Enhancing the Students' Ability to Integrate Mathematics Learning Management through Active Learning Activities

Nutjira Busadee[1]

Abstract

This paper presents a series of active learning activities aimed at enhancing students' ability to design and create integrated mathematics learning management across five thematic units: 1) Sports, 2) PISA, 3) Local Wisdom, 4) STEM, and 5) Philosophy of Sufficiency Economy. These activities encompass four teaching steps: 1) preparation, 2) exploration, 3) presentation, and 4) reflection. The study involved 20 mathematics major students enrolled in the first semester of the academic year 2022. The findings demonstrated that the students exhibited a high level of proficiency in designing and creating integrated mathematics learning management for each unit. The overall average score was 87.31%, indicating a commendable level of integration across different domains: STEM (96.0%), adherence to PISA guidelines (89.0%), integration of subjects and local wisdom (88.67%), integration within the sports context (84.0%), and integration of the philosophy of sufficiency economy (78.9%). The study strongly recommends focusing on active learning activities in each unit, such as group discussions, problem-solving exercises, interactive technology tools, and the utilization of educational games. These activities have shown the highest impact on students' abilities.

Keywords: Active Learning, PISA, STEM, Culture Wisdom, Philosophy of Sufficiency Economy

Introduction

Course 065438 [Integrated Mathematics Learning Management] is the compulsory course offered to 3rd or 4th Mathematics students in Faculty of Education, Chiang Mai University. This course provides students with comprehensive knowledge on the meaning, principles, and various types of integrated mathematics learning management. Moreover, it focuses on developing students' abilities in designing, creating, and evaluating integrated mathematics learning management. The primary objective of this course is to enhance students to design and create integrated mathematics learning management across five distinct units: 1) Sports, 2) PISA, 3) Local Wisdom, 4) STEM, and 5) Philosophy of Sufficiency Economy.

[1] Lecturer Dr., Department of Curriculum, Teaching and Learning, Faculty of Education, Chiang Mai University
Corresponding Author E –mail : nutjira.busadee@cmu.ac.th

Received: May 17, 2023 **Revised:** June 30, 2023 **Accepted:** June 30, 2023

Unit 1: Sports

According to the NCTM Journal, Mathematics Teachers, eight sports were utilized to create situations for teaching high school students about probability concepts. These sports include: running races, table tennis, football, rugby, American football, and golf (Busadee, Laosinchai & Panijpan, 2011). Sports have a positive impact on learning. Therefore, integrating sports into mathematics learning management serves as a motivating factor. By incorporating the sports into mathematics problems and situations, it becomes easier to demonstrate integration and engage students with real-life scenarios. These sport-related examples are not only relevant but also widely recognized by students, making them more likely to generate interest and actively participate in the learning process.

Unit 2: PISA

PISA, which stands for the Programme for International Student Assessment, is a globally conducted evaluation by the Organization for Economic Co-operation and Development (OECD, 2018). It aims to assess the educational systems of countries around the world. The assessment specifically measures the knowledge and skills of 15-year-old students in the subjects of reading, mathematics, and science. The exam now presents students with information derived from real-world situations, fostering the development of mathematical thinking through the application of reasoning and fundamental mathematical principles. This approach allows teachers to move away from directly instructing these principles and methods in the classroom, instead encouraging students to acquire knowledge and experience through real-life contexts. The three key components encompassed in the exam are as follows: 1) Mathematical reasoning and problem-solving processes: Students are assessed on their ability to employ critical thinking and problem-solving skills to tackle mathematical challenges effectively, 2) Mathematics content: The exam covers a broad spectrum of mathematical concepts, ensuring that students have a well-rounded understanding of various mathematical topics, and 3) Contextual relevance to 21st-century skills providing students with an opportunity to apply their mathematical knowledge in practical, real-world scenarios.

Unit 3: Local Wisdom

Leveraging local wisdom as a foundation for promoting students' 21st-century skills in teaching and learning is facilitated by the unique advantages of Thailand. With its rich historical background and cultural heritage, Thailand offers a wealth of local wisdom that can be effectively utilized in educational settings. Every community in Thailand possesses a diverse range of wisdom, making it an abundant resource for creative teaching and learning approaches. Integrating local wisdom into various subject areas and employing a variety of methods can enhance the educational experience. Teachers who creatively incorporate local wisdom not only make learning enjoyable but also foster the holistic development of 21st-century skills

among learners. Thailand's cultural richness presents an excellent opportunity for teachers to tap into the collective knowledge and practices of their local communities. By doing so, they can provide students with an engaging and relevant educational experience, nurturing their skills in critical thinking, problem-solving, collaboration, communication, and adaptability (Vanichwatanavorachai & Homfung, 2018).

Unit 4: STEM

STEM Education is an integrated learning approach that covers four disciplines: Science, Technology, Engineering, and Mathematics. The primary goal is to enable learners to apply their experience to real-world problems and careers. STEM education also supports the development of new processes or products that can be applied in the lives of learners through project-based learning or problem-based learning. Both project-based learning and problem-based learning not only facilitate the acquisition of knowledge and skills but also align with the changing needs of society and the 21st-century world, equipping learners with the skills and competencies needed to navigate a rapidly changing landscape. In addition, STEM education plays an important role in helping learners develop their abilities in various fields. These include acquiring cognitive skills, interpersonal skills and responsibility, numerical analysis, communication skills, and information technology capabilities. For this reason, learning management that focuses on STEM Education for teachers and students is extremely necessary. By providing students with the necessary tools and strategies, they can effectively promote STEM principles in future classrooms. Helping students succeed in a world that increasingly relies on STEM knowledge and skills (Klomim, 2016).

