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Integrating Mastery Adaptive and Problem-Solving (MAPS) Digital Technology Skills into a Thai Community College Student Learning Model

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Abstract

Background/purpose. The increasing integration of digital technology in education underscores the need for instructional models that support personalized, skill-based, and problem-solving-focused learning. While traditional pedagogies often fail to address these needs comprehensively, this study proposes that the Mastery Adaptive Problem-Solving (MAPS) Model offers an innovative solution for enhancing digital technology skills (DTS) and academic achievement (AA) among Thai community college students.

Materials/methods. The MAPS Model incorporates mastery learning, micro-learning, adaptive learning, and problem-based learning (PBL) into a six-step framework. Expert validation of the model was conducted using the Connoisseurship method via focus group discussions. A quasi-experimental design was employed to evaluate the model's implementation with 19 second-year Thai community college students. Student DTS and AA were measured using validated tools with reliability indices exceeding 0.80. Retention of skills and knowledge was assessed 14 days post-instruction.

Results. Experts rated the MAPS Model highly for utility, feasibility, appropriateness, and accuracy. After implementation, students' DTS significantly exceeded the set threshold (70%), with statistical significance at the .01 level. Additionally, students demonstrated significantly higher AA post-instruction than pre-instruction levels, at the .01 significance level. Retention analysis revealed no significant decline in DTS or AA 14 days after program completion.

Conclusion. The MAPS Model effectively integrates innovative pedagogical strategies to enhance DTS and AA in community college settings. Its structured, adaptable framework addresses diverse learner needs, ensuring immediate and sustained educational benefits.

1. Introduction

The global education system has undergone rapid changes, particularly in response to the COVID-19 pandemic, which began in late 2019 in China (Maqsood et al., 2021). This crisis significantly impacted educational institutions, forcing them to adapt to a "new normal" (Xie et al., 2020). A notable adjustment has been the transition to online teaching and learning models to ensure the continuity of education (Bojović et al., 2020; Wayo et al., 2020). In Thailand, government mandates, including social distancing measures and prohibitions on in-person teaching at educational institutions, necessitated the implementation of distance or electronic learning solutions (Siripipatthanakul et al., 2022).

In this context, the Community College Institute of Thailand introduced practical guidelines for transitioning from traditional face-to-face instruction to online models. These guidelines require instructors to design and manage teaching and learning activities that uphold the same standards of learning outcomes as traditional methods (Community College Institute, 2024). However, effective online learning requires more than digitizing instructional documents and placing them on platforms like Google Classroom. It demands the integration of educational theories and innovative practices to effectively achieve the desired learning objectives.

The COVID-19 pandemic exacerbated existing educational challenges, particularly in online learning environments. Studies such as by Noor and Isa (2023) reveal how learners face technical, motivational, and infrastructural barriers, emphasizing the need for effective instructional frameworks. Similarly, Rodriguez and Liu (2023) highlight the interplay between digital engagement, self-efficacy, and educational outcomes, underscoring the necessity of models that foster academic and practical competencies. These findings reinforce the critical role of community colleges in bridging educational gaps and fostering sustainable development in local communities.

Thai community colleges are vital in reducing educational inequality and fostering sustainable community development (Community College Institute, 2024; Rukspollmuang & Fry, 2022). These institutions aim to enhance knowledge, promote careers, and deliver lifelong learning opportunities. Their mission includes providing sub-degree-level higher education, academic services, and vocational training tailored to local community needs. As a result, instructors are critical to ensuring continuity in education, mainly through well-designed online teaching models incorporating advanced instructional media and technologies.

Practical courses, which differ from theoretical ones, require instructors to segment content into manageable subunits (Santhuenkaew et al., 2024). Effective micro-learning ensures content accuracy and efficiency (Leong et al., 2021), making it easier for learners to understand and retain knowledge over time (Mohammed et al., 2018; Park & Kim, 2018). Additionally, adaptive learning methodologies allow for personalized instruction (Normadhi et al., 2019), addressing individual learning differences and optimizing educational outcomes (Ussarn et al., 2021). Mastery learning, which focuses on clear objectives and structured activities, ensures all learners succeed (Bergmann, 2022; Holmes et al., 2021).

