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 ABSTRACT

This quasi-experimental study aimed to develop and examine the effectiveness of microlearning media (MLM) on the topic “Using Basic Chemical Instruments in Agriculture” for first-year undergraduate students in the Department of Agricultural Education, School of Industrial Education and Technology, King Mongkut's Institute of Technology Ladkrabang, during the first semester of the 2025 academic year. The sample consisted of 50 students selected through purposive sampling and taught using the one-group pretest–posttest research design. The research instruments included the developed MLM, a media quality evaluation form, a media efficiency evaluation form (E1/E2), and pretest–posttest achievement tests. The overall quality of the MLM was rated at a very good level ($\bar{x} = 4.60$, $SD = 0.39$), with the content quality receiving a very good rating ($\bar{x} = 4.76$, $SD = 0.43$) and the technical quality also rated at a very good level ($\bar{x} = 4.44$, $SD = 0.31$). The media efficiency score was 96.80/84.40, surpassing the standard criterion of 80/80. The comparison of learning achievement before and after using the MLM revealed that the posttest mean score ($\bar{x} = 16.88$, $SD = 2.92$) was significantly higher than the pretest mean score ($\bar{x} = 6.90$, $SD = 1.38$) at the .05 level of significance ($t = 25.24$, $p < .001$). These findings indicate that the developed microlearning media met quality and efficiency standards and effectively enhanced students' understanding and practical knowledge regarding the use of basic chemical instruments in agricultural contexts, demonstrating its potential as a suitable instructional tool for improving learning outcomes in agricultural education.

Keywords: Microlearning media, Basic chemical instruments in agriculture, Learning achievement, Instructional design

I. INTRODUCTION

In the 21st century, technological advancements have profoundly transformed society, the economy, and the education sector. Contemporary educational paradigms emphasize the integration of digital technologies to enhance accessibility, equity, and responsiveness to the diverse needs of learners. The 20-Year National Strategy (2018–2037) and the National Education Plan (2017–2036) recognize digital platforms as a fundamental infrastructure for fostering lifelong learning (Office of the National Economic and Social Development Council, 2018, Online). Additionally, the COVID-19 pandemic further highlighted the critical role of flexible and effective digital learning systems in ensuring educational continuity and quality.

Microlearning represents a pedagogical innovation that addresses the evolving needs of modern learners by presenting information in short, focused segments aimed at promoting rapid comprehension of specific topics (Asha, 2016, Online). This approach aligns with contemporary learning behaviors characterized by reduced attention spans and increased reliance on mobile technologies (Insa-ard, 2021, pp. 45-59) such as smartphones and tablets (Boonmapan et al., 2021, pp. 65-78). Empirical evidence suggests that microlearning not only enhances learner motivation and supports self-directed learning but also integrates seamlessly with social media environments, thereby fostering sustained engagement and continuous learning (Thanomchayathawat et al., 2016, pp. 208–222). Nonetheless, while its flexibility and accessibility offer clear advantages, effective implementation requires thoughtful design to ensure depth of understanding and long-term knowledge retention.

In higher education, particularly in laboratory-based disciplines such as agricultural education, traditional lectures alone are insufficient to develop students' practical understanding. Learners often come from diverse academic backgrounds, and those without a strong foundation in science frequently exhibit limited proficiency in using scientific instruments, leading to operational errors and diminished learning performance (Saikampha, 2021, p. 47). Consequently, the development of microlearning media focused on basic agricultural chemical instruments is essential for enhancing conceptual understanding, improving practical skills, and minimizing procedural errors during laboratory activities.

Therefore, this research aimed to: 1) develop microlearning media on the use of basic chemical instruments in agriculture for undergraduate students; and 2) compare the pre-test and post-test learning achievements of students in the Department of Agricultural Education, School of Industrial Education and Technology, King Mongkut's Institute of Technology Ladkrabang. Moreover, it intended to address the challenges arising from learners' diverse academic backgrounds and to enhance the effectiveness of practical learning. It was anticipated that the developed media will enable students to acquire accurate knowledge and understanding, minimize errors in the use of scientific instruments, and ultimately improve the quality of graduates by equipping them with the knowledge, skills, and competencies that align with societal needs and professional standards.