Unit 5: Philosophy of Sufficiency Economy

Integrating the sufficiency economy philosophy into learning management entails teachers incorporating the principles of sufficiency economy into activities throughout the learning process. This integration aligns with the curriculum's content, learning standards, and fundamental knowledge of self-sustainable living. Key aspects include self-reliance, frugality, utilization of local wisdom, efficient utilization of natural resources and the environment, mutual assistance, and organizing learning activities that integrate the sufficiency economy philosophy. These activities adhere to the core principles of moderation, reasonableness, and self-immunity, with two conditions: knowledge and morality (Chichirachan, 2019).

Active learning Activities are specifically designed to actively involve students in the learning process, promoting critical thinking, participation, and the application of knowledge. Here are some examples of active learning activities (Stanberry, 2018)

Group Discussions: Divide students into small groups to discuss a topic or problem relevant to the lesson. Encourage them to share their ideas, ask questions, and engage in meaningful dialogue with their peers (Rezaei, 2020).

Problem-Solving Exercises: Present students with real-world or hypothetical problems that require critical thinking and problem-solving skills (Cho, Caleon & Kapur, 2015). Allow them to work individually or collaboratively in groups to develop solutions and present their findings.

Interactive Technology Tools: Integrate interactive technology tools, such as online quizzes, virtual labs, or educational games, into the learning experience. These tools actively engage students and enhance their understanding of the subject matter. The implemented technology-based interactive method proved to be highly effective. Additionally, Bukhatwat, Ruqeishi and Khamisi (2022) mentioned that videos can create a conducive learning environment and enhance students' learning processes.

Games: Utilize educational games and activities that reinforce concepts and skills in an enjoyable and interactive manner. These games can make learning more engaging and help students retain information effectively. Furthermore, Eseryel et al. (2014) emphasized that the use of game-based learning combines elements of experiential learning and intrinsic motivation by incorporating explicit learning objectives into game applications. This approach enables learners to engage in challenging problem-solving tasks and activities that closely mirror real-world, authentic situations.

It is important to ensure that active learning activities align with the learning objectives of the lesson and provide opportunities for students to actively engage with the content, collaborate with their peers, and apply their knowledge in meaningful ways. By incorporating these teaching steps, we can enhance students' ability to integrate mathematics learning management effectively.

Step 1: Preparation: This step involves introducing and probing students with the necessary prior knowledge before engaging in practice. It helps set the foundation for their learning and prepares them for the upcoming activities.

Step 2: Exploration: In this step, students are provided with various methods and opportunities to develop their ability to design and create integrated learning management. They may work individually or effectively in groups, using cooperative or collaborative methods that promote critical thinking. Thinking tasks are designed to deepen their knowledge and consolidate their understanding of the subject matter.

Step 3: Presentation: Each student or group is required to present their task to the entire class. This presentation allows for the sharing of ideas and promotes peer assessment. Rubrics may be used to assess and evaluate the presentations, encouraging students to showcase their work and receive feedback from their peers.

Step 4: Reflection: This step focuses on helping students improve their learning by reflecting on their work. It emphasizes the importance of implementing feedback rather than

simply receiving it. Teachers provide feedback either verbally or in written form, and students are encouraged to critically analyze and evaluate their own work or that of their peers.

These four steps, Preparation, Exploration, Presentation, and Reflection, form a comprehensive framework to enhance students' ability to integrate mathematics learning management effectively.

Pre-prior knowledge for enhancing students' abilities in creating Integrated learning management.

After teaching the meaning, types, and principles of Integrated Learning Management, students were assigned two tasks to effectively prepare them for the next five units.

Activity Pre-1: Integrated Webbed Curriculum Model In this activity, students will watch a video clip that demonstrates how curriculum integration can be achieved. They will then proceed to the next step, which involves creating their own integrated webbed curriculum model. Each student will select a theme that is both interesting and relevant to real life. They will design at least five subjects under that theme, ensuring that the connections between the subjects are engaging and meaningful.

Activity Pre-2: Isomorphic Problems In this activity, students will work on solving isomorphic problems. These problems are designed to have the same underlying structure but different contexts or representations. By solving isomorphic problems, students develop the ability to recognize and transfer their problem-solving skills across different scenarios. This activity helps them build their problem-solving capabilities and prepares them for the challenges they will encounter in the upcoming units.

By engaging in these preparatory activities, students develop a solid foundation and acquire the necessary skills to effectively create integrated learning management throughout the course.

Figure 1 Examples of Student Work: Webbed curriculum model

Isomorphic problems refer to a concept in problem-solving and cognitive science. An isomorphic problem is a type of problem that has the same underlying structure or pattern, but may appear different on the surface or have different superficial elements. In other words,

isomorphic problems share the same fundamental problem-solving approach or strategy, even if the specific details or context vary.

When two problems are isomorphic, solving one of them can help in solving the other because they share common underlying principles. This allows individuals to transfer their problem-solving skills and knowledge from one problem to another, even if the specific content or context differs. By recognizing the similarities between isomorphic problems, individuals can apply familiar problem-solving techniques to new situations.

Isomorphic problems are often used in educational settings to help students develop problem-solving skills and promote transfer of learning. By presenting students with various problems that share similar structures but differ in content, educators can help students recognize patterns and develop general problem-solving strategies that can be applied to a wide range of situations.