Problem-based learning, a student-centered approach, emphasizes critical thinking and problem-solving by engaging learners in tasks that simulate real-world challenges (Paiboonsin & Sopeerak, 2016). Instructors play a guiding role, encouraging students to analyze problems and develop solutions independently.

The MAPS (Mastery Adaptive Problem-Solving) Model is uniquely designed to bridge digital literacy gaps by integrating proven educational theories—mastery, adaptive, micro, and problem-based learning. Unlike conventional instructional models, MAPS provides a personalized, scalable approach to equip diverse student populations with critical digital technology skills, particularly those in remote areas. This integration enables students to succeed academically and professionally in an increasingly digitalized world. This model is particularly beneficial for students in remote areas, as it reduces the need for travel and makes quality education accessible (Bojović et al., 2020; Nantha et al., 2024).

2. Literature Review

2. 1. Mastery Learning

Mastery learning is an instructional strategy designed to provide individualized support to ensure every student achieves mastery of a given subject (Akpan, 2020; Clark & Talbert, 2023; Cundiff et al., 2020). It emphasizes the characteristics of learners, teaching methodologies, and learning outcomes (Akpan, 2020). Instructors analyze the learning content in detail, set specific objectives, and develop tailored learning plans for individuals or groups with similar needs. This approach accommodates learners' differing aptitudes by employing diverse instructional methods, media, and timeframes (Parker & Roumell, 2020). Students are assessed against the learning objectives, and those unable to meet the criteria receive additional support through alternative methods and media to achieve mastery.

Recent studies underscore the efficacy of mastery learning in improving student achievement. For instance, Yemi (2018) found that mastery learning strategies enhance academic performance and promote positive attitudes toward learning. Moreover, integrating mastery learning in digital platforms has demonstrated significant potential in modern classrooms (Wannapiroon & Pimdee, 2022), where adaptive feedback systems ensure students' progress at their own pace.

Mastery learning is an educational strategy focused on ensuring students achieve a high level of understanding before progressing. The six steps of mastery learning synthesized for this study include (Rahman et al., 2024; Tomlinson & Jarvis, 2023):

1. **Define Learning Objectives:** Establish clear, specific, and measurable goals for what students should learn. Break down the subject matter into small, sequential units.
2. **Diverse Instructional Methods:** Provide initial teaching or presentation of the material using diverse instructional methods (Archambault et al., 2022). Ensure the instruction aligns with the predefined objectives.
3. **Formative Assessment:** Conduct regular, low-stakes assessments to gauge understanding and identify areas of difficulty. Provide immediate feedback to students on their performance.
4. **Corrective Feedback:** Offer targeted interventions for students who have not mastered the material to address learning gaps (Winget & Persky, 2022). Use alternative instructional approaches (e.g., tutoring, peer support, or additional practice) to address learning gaps.
5. **Reassessment:** Allow students to demonstrate mastery after engaging in corrective activities. This reassessment evaluates whether the corrective interventions were effective.
6. **Enrichment or Advancement:** Once mastery is achieved, provide opportunities for students to deepen their understanding or move on to advanced content (Cundiff et al., 2020). Enrichment ensures that learning extends beyond basic objectives.

This systematic approach promotes personalized learning, ensuring every student succeeds at their own pace while maintaining high standards. This systematic approach is pivotal in promoting sustained academic achievement and retention.

2. 2. Micro-Learning

Micro-learning is an emerging instructional method that delivers content in small, easily digestible units, often presented through brief activities or videos (Dwinggo Samala et al., 2023; Hamed et al., 2020; Nikou & Economides, 2018). Typically lasting 5–15 minutes, these learning sessions focus on single, specific objectives, making them ideal for modern learners who prefer concise and focused material (Mohammed et al., 2018).

The effectiveness of micro-learning lies in its flexibility and alignment with learners' needs. Hug's research (2021) suggests that micro-learning enhances memory retention and facilitates learning on the go, mainly when supported by multimedia tools. Park and Kim (2018) highlight the role of short, targeted video clips in promoting self-directed learning and bridging gaps in knowledge.