II. LITERATURE REVIEW

Technological transformations and evolving learning approaches in the 21st century have rendered traditional education management methods insufficient on their own. In particular, The COVID-19 pandemic has accelerated the adoption of online learning and digital media, which has gained widespread popularity for its ability to effectively address the needs of contemporary learners (Office of the National Economic and Social Development Council, 2018, Online). One learning model that has attracted considerable attention is microlearning, which delivers short, concise, and focused lessons that can be completed within minutes. Empirical studies have demonstrated that microlearning can enhance both academic achievement and self-directed learning skills. For example, Mohammed et al. (2018, pp. 32-38) found that learners engaged in microlearning achieved average outcomes 18 percent higher than those taught via traditional methods. Similarly, Kongsomboon (2019, pp. 51-62) developed microlearning media for vocational students, reporting an efficiency rate exceeding the 90/90 criterion, with students demonstrating significantly higher post-test scores compared to pre-test scores. Consistently, Detphong (2020, pp. 274-282) developed microlearning media on genetics for high school students, and observed that learners not only surpassed standard benchmarks, but also developed positive attitudes toward learning through this approach. Similarly, Jainuri et al. (2025, pp. 630–642) investigated Microlearning effectiveness in higher education: A systematic review and meta-analysis of student retention and learning outcomes. Based on 42 related studies conducted between the years 2020 and 2025, involving 15,673 participants across 18 countries, the findings revealed that microlearning had a significantly positive impact on learning outcomes, particularly regarding knowledge retention. The study reported an effect size as high as 0.74, especially in STEM fields (Science, Technology, Engineering, and Mathematics) when integrated with mobile technologies. Consequently, this research supports the implementation of microlearning as an effective instructional strategy.

An important hypothesis derived from the review of related literature is that instruction utilizing microlearning media has the potential to enhance students' academic achievement and foster essential 21st-century learning skills, including analytical thinking, problem-solving, and self-directed learning. Both domestic and international studies have consistently shown that learners who engage with microlearning media demonstrate statistically significant improvements in post-test scores compared to pre-test scores. In addition, learners have exhibited positive attitudes toward such media, suggesting that learning materials designed to be concise, easily comprehensible, and accessible anytime and anywhere can increase motivation and engagement. Accordingly, within the context of teaching agricultural chemistry courses involving the use of basic scientific instruments, this study hypothesizes that the development of microlearning media on basic agricultural chemical instruments will enable students to achieve higher learning outcomes after instruction than before, while the developed media will meet the established quality and efficiency criteria of 80/80.



III. RESEARCH METHODOLOGY

This study employed a quasi-experimental research design, specifically the one-group pretest–posttest design, to evaluate the effectiveness of the developed microlearning media on the learning achievement of undergraduate students. This design was considered appropriate for authentic educational settings where random assignment of participants is not entirely feasible, while still enabling the researcher to accurately measure changes in learners' performance before and after exposure to the instructional media.

3.1 Conceptual Framework

The conceptual framework of this study centered on the development of microlearning media for the use of basic agricultural chemical instruments among undergraduate students. The independent variable was the microlearning media, which was developed following the ADDIE Model, comprising five phases: (1) Analysis, (2) Design, (3) Development, (4) Implementation, and (5) Evaluation. The dependent variables included: (1) the quality of the media, assessed in terms of content and technical aspects; (2) the efficiency of the media, measured against the 80/80 (E1/E2) standard criterion; and (3) students' learning.

3.2 Population and Sample

The population for this study consisted of first-year undergraduate students in the Department of Agricultural Education, School of Industrial Education and Technology, King Mongkut's Institute of Technology Ladkrabang. A simple random sampling method was employed to select a sample of 50 first-year students from the same department, enrolled in the first semester of the 2025 academic year. This group served as the experimental cohort for examining students' learning achievement before and after instruction using the developed microlearning media.