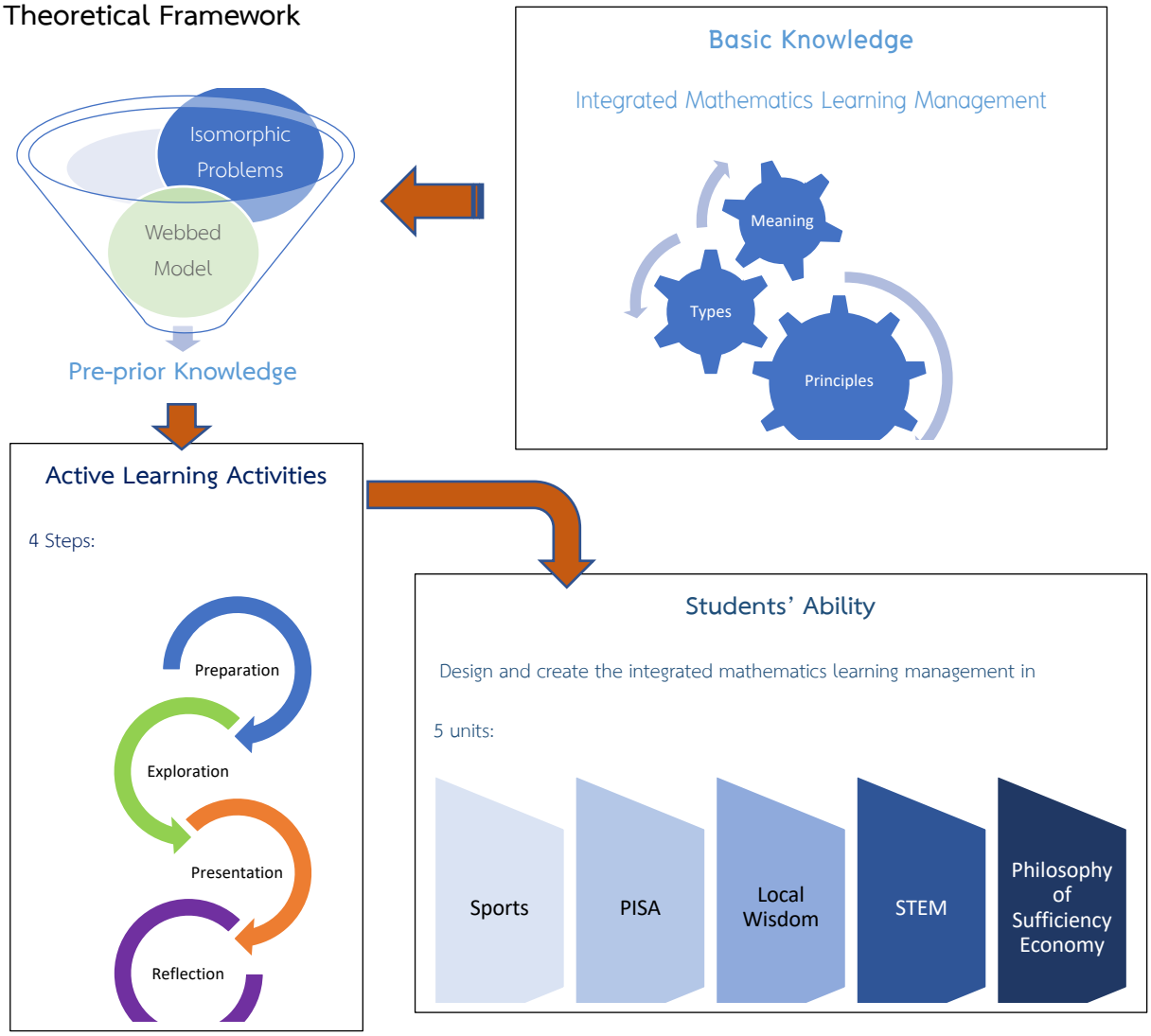
Isomorphic Problems: the students were assigned to creates set of 3 problems which different situations but the same problems' solving.

Figure 2 Examples of Student Work: Isomorphic Problems

Research Objective

To enhance the students' ability to design and create the integrated Mathematics learning management in 5 units through active learning activities.

Theoretical Framework



Research Methodology

1. Participants

The participants were 20 students enrolled in the 065438 course in the first semester of the academic year 2022.

2. Research instruments

Integrated learning management plan assessment form was used to assess the student's ability to design and create the integrated learning management plans in 5 units.

3. Data Collection

The researcher employed research instruments and utilized the analytic method to analyze the data, as depicted in Table 1. By assessing the individual students' abilities in each unit, their scores were averaged and converted into percentages. This allowed for the determination of their proficiency level based on the specified criteria.

Table 1 Details of research instruments and data collection

Unit	Research instrument	Data Collection (Establish scoring criteria based on specific issues)
Sports	Assessment form for evaluating students' ability in integrating sports into mathematics teaching	- Appropriateness of Sport Situations - Correspondence of sports to mathematical concepts - Additional information about the rules and regulations of the sport - Appropriateness of worksheets/activity sheets
PISA	Assessment form for evaluating students' ability in designing mathematics teaching in accordance with PISA guidelines	- Situations and Contexts - Content Areas - Competencies/Processes
Local Wisdom	Assessment form for evaluating students' ability in designing mathematics teaching in accordance with Local Wisdom	- Appropriateness of selected local wisdom - Concordance of local wisdom and mathematics content - Ability to design mathematics instruction that integrates local knowledge according to the 5W1H principle. - Appropriateness of worksheet design/activity sheet for learning management
STEM	Assessment form for evaluating students' ability in designing mathematics teaching in accordance with STEM education	- Interesting topics and problem situations created - Ability to analyze STEM: Science, Technology, Engineering and Mathematics - Ability to design sub-activities
Philosophy of Sufficiency Economy	Assessment form for evaluating the quality of performance in adjusting the learning management plan in accordance with the Philosophy of Sufficiency Economy	- Ability to analyze 3 loops 2 conditions - Ability to integrate desirable characteristics into a given learning management plan - Ability to align learning plans with the Philosophy of Sufficiency Economy

Details of instruction using active teaching activities for each step in 5 units as shown in the table 2.