For this study, two critical steps in the micro-learning process were identified:

- Create content with a single learning objective.
- Present the content via video or other concise formats.

Recent advancements in micro-learning technology, such as interactive platforms and AI-driven content recommendations (Shail, 2019), further support its application in fostering engagement and retention (Hamed et al., 2020; Hug, 2021).

2. 3. Adaptive Learning

Adaptive learning personalizes the educational experience by tailoring content and methods to each learner's needs and abilities (Holland, 1977; Ipinnaiye & Risquez, 2024). Through initial assessments and continuous analysis, adaptive systems adjust instructional strategies to address individual strengths and weaknesses (Jing et al., 2023).

Adaptive learning has gained prominence due to its alignment with digital education trends. Park and Lee (2013) emphasized that adaptive learning systems, powered by advanced technology, offer dynamic adjustments to learning paths, ensuring timely intervention and support. Additionally, Gligorea et al. (2023) highlighted the ability of adaptive learning models to enhance engagement and learning efficiency in online environments. The six steps of adaptive learning synthesized for this study include:

1. Orientation.
2. Conduct pre-tests for each subject.
3. Conduct pre-tests for each learning unit.
4. Deliver tailored learning content.
5. Conduct post-tests for each learning unit.
6. Conduct post-tests for each subject.

Studies such as Jing et al. (2023) validate the importance of adaptive learning in increasing both academic performance and learner satisfaction by addressing diverse educational needs.

2.4. Problem-Based Learning (PBL)

Problem-based learning (PBL) is a learner-centered approach that involves solving real-world problems as a central element of instruction (Chandra et al., 2024). PBL prioritizes skill development over rote memorization, enabling learners to develop critical thinking and problem-solving capabilities.

The application of PBL in digital learning environments has shown remarkable results. Saechan and Morsorn (2016) demonstrated that PBL facilitates meaningful learning and empowers students to create and apply knowledge. Learners actively engage in the learning process by defining problems, exploring solutions, and synthesizing findings.

The three key steps of PBL synthesized for this study are:

1. Define the problem.
2. Explore and solve the problem.
3. Conclude and synthesize solutions.

Recent research highlights the integration of PBL with digital tools, such as simulations and collaborative platforms (Fidan & Tuncel, 2019), to enhance learner engagement and improve problem-solving outcomes (Hmelo-Silver et al., 2018). This approach is particularly relevant for developing DTS, as it mirrors challenges learners may face in real-life scenarios.

2. 5. Problem Statement

Despite the growing demand for digital literacy and technology proficiency in modern workplaces (Morgan et al., 2022), many community college students face significant barriers to achieving these skills due to varying learning paces, diverse backgrounds, and limited access to tailored instructional approaches. Traditional teaching models often fail to address these challenges, leading to gaps in skill acquisition and learning retention (Saechan & Morsorn, 2016).

Integrating mastery learning, micro-learning, adaptive, and problem-based learning (PBL) has shown promise in addressing these educational disparities by offering personalized, flexible, and engaging learning experiences. However, these approaches are seldom synthesized into a cohesive instructional model designed to enhance DTS for community college students (Riel et al., 2012).

This gap underscores the need for an innovative, evidence-based instructional framework like the MAPS (Mastery Adaptive Problem-Solving) Model, which unifies these approaches to cater to diverse learner needs. The development and implementation of the MAPS Model aim to bridge the gap between theoretical knowledge and practical application, ensuring students acquire and retain critical digital skills required for their academic and professional success.

2. 6. Research Objectives (ROs)

RO1: To develop the Mastery Adaptive Problem-Solving (MAPS) Model.

RO2: To examine the outcomes of implementing the MAPS Model.

RO3: To compare students' DTS after using the MAPS Model against a benchmark of 70%.

RO4: To compare students' academic achievement before and after using the MAPS Model.

RO5: To investigate the retention of academic achievement and DTS 14 days after using the MAPS Model.

2.7. Research Questions (RQs)

RQ1: What is the structure of the MAPS Model?

