94). The highest average score (4.80) for accurate content references is provided. Expert feedback suggested creating user manuals and translating the menu into Thai for broader accessibility. Furthermore, the three efficient tests were conducted after the completion of the development phase. The research findings indicated that the effectiveness of the metaverse of Thai herbs using the ADDIE for a one-on-one group (3 students) are shown in Table 1.

Table 1 The effectiveness assessment of the metaverse of Thai herbs using the ADDIE Model (one-on-one group) according to the 80/80 efficiency criterion.

N	During Learning			After Learning			Effectiveness Value
	A	$\sum x$	E_1	B	$\sum y$	E_2	E_1/E_2
3	20	49	81.67	20	50	83.33	81.67/83.33

From Table 1, it was found that when 3 junior high students underwent the teaching and learning process with the metaverse of Thai herbs using the ADDIE Model. They scored correctly on the during-learning test at 81.67% and on the post-learning assessment at 83.33%. This indicates that the metaverse of Thai herbs using the ADDIE Model has an effectiveness of 81.67/83.33, which met the established criteria of 80/80. Moreover, the effectiveness assessment of the metaverse of Thai herbs using the ADDIE Model for the field group of 9 students is shown in Table 2.

Table 2 The effectiveness assessment of the metaverse of Thai herbs using the ADDIE Model (small group) according to the 80/80 efficiency criterion.

N	During Learning			After Learning			Effectiveness Value
	A	$\sum x$	E_1	B	$\sum y$	E_2	E_1/E_2
9	20	149	82.78	20	152	84.44	82.78/84.44

From Table 2, it was found that when 9 junior high students underwent the teaching and learning process with the metaverse of Thai herbs using the ADDIE Model. They scored correctly on the during-learning test at 82.78% and on the post-learning assessment at 84.44%. This indicates that the metaverse of Thai herbs using the ADDIE Model has an effectiveness of 82.78/84.44, which met the established criteria of 80/80. Besides, the effectiveness assessment of the metaverse of Thai herbs using the ADDIE Model for the field group of 21 students is shown in Table 3.

Table 3 The effectiveness assessment of the metaverse of Thai herbs using the ADDIE Model (field group of 21 people) according to the 80/80 efficiency criterion.

N	During Learning			After Learning			Effectiveness Value
	A	$\sum x$	E_1	B	$\sum y$	E_2	E_1/E_2
21	20	356	84.76	20	358	85.24	84.76/85.24

From Table 3, it was found that when 21 junior high school students underwent the teaching and learning process with the metaverse of Thai herbs using the ADDIE Model scored correctly on the during-learning test at 84.76% and on the post-learning assessment at 85.24%. The metaverse of Thai herbs had an effectiveness of 84.76/85.24, which met the established criteria of 80/80.

2. Results of comparing learning achievement scores before and after organizing learning activities using metaverse of Thai herbs: The learning achievement comparison, represented in Table 4, highlights the effect of the metaverse. Pre-test and post-test revealed significant score differences, demonstrating improvements in student learning.

Table 4 Pre-test, post-test and difference scores of learning achievement among the target group (30)

	Pre-test	Post-test	Difference
Total	208	401	194
%	34.67	66.83	32.16
mean	6.93	13.37	6.47
SD	1.36	1.52	0.94

As shown in Table 4, the target group that learned using the metaverse of Thai herbs achieved a pre-learning average score of 6.93 (34.67%) and a post-learning average score of 13.37 (66.83%) out of a total score of 20 points, reflecting a 32.16% increase (*SD* = 0.94). The histogram indicates the SD for score differences before and after testing measured at 0.94. All details of pre-test, post-test and difference scores of learning achievement among the target group (30) are depicted using bar graph in the Figure 6.

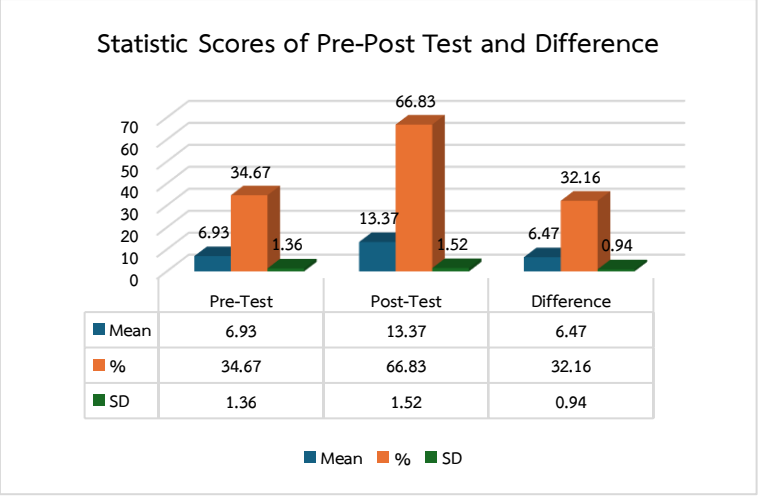


Figure 6 Statistical results before and after the learning activity undertaken by the target group.