Table 2 Details of instruction using active teaching activities for each step in 5 units

<table>
<tr><th>Teaching Step</th><th>Active Learning Activities</th></tr>
<tr><td>Unit 1: Sports</td><td></td></tr>
<tr><td>1) preparation</td><td>Engage in 3 activities (Bingo,Word wall, and Probability in Sports)</td></tr>
<tr><td>2) exploration</td><td>Group members collaborate to integrate the incorporation of sports into the teaching of mathematics across different grade levels.</td></tr>
<tr><td>3) presentation</td><td>Group representatives presented:</td></tr>
<tr><td>4) reflection</td><td>Teacher and fellow students provided oral suggestions.</td></tr>
<tr><td>Unit 2: PISA</td><td></td></tr>
<tr><td>1) preparation</td><td>Engage in 5 activities (Pretest, What is PISA?, Mathematical Literacy,PISA Tests, and Contents & Contexts)</td></tr>
<tr><td>2) exploration</td><td>Individual Task: creating a mathematics problem that integrates content-based, real-life contexts, in accordance with the PISA guidelines.</td></tr>
<tr><td>3) presentation</td><td>Individual presentation:
The outcome of categorizing students' problems based on content and context aligns with the PISA guideline as follows.
<table>
<tr><td colspan="2" rowspan="2">The number of students</td><td colspan="4">Contexts</td></tr>
<tr><td>Personal</td><td>Education/ Occupational</td><td>Public</td><td>Scientific</td></tr>
<tr><td rowspan="4">Contents</td><td>Space & Shape</td><td>3</td><td>2</td><td></td><td></td></tr>
<tr><td>Change & Relationships</td><td></td><td>2</td><td></td><td>1</td></tr>
<tr><td>Quantity</td><td>2</td><td>4</td><td>2</td><td>1</td></tr>
<tr><td>Uncertainty & Data</td><td></td><td>2</td><td></td><td>1</td></tr>
</table></td></tr>
<tr><td>4) reflection</td><td>- The teacher expressed their opinion verbally.
- Students express their opinions through a questionnaire in Google Forms, and all comments are forwarded to the author anonymously. without revealing the name of the commenter.</td></tr>
<tr><td>Unit 3: Local Wisdom</td><td></td></tr>
<tr><td>1) preparation</td><td>Engage in 2 activities (Kahoot and Distinctive identity of the community)</td></tr>
<tr><td>2) exploration</td><td>Individual Task: Students are tasked with selecting the unique aspects of their community's identity and integrating those elements into their mathematics instruction.</td></tr>
<tr><td>3) presentation</td><td>Individual presentation:
Examples of community identities selected and presented by students include locations, traditions, and foods.</td></tr>
<tr><td>4) reflection</td><td>- The teacher expressed their opinion verbally.
- Students express their opinions through a questionnaire in Google Forms, and all comments are forwarded to the author anonymously. without revealing the name of the commenter.</td></tr>
</table>

Teaching Step	Active Learning Activities
Unit 4: STEM Education	
1) preparation	Engage in 2 activities (Introduction to STEM andSTEM Situation/Problem)
2) exploration	Individual Task: Create situations or problem-based worksheets that integrate STEM to facilitate problem-solving.
3) presentation	Individual Presentation:
4) reflection	Students express their opinions through a questionnaire in Google Forms, and all comments are forwarded to the author anonymously. without revealing the name of the commenter.
Unit 5: Philosophy of Sufficiency Economy	
1) preparation	Engage in 2 activities (Sufficiency Economy Philosophy and Example of a learning management plan)
2) exploration	Individual assignment: Adjustment of the learning management plan.
3) presentation	Presented by representatives
4) reflection	The lecturer provided comments in class for the representatives, while feedback for the remaining participants was given through Microsoft Teams.

There are 5 active learning activities which consisted of 20 sub-activities and 6 supplementary clips were used for enhancing students' ability in creating integrated learning management plans.

Details of active learning activities in each unit are as follows.

Unit 1: Sports

In this Unit, we will begin by engaging in two interactive games: Bingo and a game from the website wordwall.com, which allows teachers to create customized games. The purpose of the Bingo game is to introduce students to the diverse world of sports, piquing their interest and providing an enjoyable experience. These games serve the additional benefit of helping students visualize the connections between various sports and the corresponding answers at each level of the game.

Figure 3-1 Bingo Game: Sports

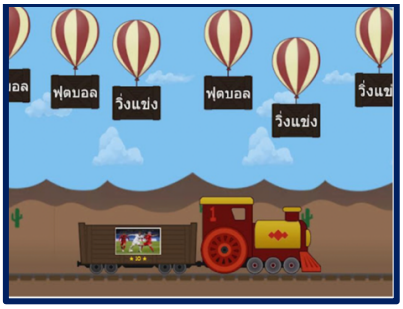


Figure 3-2 Wordwall Game: Sports

The instructor will present a video clip showcasing the teaching of statistics and probability, using a sports context as an example. This clip will provide students with a visual demonstration of how these mathematical concepts can be applied in the realm of sports, enhancing their understanding and engagement.