RQ2: How effective is the MAPS Model in enhancing students' DTS compared to the set benchmark of 70%?

RQ3: How does the student's academic achievement after using the MAPS Model compare to their academic achievement before using it?

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RQ4: Do students retain their academic achievement and DTS 14 days after completing the MAPS Model?

3. Methods

3. 1. Process 1: MAPS Model Development

3. 1. 1. Step 1: MAPS model development

The development of the MAPS Model relied on comprehensive data collection from various sources, including documents and research studies related to the MAPS Model published between 2010 and 2024. The focus extended to domestic and international works identified using keywords relevant to the components of the MAPS Model. A document and research synthesis form was employed to analyze and synthesize data from books, journal articles, and theses, with sources from libraries and online databases. To ensure rigor, relevant content was synthesized using keywords associated with the MAPS Model, as illustrated in Figure 1. A systematic content analysis and synthesis were conducted to extract critical insights that informed the model's development.

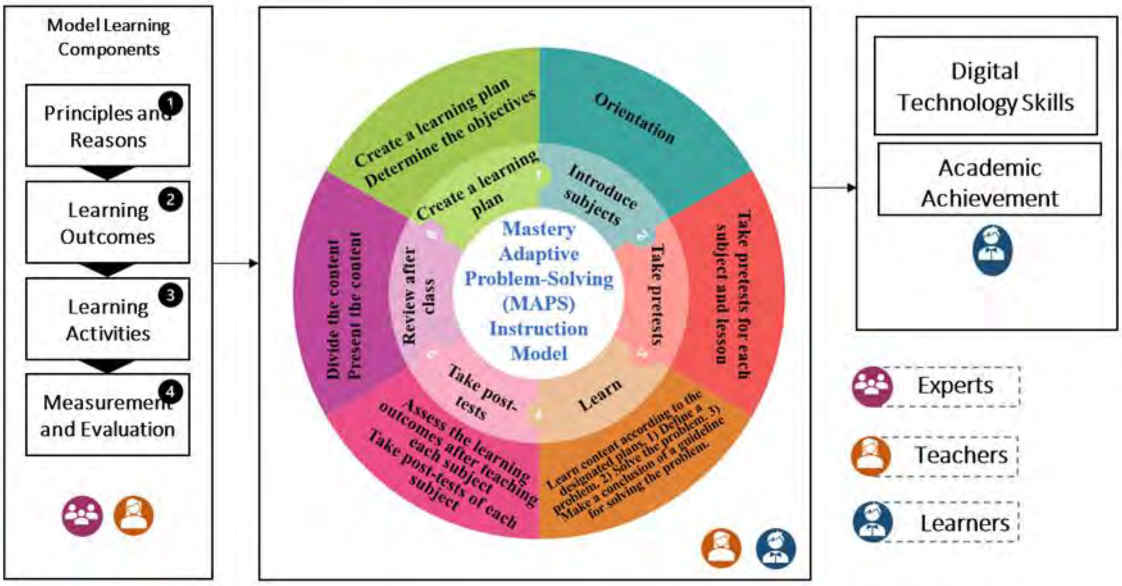

Figure 1. A Mastery Learning, Adaptive Microlearning, Problem-Solving Model For Developing Digital Technology Skills for Thai Community College Students.

3. 1. 2. Step 2: MAPS model quality assessment

Nine experts, purposively selected based on their expertise and qualifications, evaluated the quality of the MAPS model (Pimdee et al., 2024). This group comprised three experts in computer education, two in learning model development, two in curriculum and instruction, one in measurement and evaluation, and one in educational technology.

To conduct the assessment, the study employed the CIPP (Context, Input, Process, Product) Evaluation Model (Kiettikunwong & Narot, 2024; Stufflebeam, 2015; Yarbrough et al., 2010). This framework enabled a thorough evaluation across four dimensions: utility, feasibility, appropriateness, and accuracy (Darma, 2019; Rooholamini et al., 2017). A 5-point Likert scale quality assessment form comprising 29 items was used, with an index of item congruence (IOC) ranging from 0.60 to 1.00.