As shown in Figure 6, based on the above bar graph, the SD for the difference in overall pre- and post-test scores measured 0.94 (less than 1). This is shown that the distribution of the answers selected by the target group was not varied and the total scores were not affected. Importantly, the target group have similar Thai herbs background knowledge. This can cause the scores received not to be variously distributed.

Discussion

This study developed the metaverse of Thai herbs using the ADDIE model, focusing on a case study in Wang Seua Fai Sub-district, Mae Tha District, Lampang Province, Thailand. The metaverse received a quality assessment mean score of 4.54, indicating a very high standard (*SD* = 0.94). This was because the study successfully implemented all five phases of the ADDIE model (Mutmainnah *et al*., 2024) and the researchers designed the components of the Thai herb metaverse using behaviorism and cognitivism learning theories with Chaicharoen (2008) by applying them to create components of the Thai herb metaverse including learning objectives, lesson usage instructions, control buttons, additional learning resources for lesson content in static image format, 3D images using AR technology, video clips of Thai herb preparation and tests.

The results of the efficiency testing of the Thai herb metaverse conducted 3 times - one on one group, small group and field group - found that the efficiency was 81.67/83.33, 82.78/84.44 and 84.76/85.24 respectively, which met the established criterion of 80/80. This was because the Thai herb metaverse was quality-checked by 5 experts with an average score at a high level and had a comprehensive design of the Thai herb metaverse components according to learning theory. This was also consistent with Dudley *et al.* (2023) mentioned that the metaverse is an instructional medium that promotes diverse user needs, can always increase accessibility and has the potential to create enjoyment for users. This metaverse evolved in response to community issues and needs, ensuring relevance and effectiveness.

Results of comparing learning achievement scores before and after organizing learning activities using metaverse of Thai herbs through the ADDIE Model: It was found that students had an average pre-learning score of 6.93 (34.67%), while the average post-learning score increased to 13.37 (66.83%), showing that students had post-learning scores higher than pre-learning scores by 32.16% (SD = 0.94). This is consistent with Darda *et al*. (2024) found that Metaverse, which is a fully immersive online learning environment where learners can interact through avatars to demonstrate the potential for collaborative and participatory learning among students. Furthermore, from observation, students showed special interest in exploring and gaining knowledge from the metaverse of Thai herbs, which has characteristics like playing games. This is because the researcher developed metaverse of Thai herbs using the ADDIE Model, which is an appropriate framework for developing instructional media, consistent with Latip (2022) studied the implementation of the ADDIE model in the development of science literacy-based learning multimedia. The researcher conducted 5 steps as follows: (1) Analysis: comprising problem analysis, content analysis, curriculum analysis and multimedia objectives analysis; (2) Design: comprising the creation of flowcharts and storyboards; (3) Development: the stage of creating multimedia and validating accuracy by expert teams and teachers; (4) Implementation: the stage of limited trial use in science classrooms; and (5) Evaluation: the stage of receiving feedback about the multimedia from experts, teachers and students. Moreover, metaverse effectively enhance the learning process by incorporating static images, AR 3D visuals and videos, creating engaging and interactive learning experiences through user avatars (Wang, 2023).

However, the use of the metaverse of Thai herbs still has limitations regarding equipment for accessing metaverse. Teachers must prepare equipment that can support 3D images, AR technology and video clips, such as computers, mobile phones, tablets and internet connectivity.

Conclusion and Suggestion

The study successfully achieved its objectives, confirming that the metaverse maintains a high standard of quality and that post-learning scores significantly exceeded pre-learning scores. Critical elements, including static images, 3D visuals and video demonstrations, allowed students to explore content through avatars, significantly enhancing the learning experience. Moreover, learning through metaverse helps promote participation in online learning with peers, creates motivation for learning and allows students to return and review the learning content as well. Furthermore, it enhances equitable access to knowledge for students and interested individuals through self-directed learning at any time, without requiring direct interaction with actual Thai herbal environments. This is because the metaverse closely simulates real herbal learning contexts through static images, 3D AR visuals and video clips to effectively motivate the target group. This will solve the problem when learners want to study actual Thai herbs during the summer season when herbal plants are not growing. Beyond benefiting local students, the metaverse enables them to share herbal knowledge with peers and family members, reinforcing practical applications of traditional herbal wisdom in daily life. This sharing and application ensure the sustainable transmission of valuable knowledge across generations.

It is recommended for this research that instructors should prepare equipment for accessing online resources, including having a stable internet connection. Moreover, clear learning objectives should be studied, along with a layout of the learning resources to enable students to utilize the resources effectively. Besides, studying content related to Thai herbs, including information on their properties, benefits and methods of use is required. However, future research trends support teachers in creating and using AR and Metaverse in organizing learning activities to develop learners' learning processes, while also enhancing the communication of national culture through Metaverse.

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