Figure 3-3 An example of integrating sports contexts in teaching mathematics

After that, students will be divided into 4 groups to help design a mathematical problem/situation by integrating the sports context as shown in the figure.

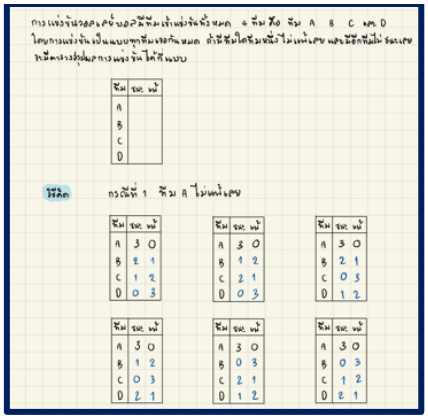


Figure 3-4 Examples of Student Work: Sports Context

Unit 2: PISA

Activity 1 students take a quiz before studying this topic.

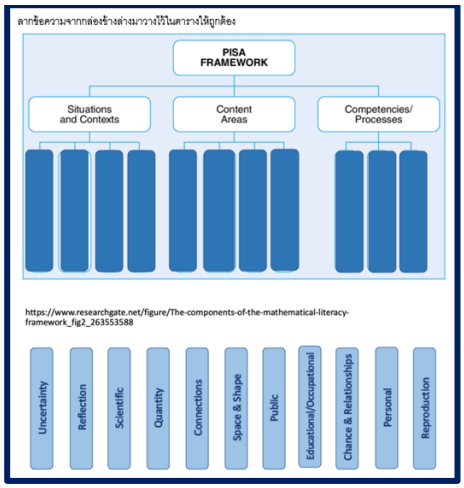


Figure 4-1 Liveworksheets: Pretest

Then let the students watch the clip of what is PISA?

Activity 2 Mathematical Literacy by matching definitions and important words given.

Figure 4-2 Liveworksheets: Mathematical Literacy

Then let the students watch the math performance clip.

Activity 3 PISA TESTS: Students take the PISA exam, then each person presents 2 assigned PISA problems for their peers to assess their presentation.

Figure 4-3 PISA Tests Activity: https://pisaitems.ipst.ac.th/quiz_math

Activity 4 Contents & Contexts: Students conduct activities to analyze situations that determine what content and context are in.

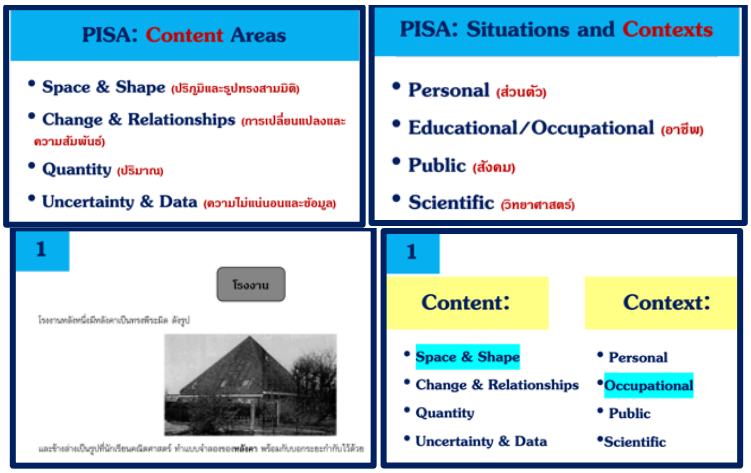


Figure 4-4 Contents & Contexts Activity

Activity 5: Compose a problem in the PISA style. Have each student design a problem situation according to the PISA style and present it to the class. Then, ask a friend to rate the presentation.

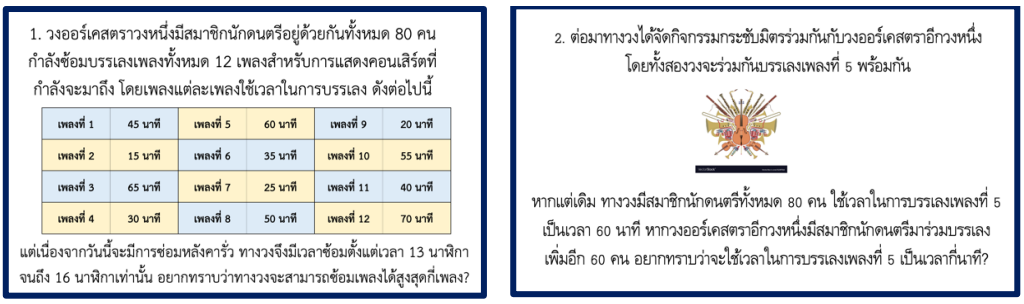


Figure 4-5 Examples of Student Work: PISA

Unit 3: Local Wisdom

On the topic of integrating local wisdom, we will start with two games from the kahoot.com website: folk toys/learning resources and community learning center games. These games will help students recognize the abundance of learning resources available in the community and demonstrate how they can be integrated into mathematics teaching.

Figure 5-1 Kahoot Game: Folk Toys

The students watched the clip titled “Artimatics: Integrating Two Sciences More Than They Thought: by Teacher Mew” and then completed Activity 1, which focused on the outstanding identity of the community. Each person was asked to present what comes to mind for most people when mentioning a particular place and share it with the class.