The evaluation process involved expert feedback obtained through focus group discussions conducted via Zoom on September 20, 2021. After the discussions, experts completed the quality assessment forms, and all returned, resulting in a 100% response rate. The data were analyzed using mean and standard deviation (SD) to determine the model's overall quality.

3. 2. Process 2: MAPS Model Implementation

3. 2. 1. Population and sample

The population comprised second-year community college students at Tak Community College enrolled in the second semester of the 2021 academic year. A cluster random sampling method was employed, using academic disciplines as the sampling unit. The final sample consisted of 19 diploma students from the Local Government Program at the Academic Service Center in Mueang District, Tak Province (Pimdee et al., 2024).

The participants had an average age of 23 years, ranging from 20-25 years, with 47% male and 53%. Most of these students were employed during their studies and were from rural areas, reflecting the demographics of Tak Province. This context is particularly significant, as it highlights the potential challenges faced by students in remote settings, including limited access to digital resources and infrastructure. This demographic information provides an essential backdrop for understanding the applicability and impact of the MAPS Model in addressing educational inequities in underserved regions.

3. 2. 2. Research instruments

Several research instruments were employed to implement the MAPS Model effectively. The MAPS Model itself served as the primary experimental tool. The Digital Technology Skills (DTS) Assessment was developed based on prior studies examining the needs of community college students (Ussarn et al., 2021). This assessment utilized an analytical rubric scoring method to evaluate procedural performance. It comprised 16 items grouped into four levels of skills: imitation, guided execution, accuracy, and consistency, amounting to a total score of 36 points. The assessment demonstrated an IOC ranging from 0.80 to 1.00 and a reliability coefficient of 0.80.

The academic achievement (AA) test was another critical instrument, consisting of a 60-item multiple-choice questionnaire. This test was based on Anderson and Krathwohl’s adaptation of Bloom’s taxonomy (Wilson, 2016), assessing students across three levels: remembering, understanding, and application. The IOC values ranged from 0.80 to 1.00, difficulty indices from 0.21 to 0.79, discrimination indices from 0.25 to 0.92, and reliability (KR-20) of 0.95.

3. 2. 3. Data collection

The study's data collection spanned three months, from December 2021 to February 2022, following the implementation of the MAPS Model. Initially, pre-academic achievement tests were administered to all participants to establish baseline knowledge levels. Subsequently, instructional activities were conducted according to the learning plans designed under the MAPS framework. Post-academic achievement tests were administered after completing the instructional activities to evaluate the participants' progress in AA and DTS.

In addition, a retention assessment was conducted to measure the long-term effectiveness of the MAPS Model. This involved administering retention tests 14 days after the conclusion of the instructional activities in March 2022. The assessment focused on determining whether the gains in AA and DTS were retained over time, thus providing valuable insights into the model's sustainability and impact.

3. 2. 4. Data analysis

The data analysis aimed to evaluate the effectiveness of the MAPS Model in enhancing students' academic and digital technology skills. To analyze DTS, a one-sample t-test was conducted to compare the post-learning DTS scores to the established 70% benchmark. For AA, a dependent t-test was employed to compare the pre- and post-academic achievement scores, highlighting the progress made by the participants.

The selection of a 70% benchmark as the minimum proficiency threshold is consistent with its widespread use in educational settings to signify mastery of essential skills, as Dunlea (2015) showed in Jaspan, who used this benchmark for EFL proficiency tests. Furthermore, this threshold aligns with educational policies in Thailand and globally, which often utilize similar benchmarks to evaluate student progress and achievement. This choice ensures that the study's evaluation metrics are academically rigorous and practically relevant.

Additionally, a retention study was performed using a dependent t-test to assess whether the participants retained their academic and digital technology skills 14 days after completing the instructional activities. This analysis provided crucial evidence of the MAPS Model's effectiveness in fostering immediate learning gains and long-term retention of knowledge and skills.