3.3 Research Instruments

The research instruments used in this study were categorized into four types as follows:

3.3.1 Microlearning media on the use of basic agricultural chemical instruments for undergraduate students.

3.3.2 Evaluation form for media quality, completed by experts, assessing both content and technical aspects of the microlearning media.

3.3.3 Efficiency evaluation form (E1/E2) to determine the effectiveness of the microlearning media on the use of basic agricultural chemical instruments for undergraduate students.

3.3.4 4. Achievement test designed to measure students' learning outcomes before and after instruction.

3.4 Development of Microlearning Media on Basic Agricultural Chemical Tools of Undergraduate Students

In the development of the microlearning media, the researcher utilized the ADDIE Model as the guiding framework, as illustrated in Figure 1. The ADDIE Model is a widely recognized approach for designing and developing instructional media, comprising five key phases as follows:



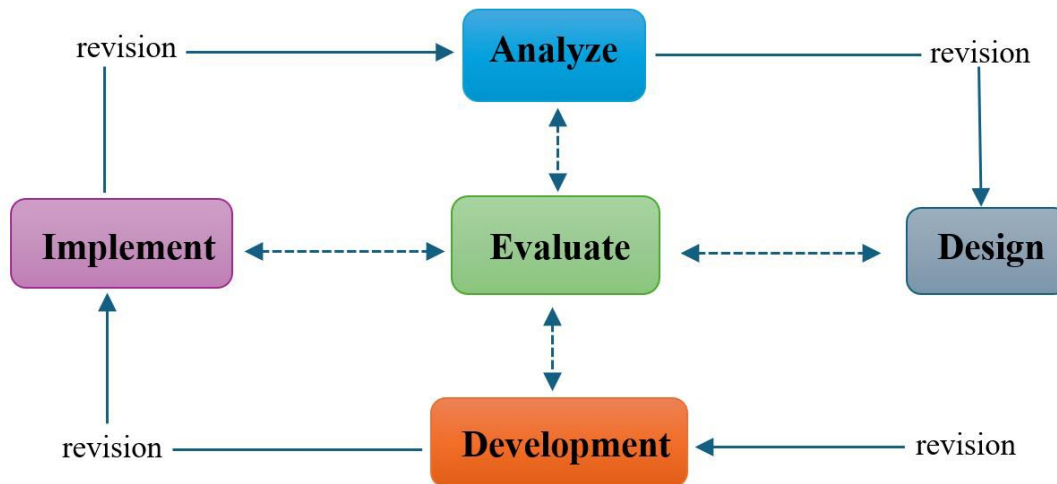


Figure 1: Structure of the ADDIE model

Source: Thienthong (2005, p. 131)

Step 1: Analysis : In this phase, the researcher conducted an analysis of the curriculum and course content for Agricultural Chemistry. The analysis comprised three main components:

1.1 Content Analysis – The structure and scope of the lesson content were examined to identify key concepts and topics appropriate for the development of microlearning materials.

1.2 Learner Analysis – The characteristics of the sample group were analyzed, including their prior knowledge, learning needs, and technological readiness.

1.3 Technology Analysis – The technologies to be employed in the lessons were evaluated, focusing on tools for presenting instructional content, designing learning activities, creating assessments, and collecting learner data.

Step 2: Design : In this phase, the researcher designed the structure of the lessons and learning units for the microlearning media. The design process included the development of a content presentation plan, multimedia elements such as animations and graphics, and alongside the practical worksheets. Additionally, pre-test and post-test assessments, along with practical worksheets, were designed to evaluate students' skills after learning and overall learning outcomes

Step 3: Development : During the development phase, the researcher created the digital microlearning media by integrating text, images, audio, and video to support learners' understanding of the proper use of laboratory instruments. Worksheets and achievement tests were also developed as part of the learning package. The completed media were subsequently reviewed by the research advisor and subject-matter experts to ensure content accuracy and technical appropriateness. Revisions were made based on their feedback and recommendations.