Figure 5-2 Examples of Student Work: Local Wisdom

Activity 2: Integration in Mathematics (Disciplinary). Choose a theme from Activity 1 to study further and analyze its relation to mathematics in teaching. Select one topic and design an activity along with a teaching file, worksheet, or activity sheet.

Figure 5-3 Examples of Student Work: Disciplinary

Unit 4: STEM

Activity 1: Students study the basic knowledge about STEM from the given knowledge sheet and summarize it in a presentation file. Then, the students watch a clip introducing STEM education, along with additional STEM integration sample documents.

Figure 6-1 Examples of Student Work: STEM Summary

Activity 2: Create a situation or problem that integrates STEM to solve the problem, with details of activities similar to the given example. Include sample clips from YouTube and present it online for friends to evaluate.

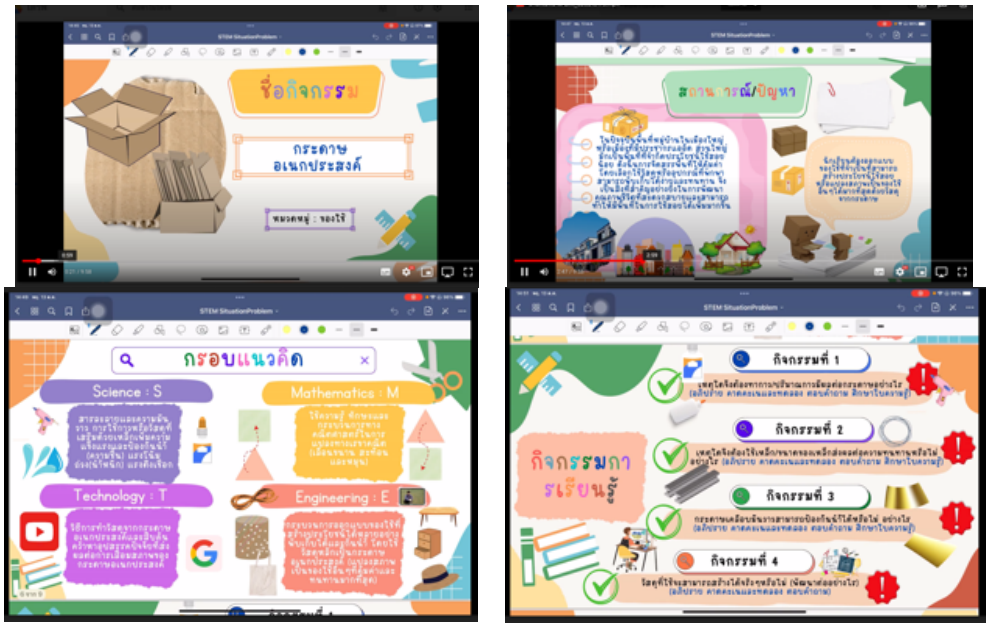


Figure 6-2 Examples of Student Work: STEM

Unit 5: Philosophy of Sufficiency Economy

Students have watched the clip "Animation Understanding, Accessing, Developing, Knowing the Sufficiency Economy Philosophy" and the cartoon "Sufficiency Economy Philosophy: 3 Rings, 2 Conditions". On the Google Site, there will be definitions and examples. Students studied a sample of an integrated learning management plan for sufficiency economy, including inserting desirable characteristics into the plan. After that, the students completed an activity to adjust the learning management plan by selecting one of the four given integrated learning management plans and enhancing it in their own form. The goal was to ensure that the learning management plan integrates all three loops of the Sufficiency Economy Philosophy and satisfies the two conditions required for complete and appropriate instruction at that level.

Figure 7-1 Examples of Student Work: Students' Summary in Philosophy of Sufficiency Economy

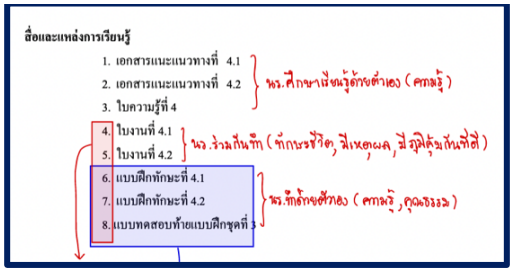


Figure 7-2 Examples of Student Work: Students analyze and make adjustments to the instructional plan integrating the Philosophy of Sufficiency Economy

Research Results

The results of the analysis of the average score in percentage of each activity in each unit are shown in the table 3.

Table 3 The average percentage of students in each unit

Unit	Average Percentage	Level
Sports	84.0	good
PISA	89.0	very good
Local Wisdom	88.67	very good
STEM	96.0	very good
Philosophy of Sufficiency Economy	78.9	good
Total	87.31	very good

Overall, students' average scores in all topics were 87.31 percent, which is at a very good level. The topic that received the highest score was Isomorphic Problems because all students were able to create problems that were similar and had the same problem-solving methods. Even though the Deep Isomorphism problem that the students composed has quite similar contexts, it is considered a problem that can be used for learning management

effectively. The topic that received the lowest score was the adaptation of the learning management plan that integrated the philosophy of sufficiency economy. This is because most students focused on adjusting other components into fine details, rather than focusing on integrating the philosophy of sufficiency economy with the complete 3 loops and 2 conditions as they should. As a result, the score in the adjustment of the plan was significantly lower than the other topics.

Discussion

The research discussions are divided into units as follows.

Sports: When it comes to sports, merely incorporating sports scenarios into mathematical problems may lack the elegance of integrating mathematics with an understanding of the respective sport's rules and regulations. However, the students will truly relish delving into topics that relate to their daily lives or exploring mathematics that captivate their interest, as opposed to conventional problem-solving approaches (Busadee, Laosinchai & Panijpan, 2011).