4. Results

4.1. Expert Evaluation Results of the MAPS Model

Table 1 shows the experts' evaluations of the MAPS Model across four dimensions: utility, feasibility, appropriateness, and accuracy. Experts rated the model as highly effective overall, with appropriateness and utility receiving the highest scores. Following a structured interpretive framework, the mean scores were categorized as 4.50 – 5.00 (highly effective), 3.50 – 4.49 (significantly effective), 2.50 – 3.49 (moderately effective), 1.50 – 2.49 (slight effectiveness), and 1.00 – 1.49 (minor to no effectiveness).

Table 1. Expert Evaluation of the MAPS Model.

Dimension	Experts (*n*=9)		Level	Rank
	Mean	SD		
Utility	4.41	0.42	High	2
Feasibility	4.33	0.47	High	3
Appropriateness	4.41	0.34	High	1
Accuracy	4.25	0.32	High	4
Overall	4.35	0.33	High	-

Table 1 also provides a detailed breakdown of each dimension's mean scores and standard deviations. Appropriateness and utility ranked highest, reflecting the model's strong alignment with user needs and ethical standards. Feasibility and accuracy, though slightly lower, also received high ratings, underscoring the model's practical implementation and reliability. These results collectively validate the MAPS Model as a comprehensive and practical instructional framework for addressing diverse educational needs.

4. 2. Implementation Results of the MAPS Model

4. 2. 1. Student digital technology skills results

Table 2 compares students' Digital Technology Skills (DTS) post-learning and the 70% benchmark. The results show that students' DTS after using the MAPS Model significantly exceeded the 70% benchmark, with a mean score of 78.07% and a p-value of <.001. This indicates that the MAPS Model effectively enhanced students' digital technology competencies, exceeding the minimum required proficiency.

Table 2. Comparison of DTS after Using the MAPS Model Using a 70% Benchmark

Skill	Full Score	Students (*n*=19)		%	t-value	*p*-value
		Mean	SD			
Digital technology	36	28.11	10.01	78.07	3.51**	<.001
Specified criteria	-	25.20	-	70		

**Sig.< .01

These findings highlight the effectiveness of the MAPS Model in fostering critical digital skills, which are essential for navigating modern educational and professional environments. The statistical significance of the results further underscores the effectiveness of the instructional strategies employed.

4. 2. 2. Student academic achievement results

Table 3 compares students' academic achievement before and after using the MAPS Model. The results reveal a significant improvement in post-academic achievement, with a mean score of 41.21 out of 60, compared to the mean of 19.05 for pre-academic achievement. This substantial increase, supported by a p-value of 0.00, demonstrates the MAPS Model's efficacy in enhancing students' academic performance.

Table 3. Comparison of Student Pre- and Post-Learning Academic Achievement

Academic Achievement	Students	Full Score	Mean	SD	t-value	df	Sig.
After Study	19	60	41.21	5.37	16.98*	18	0.00
Before Study			19.05	4.47			

Note. After study: Shapiro-Wilk = 0.97, df = 19, Sig. = 0.68, Before study: Shapiro-Wilk = 0.98, df = 19, Sig. = 0.92

These outcomes validate the instructional design of the MAPS Model and emphasize its potential for addressing educational disparities and promoting student success in diverse learning contexts. The reliability and consistency of the results, as indicated by Shapiro-Wilk tests, further reinforce the model's effectiveness.

4. 2. 3. Academic achievement and digital technology skills retention

Table 4 highlights the results of a post-test and a follow-up test conducted 14 days after the learning program to measure students' academic achievement and DTS retention. The testing process involved:

Post-Test: Administered immediately after the learning activities to establish baseline levels of achievement and skills after using the MAPS Model.

Retention Test: Conducted two weeks later to evaluate the durability of learning outcomes and digital skills over time. The importance of this retention testing lies in its ability to assess the long-term efficacy of the MAPS Model, ensuring that knowledge and skills acquired are not only momentary but persist, which is critical for practical application in real-world contexts (Yang et al., 2021).

Academic Achievement Retention: The mean scores for academic achievement increased slightly from 41.21 (SD = 5.37) immediately after learning to 42.47 (SD = 5.15) after 14 days. The t-value

(0.98) and p-value (0.17) indicate no significant difference between the two tests, suggesting strong retention of academic concepts over the 14 days.