Step 4: Implementation : In this phase, the researcher implemented the developed microlearning media to examine its completeness, clarity, and overall appropriateness prior to making necessary revisions and improvements. Subsequently, the finalized media were administered to a sample group of 50 first-year undergraduate students to evaluate its efficiency based on the 80/80 (E1/E2) standard criteria.

Step 5: Evaluation : In the final phase, the researcher evaluated both the efficiency and quality of the microlearning media by analyzing students' learning achievement before and after the intervention. Additionally, expert evaluations of content and technical quality were reviewed. The findings from these assessments were subsequently used to refine and enhance the instructional media to achieve greater effectiveness.

3.5 Data Collection

The researcher conducted the experiment in accordance with the specified research design using the microlearning media titled "Using Basic Chemical Instruments in Agriculture" which had been reviewed and validated by experts. The experiment was implemented with a sample group of 50 first-year undergraduate students. The data collection process involved the following steps:

3.5.1 The researcher explained the objectives, experimental procedures, and usage of the microlearning media to ensure that participants clearly understood the process.

3.5.2 The participants completed a pre-test to assess their prior knowledge before engaging with the learning media.

3.5.3 The students then participated in the learning activities using the microlearning media, which consisted of five learning units.

3.5.4 Upon completion of the lessons, the participants took a post-test to measure their learning achievement after using the media.

3.5.5 Finally, the researcher collected and verified the accuracy of all data before proceeding with statistical analysis using appropriate methods.

3.6 Data Analysis

3.6.1 The appropriateness and quality of the microlearning media, along with learners' satisfaction, were analyzed using the Mean ($\bar{x}$) and Standard Deviation (SD). The interpretation of the mean scores followed a five-level rating scale (Leekitwattana, 2016, p. 172), as shown below:

Mean scores between 4.50–5.00 indicate the highest level of quality.

Mean scores between 3.50–4.49 indicate a high level of quality.

Mean scores between 2.50–3.49 indicate a moderate level of quality.

Mean scores between 1.50–2.49 indicate a low level of quality.

Mean scores between 1.00–1.49 indicate the lowest level of quality, suggesting that improvement is needed.

3.6.2 The efficiency of the microlearning media was evaluated using the E1/E2 (80/80) efficiency criterion, which measures the instructional effectiveness of the developed media.

3.6.3 The comparison of students' learning achievement before and after using the microlearning media was conducted using the Dependent Samples t-test (Paired Samples t-test) to determine whether the difference between pre-test and post-test scores was statistically significant at the .05 level.



IV. RESULTS

Based on the implementation of this research, the findings from the data analysis can be summarized as follows:

4.1 Results of the quality evaluation of the microlearning media on using basic chemical instruments in agriculture for undergraduate students are presented as follows.

The microlearning media titled “Using Basic Chemical Instruments in Agriculture” for undergraduate students encompassed concise instructional content outlining operational principles, instrument usage procedures, practical worksheets, and corresponding pre-test and post-test assessments. The instructional design emphasized self-directed learning, facilitated through the Google Classroom platform, which supports both desktop and mobile access. This approach enables learners to engage in flexible, continuous learning at their own pace, anytime and anywhere, as illustrated in Figures 2–5.