PISA: Students are performing admirably. Once students grasp the patterns of PISA problems, they can individually create problems within their own contexts, incorporating diverse generated patterns. They have the option to provide explanations for their choices and substantiate their reasoning by filling in equations or establishing relationships, with a particular focus on analytical thinking. This entails offering examples or making mathematical predictions. Apart from creating the examinations based on PISA guidelines, the students' practice outcomes will have a constructive impact on their own learning journeys, whether they become future educators as pre-service teachers or continue their professional growth as in-service teachers (Chanthum, Tantinai & Angganapattarakajorn, 2022).

Local Wisdom: In addition to students gaining insights into the spatial identity of their own communities, a remarkable aspect of this unit is the design and development of learning materials and worksheets centered around topics selected by the students (Zaki, Upu & Minggi, 2021). This includes the incorporation of the 5W1H (Who, What, When, Where, Why, How) approach, which serves to enhance students' ability to design effective learning management. Notably, this aligns with the national education policy's emphasis on fostering connections between students, parents, and communities. This aspect serves as a significant advantage for students who will graduate as teachers, as they are expected to become future community leaders and play a pivotal role in societal development.

STEM: In STEM teaching, mathematics is often perceived solely as a tool for calculations or hypothesis investigations. However, in this unit, we highlight the role of mathematics as a hero in STEM education. We also emphasize the significance of integrating

multiple subjects together. Students can discern how each subject in STEM teaching relates to one another. So why is it crucial to integrate various disciplines? Integration of multiple disciplines allows students to recognize the interconnected nature of different fields. Furthermore, it is important for students to realize that integrating mathematics teaching into STEM is not as difficult as they might have initially thought. Students 'task suggests that they can design and create problem situations in a STEM-style by utilizing key knowledge and effective questioning techniques (Klomim, 2016). By tailoring each topic to individual students, mathematics students can analyze the non-mathematical knowledge that their students should possess. This enables them to prepare a comprehensive set of knowledge to support students in successfully solving STEM problems.

Philosophy of Sufficiency Economy: While this unit does not involve students creating their own learning management plans, it does emphasize the importance of students being able to analyze the three loops and two conditions within the provided learning management plan. They are encouraged to assess whether these elements are included, and if so, how they are incorporated. If not included, students explore the possibilities of inserting them at any appropriate stage, along with considering the insertion of desirable characteristics, which is one of the three competencies learners should possess. The students have performed exceptionally well in this regard. It is expected that those who learn from this group of students will greatly benefit from the lessons learned in this unit throughout their academic journey. They will be able to apply this philosophy to their future, both in teaching and in life beyond the classroom (Klomim, 2019).

Small Group Discussion is a process of active learning that yields quick and effective results in learning. Teachers play an essential role in designing activities that foster group discussion. However, Lee, Morrone, and Siering (2018) noted that during small group discussions, some students may miss the opportunity to hear from the instructor or engage with the entire class. Therefore, they suggested that a class-wide discussion before or after the small group discussion is crucial for the success of active learning in large classrooms. Rezaei (2020) also states that instructors need to establish and communicate the rules before the class begins or early in the semester. They should clearly define their role as a teacher, the students' roles, and the policies regarding unacceptable behavior. Furthermore, teaching students how to ask appropriate questions can be beneficial.

Engaging students in group problem-solving activities as part of active learning has a positive impact on the development of critical thinking and problem-solving skills. This finding aligns with Isabel and Barbosa (2023), who emphasized that active learning fosters collaborative work and facilitates mathematical communication, which in turn leads to the emergence of diverse strategies for solving assigned tasks, ultimately benefiting students' learning outcomes.

The utilization of technology in proactive activities such as Kahoot, Liveworksheets, quizzes, and Socratives significantly aids students in grasping concepts more quickly and easily. Incorporating video clips also reduces lecture time, allowing for more extensive engagement in practical exercises. The creation of well-designed video clips positively impacts students, aligning with Bukhatwat, Ruqeishi and Khamisi (2022)'s findings, which emphasized the students' increased self-reliance, leading to student-centered learning. Additionally, students expressed a desire for instructors to provide more videos encompassing various topics, highlighting their ability to effectively utilize technology and derive benefits from it.

The use of games is a key factor that facilitates the integration of each unit into the mathematics teaching for students. Games serve as stimuli and challenges that ignite enthusiasm and motivation to engage with the content. Additionally, games aid in comprehending the integration model within each unit. This aligns with the findings of Eseryel et al. (2014), who emphasized the importance of sustaining student motivation throughout gameplay when designing educational games. Students naturally seek novelty and enjoy exploring problems. When students perceive an increase in their problem-solving competence, their motivation and willingness to invest more time and effort in problem-solving tasks are further enhanced.

While it is challenging to determine the most effective active learning activity, as its form should align with the specific topics, difficulty levels, preferences, proximity, familiarity, and unfamiliarity that students encounter, it undeniably plays a crucial role in the success of each learning unit. The joy, excitement, and enthusiasm displayed by students during these activities serve as clear indicators. Moreover, the collective experience and competencies of the students provide a strong assurance that the designed activities are fulfilling their intended purpose effectively and flawlessly.

The abundance of active learning activities alone is not sufficient. The design of these activities should be rooted in a deep understanding of the learners' knowledge and aimed at creating meaningful learning experiences (Lugosi & Uribe, 2022). By considering the perceived benefits of such design and its potential impact on student engagement, all students can maximize the benefits of this course. With willingness and commitment, time invested in these activities will undoubtedly yield valuable outcomes, ensuring a worthwhile learning journey.