Table 4. Retention of AA and DTS

Achievement/Skills	Students	Full Score	Mean	SD	t-value	df	Sig.
Academic achievement immediately after class ends	19	60	41.21	5.37	0.98	18	0.17
Academic Achievement Retention 2 weeks after class ends			42.47	5.15			
Post-test academic achievement: Shapiro-Wilk = 0.94, df = 19, Sig. = 0.31 14-day post-test academic achievement: Shapiro-Wilk = 0.94, df = 19, Sig. = 0.21							
Digital Learning Skills immediately after class ends	19	36	28.11	3.60	1.05	18	0.15
Digital Learning Skills retention 2 weeks after class ends			28.82	4.03			
Post-digital learning skills: Shapiro-Wilk = 0.95, df = 19, Sig. = 0.37 14-day digital learning skills: Shapiro-Wilk = 0.93, df = 19, Sig. = 0.16							

Digital Technology Skills Retention: The mean scores for DTS also showed a slight increase from 28.11 (SD = 3.60) immediately post-class to 28.82 (SD = 4.03) two weeks later. The t-value (1.05) and p-value (0.15) confirm no significant decline, indicating stable retention of digital skills.

Normality of Data Distribution: The Shapiro-Wilk test for normality yielded p-values above 0.05 for all measures, confirming that the data distribution is appropriate for parametric testing.

Interpretation of Results: The results suggest that the MAPS Model effectively enhances academic achievement and DTS and ensures the retention of these outcomes over time. This durability is critical in educational contexts, as it demonstrates the model's ability to promote meaningful and lasting learning rather than superficial or short-term gains. Retention testing is a vital indicator of the effectiveness of any instructional model. The MAPS Model's ability to maintain academic achievement and digital skills over two weeks underscores its potential for application in real-world educational settings, where learners must retain and apply skills beyond the classroom environment. This finding adds to the credibility of the MAPS Model as a sustainable and impactful learning framework.

5. Discussion

5. 1. Effectiveness of the MAPS Model

The findings of this study underscore the significant impact of the Mastery Adaptive Problem-Solving (MAPS) Model in enhancing digital technology skills (DTS) and academic achievement (AA) among community college students. The model's structured yet flexible framework, encompassing mastery learning, micro-learning, adaptive learning, and problem-based learning, has proven effective in addressing the unique challenges of online education. This aligns with broader research that highlights the efficacy of these pedagogical approaches in fostering durable and applicable knowledge (Mohammed et al., 2018; Scott et al., 2020).

The structured process of the MAPS Model—clearly defined objectives, segmented learning units, personalized instruction, and practical problem-solving activities—facilitates immediate skill acquisition and long-term retention. Research on mastery learning corroborates this by emphasizing its capacity to ensure all learners meet predefined goals, thereby minimizing disparities in learning outcomes (Scott et al., 2020). Similarly, micro-learning's concise and focused instructional units have enhanced comprehension and retention, as Mohammed et al. (2018) and Choo and Rahim (2021) demonstrated.

5. 2. Alignment with Broader Educational Strategies

Adaptive learning, a cornerstone of the MAPS Model, offers personalized learning experiences by adjusting content delivery to match individual needs. This approach enhances engagement and boosts academic performance, as evidenced by studies like Eau et al. (2022) and Seters et al. (2012). The integration of adaptive learning within the MAPS Model is particularly beneficial for addressing community college students' diverse abilities and prior knowledge levels, ensuring equitable access to quality education.

Problem-based learning, another critical component of the MAPS Model, fosters critical thinking and problem-solving skills through real-world applications. Temel (2014) highlights the potential of this approach to improve learners' problem-solving abilities, especially in technical and applied fields. By engaging students in realistic scenarios, the MAPS Model prepares them for academic success and equips them with skills relevant to their professional and community contexts.

5. 3. Retention and Practical Implications

One of the most noteworthy outcomes of this study is the retention of DTS and AA among students even two weeks post-intervention. This finding suggests that the iterative and interactive elements of the MAPS Model effectively embed learning, consistent with the durability of knowledge reported in mastery and micro-learning frameworks (Mohammed et al., 2018; Scott et al., 2020). Retaining and applying knowledge is particularly critical for community college students, who often balance education with other responsibilities.