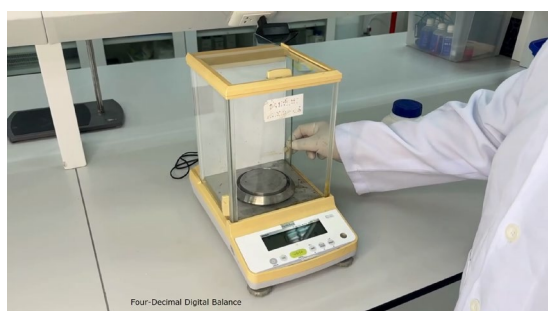


Figure 2: Four-decimal digital balance

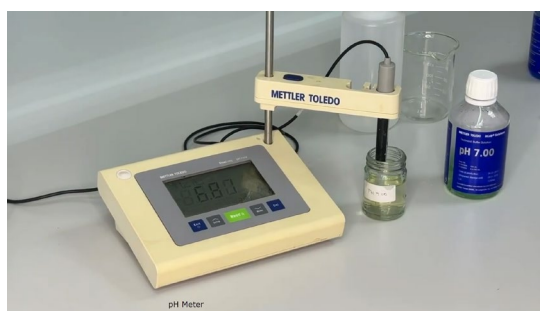


Figure 3: pH meter



Figure 4: Brix refractometer



Figure 5: Hot air oven

The quality analysis of the microlearning media on using basic chemical instruments in agriculture for undergraduate students encompassed two aspects: content quality and technical production quality. Each aspect was evaluated by three experts, and the results of the analysis are presented in Table 1.

Table 1: Mean scores, standard deviations, and quality levels of the microlearning media on using basic chemical instruments in agriculture for undergraduate students, classified by overall and individual aspects.

Evaluation items	$\bar{x}$	SD	Quality level
1. Content aspect	4.69	0.38	The highest
2. Technical production aspect	4.52	0.40	The highest
Total	4.60	0.39	The highest

As shown in Table 1, the evaluation of the developed microlearning media indicated that its overall appropriateness was rated at the highest ($\bar{x} = 4.60$, $SD = 0.39$) based on assessments by three experts. When examining each aspect individually, the content quality received the highest mean score ($\bar{x} = 4.69$, $SD = 0.38$), also rated at the highest, followed by the technical production quality ($\bar{x} = 4.52$, $SD = 0.40$), which was similarly assessed the highest.

4.2 Results of the efficiency analysis of the microlearning media on using basic chemical instruments in agriculture for undergraduate students.

The results of the efficiency evaluation of the microlearning media on using basic chemical instruments in agriculture for undergraduate students, calculated using the E1/E2 formula, are presented in Table 2.

Table 2: Results of the efficiency analysis of the microlearning media using basic chemical instruments in agriculture for undergraduate students.

Scores	Students (n=50)			Specified criterion
	Full score	Mean score	Average percentage	
End-of-lesson test	25	24.20	96.80	80 (E ₁)
Post-test	20	16.88	84.40	80 (E ₂)

* Specified criterion E₁/E₂ (80/80)

From Table 2, the results of the efficiency evaluation of microlearning media on using basic chemical instruments in agriculture for undergraduate students revealed that the developed media met the established efficiency standard. The mean efficiency during learning (E₁) was 96.80, and the post-learning efficiency (E₂) was 84.40, both exceeding the specified 80/80 standard criterion.

4.3 Results of the comparative analysis of students' learning achievement before and after instruction.

The results of the analysis comparing students' learning achievement before and after instruction, conducted using the Dependent Samples t-test, are presented in Table 3.

Table 3 Comparison of students' learning achievement before and after instruction with the microlearning media on using basic chemical instruments in agriculture

Test	n	$\bar{x}$	SD	t	df	p
Pre-test	50	6.90	1.38	25.24	49	<0.001
Post-test	50	16.88	2.92			

* Statistically significant at the .05 level



From Table 3, the analysis comparing students' learning achievement before and after instruction using the microlearning media on basic chemical instruments in agriculture, conducted with the Dependent Samples t-test, revealed that the mean post-test score ($\bar{x} = 16.88$, $SD = 2.92$) was higher than the mean pre-test score ($\bar{x} = 6.90$, $SD = 1.38$). This difference was statistically significant at the 0.05 level ($t = 25.24$, $df = 49$, $p < 0.001$), indicating that the developed microlearning media effectively enhanced students' learning achievement.

V. CONCLUSION AND DISCUSSION

The developed microlearning media on basic chemical instruments in agriculture proved to be of very high quality, efficient, and effective in enhancing first-year undergraduate students' learning achievement. It not only improved knowledge and practical skills but also promoted self-directed learning and motivation. These results suggest that microlearning media can be successfully applied in practice-oriented courses, providing a flexible, accessible, and engaging approach to laboratory instruction for digital-age learners. Furthermore, the flexibility of this microlearning media allows for its effective adaptation to other laboratory courses within agricultural or agricultural science curricula, particularly for instruction involving similar basic agricultural tools. Whether utilized for reviewing prior knowledge or acquiring new skills and engaging learning method that perfectly meets the needs of learners in the digital age.