Acknowledgments

The success of this research study is greatly dependent on the support of all participants. I am sincerely grateful for the financial support generously provided by the Teaching and Learning Innovation Center at Chiang Mai University (TLIC CMU).

References

Bukhatwat, Ruqeishi and Khamisi. (2022). The usefulness of technology-based interactive methods in teaching mathematics and statistics at the college level. *Shanlax International Journal of Education*, 10(3) , 30-40. Retrieved form https://files.eric.ed.gov/fulltext/EJ1340904.pdf

Busadee, N., Laosinchai, P., & Panijpan, B. (2011). Possibility and probability lessons from popular sports. *Mathematics Teacher, NCTM, 105*(5), 373-378.

Chanthum, P., Tantinai, P., & Angganapattarakajorn, V. (2022). The effects of active learning management with Think – Pair - Share on mathematical reasoning ability and achievement of mathayomsuksa 3 students. *Education Journal, Faculty of Education, Nakhon Sawan Rajabhat University, 5*(2), 8-16. Retrieved from https://so02.tci-thaijo.org/index.php/edunsrujo/article/view/255289/173186

Chitchirachan, C. (2019). A model development of learning by integration of the sufficiency economy philosophy for potential development of students in the higher educational institutions of the northeastern region. *Srinakharinwirot Academic Journal of Education, Faculty of Educarion, Srinakharinwirot University, 20*(2), 161-171. Retrieved from https://ejournals.swu.ac.th/index.php/jedu/article/view/12357

Cho, Y. H., Caleon, I.S. & Kapur, M. (2015). *Authentic problem solving and learning in the 21st century: Perspectives from Singapore and Beyond*. Springer Education Innovation Book Series, Dennis KWEK.

Eseryel, D., Law, V., Ifenthaler, D., Ge, X., Miller, R. (2014). An investigation of the interrelationships between motivation, engagement, and complex problem solving in game-based learning. *Educational Technology & Society, 17*(1) , 42–53. Retrieved form https://www.jstor.org/stable/jeductechsoci.17.1.42

Isabel, V. & Barbosa, A. (2023). Active learning strategies for an effective mathematics teaching and learning. *European Journal of Science and Mathematics Education, 11*(3), 573-588. Retrieved from https://www.researchgate.net/publication/369660981

Klomim, K. (2016). Learning management based on STEM Education for student teachers. *Journal of Education, Naresuan University, 18*(4), 334-348. Retrieved from https://so06.tci-thaijo.org/index.php/edujournal_nu/article/view/70988

Klomim, K. (2019). Active learning management with integrated King's science to enhance problem solving skills and teamwork learning skills for student teachers in mathematics education. *Humanities, Social Sciences and Arts, Veridian E-Journal, Silpakorn University, 12*(1), 1242-1259. Retrieved from https://he02.tci-thaijo.org/index.php/Veridian-E-Journal/article/view/148245/147099

Lee, D., Morrone, A. S., & Siering, G. (2018). From swimming pool to collaborative learning studio: Pedagogy, space, and technology in a large active learning classroom. *Educational Technology Research and Development, 66*(1), 95-127. Retrieved from https://www.researchgate.net/publication/321960690_From_swimming_pool_to_collabcollabo_learning_studio_Pedagogy_space_and_technology_in_a_large_active_learning_cclassroo

Lugosi, E. & Uribe, G. (2022). Active learning strategies with positive effects on students' achievements in undergraduate mathematics education. *International Journal of Mathematical Education in Science and Technology, 53*(2), 403-424. Retrieved from 10.1080/0020739X.2020.1773555

OECD. (2018). *PISA for development assessment and analytical framework: reading, mathematics and science*. OECD Publishing, Paris. Retrieved from http://dx.doi.org/10.1787/9789264305274-en

OECD. (2018). *PISA 2021 Mathematics Framework (Second Draft)*. PISA, OECD Publishing, Paris. Retrieved from https://www.oecd.org/pisa/sitedocument/PISA-2021-mathematics-framework.pdf

Rezaei, A. R. (2020). Groupwork in active learning classrooms: recommendations for users. *Journal of Learning Spaces, 9*(2), 1-21. Retrieved from https://files.eric.ed.gov/fulltext/EJ1273667.pdf

Stanberry, L. M. (2018). Active learning: a case study of student engagement in college calculus. International *Journal of Mathematical Education in Science and Technology, 49*(6), 959-969. Retrieved from 10.1080/0020739X.2018.1440328

Vanichwatanavorachai, S. & Homfung, C. (2018). The creative integration of local wisdom into teaching and learning in the 21st century. *Veridian E-Journal, Silpakorn University, 11*(3), 2551-2563. Retrieved from https://he02.tci-thaijo.org/index.php/Veridian-E-Journal/article/view/161261

Zaki, A., Upu, H., & Minggi, I. (2021). Model-Eliciting Activities (MEAs) with integrated local wisdom as a mathematics learning model. *IOSR Journal of Research & Method in Education, 11*(6), 1-7. Retrieved from https://www.iosrjournals.org/iosr-jrme/papers/Vol-11%20Issue-6/Ser-4/A1106040107.pdf

Citation

Nutjira Busadee. (2023). Enhancing the Students' Ability to Integrate Mathematics Learning Management through Active Learning Activities. *e-Journal of Education Studies, Burapha University, 5*(2), 100-121. สืบค้นจาก https://so01.tci-thaijo.org/index.php/ejes/article/view/267378