Moreover, the MAPS Model's focus on practical and scalable solutions aligns with the needs of remote and underserved communities. By minimizing the need for physical infrastructure and travel, the model ensures that quality education is accessible to all, reinforcing its role in reducing educational inequities. This resonates with findings from Choo and Rahim (2021), who emphasize the practicality and cost-effectiveness of micro-learning strategies in online education settings.

5. 4. Broader Impacts and Future Applications

The successful implementation of the MAPS Model provides a valuable template for addressing the evolving demands of online education. Its comprehensive design enhances individual learning outcomes and contributes to the broader goals of community development and workforce readiness. Future research could explore the application of this model in other contexts, such as higher education or professional training, to validate its versatility and scalability.

By integrating insights from mastery, micro, adaptive, and problem-based learning, the MAPS Model represents a holistic approach to education. Its success reaffirms the importance of evidence-based instructional design in overcoming the challenges of online and remote learning environments.

6. Conclusion

The MAPS Model is a proven instructional approach that effectively combines mastery, micro-learning, adaptive, and problem-based learning to enhance DTS and AA. Its structured yet flexible design allows for personalized learning, ensuring all students meet learning objectives and retain their knowledge and skills.

Experts rated the model highly across all dimensions, and its implementation yielded statistically significant improvements in students' performance, surpassing established benchmarks. Moreover, the retention of learning outcomes demonstrates the model's capacity to provide durable educational benefits.

This study highlights the potential of the MAPS model as an innovative framework for improving education in technical and vocational fields, contributing to the development of a skilled and adaptable workforce. Future research should expand on this work to refine and validate the model in diverse educational contexts.

The MAPS Model offers a replicable and scalable framework for integrating diverse instructional strategies in vocational and community college settings. Its emphasis on personalization and active learning is well-suited for fostering technical and practical skills.

7. Implications

The findings of the current study suggest the following implications for research and practice:

Broader Application Across Disciplines and Demographics: Future studies should explore the implementation of the MAPS Model across various academic disciplines, such as STEM, humanities, and vocational training, and among diverse age groups to determine its adaptability and effectiveness in different educational contexts.

Long-Term Retention Studies: Investigating the long-term retention of academic achievement and digital skills beyond the 14 days is essential to assess the sustained impact of the MAPS Model. Studies spanning several months or an academic year could provide deeper insights into the durability of learning outcomes.

Integration of Emerging Technologies: Incorporating emerging technologies, such as AI-driven adaptive learning tools and augmented reality (AR), could enhance the personalized and interactive aspects of the MAPS Model. These advancements may improve its scalability and effectiveness in diverse learning environments.

Comparative Studies: Conducting comparative research between the MAPS Model and other instructional models would help identify its relative strengths and areas for improvement, contributing to the refinement of pedagogical frameworks.

8. Limitations

While this study provides compelling evidence supporting the effectiveness of the MAPS Model, several limitations should be acknowledged. These include:

Scope and Context: The research was conducted in a single community college and focused on a specific subject area, which may limit the generalizability of the findings to other educational settings or disciplines.

Sample Size: The study involved a relatively small sample of 19 students, which may affect the robustness of the results. Larger-scale studies are recommended to validate these findings.

Short-Term Evaluation: The retention analysis was limited to 14 days. While the results indicate strong short-term retention, longitudinal studies are necessary to evaluate the model's impact over extended periods.

Limited Technological Integration: Although the MAPS Model incorporates digital learning strategies, its effectiveness with more advanced technologies, such as AI-driven tools, remains unexplored.

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Declarations

Author Contributions. T.K.: Conceptualization, software use, validation, investigation, resources, writing, review and editing, and supervision. A.U.: Conceptualization, software use, validation, formal analysis, investigation, resources, writing—original draft preparation, writing—review, and editing. M.C.: Software use, validation, formal analysis, original draft preparation, and writing review and editing. P.P: Conceptualization, software use, validation, formal analysis, original draft preparation, review and editing, and supervision. All authors have read and agreed to the published version of the manuscript.

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