The self-directed microlearning media on "Using Basic Chemical Instruments in Agriculture" for first-year undergraduate students were developed to enhance knowledge, understanding, and practical laboratory skills. A quasi-experimental one-group pretest–posttest design was employed with a sample of 50 students from the Department of Agricultural Education, School of Industrial Education and Technology, King Mongkut's Institute of Technology Ladkrabang. The evaluation of the media indicated very high overall quality ($\bar{x} = 4.60$, $SD = 0.39$) in both content and technical aspects. The content was systematically aligned with learning objectives and reviewed by experts, ensuring accuracy, appropriateness, and learner-centered design. Consequently, the media were found to be complete, suitable, and effective for instructional use. These findings align with Anderson and Krathwohl (2001, p. 131), who emphasized instructional design principles under the ADDIE Model, including learner analysis, alignment of learning activities with objectives, and continuous evaluation. They also support Boonmapan et al. (2021, pp. 65-78), who reported that microlearning is particularly suited for digital-age learners due to its concise, accessible, and easily understandable content, which enhances motivation and fosters self-directed learning. The media's efficiency was measured using the E1/E2 (80/80) standard criterion. The mean efficiency during learning (E1) was 96.80, and post-learning efficiency (E2) was 84.40, both exceeding the standard criterion. This demonstrates that the media facilitated continuous understanding and enabled learners to apply knowledge effectively, in line with the efficiency standards proposed by (Brahmawong, 2013, pp. 7-20). These results are consistent with findings by Mohammed et al. (2018, pp. 32-38), who noted that microlearning improves learning efficiency and content retention compared to traditional methods, and



Kongsomboon (2019, pp. 51-62), who reported that systematically designed microlearning media can surpass standard efficiency benchmarks and significantly enhance academic achievement. A comparison of pre- and post-test scores revealed a significant increase in students' learning achievement. The mean post-test score ($\bar{x} = 16.88$, $SD = 2.92$) was significantly higher than the mean pre-test score ($\bar{x} = 6.90$, $SD = 1.38$) at the 0.05 significance level ($t = 25.24$, $p < 0.001$). This indicates that the microlearning media effectively enhanced students' understanding and practical skills. The findings support, who suggested that microlearning allows learners to quickly grasp essential knowledge, reinforces learning, and improves content retention, and align with Boonmapan et al. (2021, pp. 65-78), who confirmed that microlearning media increase learners' motivation and satisfaction. Overall, the results demonstrate that self-directed microlearning media are an effective tool for practice-oriented courses, particularly those involving laboratory work or the use of scientific instruments. The combination of high-quality design, strong efficiency, and significant learning gains highlights the potential of microlearning to support flexible, engaging, and learner-centered education in the digital age. Consistent with cognitive load theory, the human brain possesses a finite capacity for processing new information; thus, an excessive influx of data can lead to cognitive overload and hinder learning (Sweller, 1988, pp. 257–285). Microlearning mitigates this challenge by decomposing complex subject matter into manageable segments, typically ranging from 3 to 5 minutes. By excising unnecessary elements and prioritizing concise content, microlearning delivers focused, self-contained learning units that directly address learning objectives.

SUGGESTION

The developed microlearning media can be applied in practice-oriented courses, particularly those involving scientific instruments or laboratory work, to support learners in using equipment accurately and safely. Integration with hands-on sessions is recommended to promote holistic learning and enhance overall learning efficiency. Future research should involve more diverse samples and educational contexts to examine the effectiveness of microlearning on additional outcomes, such as analytical thinking and learning motivation. Furthermore, the development of interactive media utilizing Virtual Reality (VR) or Augmented Reality (AR) is suggested to provide realistic and sustainable learning experiences for digital-age learners. Additionally, future research should extend to measuring knowledge retention (e.g., administering a follow-up test after four weeks) to verify that knowledge acquired through microlearning remains durable over time.



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