Enhancing Problem-Solving Ability through Active Learning with 21st-Century Media in the Values of Happiness Course

1st Boonyalak Tumnanchit
Faculty of Humanities and Social Science
Suan Dusit University
Bangkok, Thailand
boonyalaks@gmail.com

2nd Sutsawad Jandum
Faculty of Humanities and Social Science
Suan Dusit University
Bangkok, Thailand
plechun@hotmail.com

***Abstract*— The purposes of this study were: (1) to compare the post-learning problem-solving ability of students taught through active learning using 21st-century media and learning resources to that of students taught through the traditional teaching method, and (2) to compare students' problem-solving ability before and after instruction using active learning with 21st-century media and learning resources. The participants were 53 second-year undergraduate students enrolled in the Values of Happiness course (Course Code: 2500120) during the second semester of the 2022 academic year at Suan Dusit University. The students were divided into two groups: an experimental group of 26 students, taught through active learning with 21st-century media and learning resources, and a control group of 27 students, taught using a traditional teaching approach. The research instrument was a questionnaire measuring students' problem-solving ability, with a Cronbach's alpha reliability coefficient = .918. Data were analyzed using percentage, arithmetic mean, and standard deviation. The findings revealed that: (1) students taught through active learning with 21st-century media and learning resources demonstrated a greater improvement in problem-solving ability than those taught using the traditional approach, and (2) students taught through active learning using 21st-century media and learning resources achieved higher posttest scores in problem-solving ability compared to their pretest scores.**

Keywords*— *active learning, 21st century, style, problem solving

I. INTRODUCTION

From an educational research perspective, active learning can enhance students' problem-solving abilities through several cognitive mechanisms. First, it promotes deep processing. Traditional lecture-based instruction often places learners in a passive role, emphasizing surface-level memorization. In contrast, active learning activities—such as group discussions, collaborative problem-solving, and peer instruction—require students to retrieve prior knowledge, make connections, and reorganize information into meaningful knowledge structures. These processes are essential for addressing complex problems.

Second, active learning provides opportunities for practice and immediate feedback. Problem-solving is a skill rather than a static body of knowledge, and its development requires deliberate practice accompanied by timely feedback. Active learning enables students to apply their knowledge, make mistakes, and correct misunderstandings during the learning process before misconceptions become entrenched.

Third, active learning helps reveal incomplete understanding and promotes metacognitive awareness. When students are required to explain or justify their reasoning to peers or instructors, gaps in their comprehension often become apparent. This process encourages self-regulated learning, a critical characteristic of effective problem-solvers.

Fourth, active learning strengthens the ability to transfer knowledge to new contexts. Real-world problems rarely correspond exactly to textbook examples. Learning activities that require students to apply concepts and principles across varied situations enhance their capacity to transfer knowledge, rather than simply memorize fixed procedures or formulas (Freeman et al., 2014).

Research has consistently demonstrated the effectiveness of active learning in higher education. Freeman et al. (2014) reported that active learning significantly improved student learning outcomes and was particularly beneficial for students from disadvantaged backgrounds. However, students' perceptions do not always align with empirical evidence. A 2019 study that randomly assigned students to active learning or traditional lecture-based classrooms found that those in active learning environments achieved superior academic outcomes and greater learning gains. Nevertheless, some students perceived active learning as less effective, particularly when they expected instructors to deliver content directly.

There are multiple strategies to incorporate active learning into classroom instruction. Common strategies include question-and-answer sessions, group discussions, interactive lectures, peer instruction, and experiential learning activities (Kirkland, 2023). Moreover, 21st-century media and technological innovations can be integrated into active learning, as digital technologies increasingly shape students' daily lives. For example, learners can communicate with peers and instructors via mobile devices and access learning content through digital platforms such as blogs and YouTube (Blair, 2023; Silberman, 1998).

Active learning emphasizes constructing knowledge by building upon prior understanding. This approach aligns with student-centered learning, which has gained increasing attention in higher education. Students acquire knowledge from diverse sources, including instructors, peers, the Internet, and digital resources. Activities that encourage collaboration and hands-on practice stimulate interest, foster enthusiasm, create interactive classroom environments, and enhance the development of 21st-century learning skills (Chompoosaen et al., 2020). These practices also support educational policies promoting innovative teaching methods to prepare students for contemporary societal demands.

Recent research further supports the effectiveness of active learning in higher education. Boedeker et al. (2024) conducted a two-day randomized crossover trial involving

146 second-year medical students, comparing traditional lecture-based instruction with interactive large-group learning using identical case studies. Results indicated that students engaged in active learning achieved higher knowledge test scores, with an effect size of approximately 0.27 standard deviations, and reported stronger perceptions of their own learning, with an effect size of 0.56 standard deviations. Notably, students with lower prior academic performance benefited most from active learning. These findings suggest that active learning not only improves overall outcomes but also helps reduce disparities in academic achievement.

Based on this rationale and supporting evidence, the researchers investigated the enhancement of students' problem-solving ability through active learning using 21st-century media and learning resources in the Values of Happiness course. The study integrated active learning techniques, modern media, and participatory problem-solving activities, including online tasks, into the instructional process. These approaches were expected to increase student engagement and strengthen their problem-solving capabilities.

II. OBJECTIVES

1. To compare the post-learning problem-solving ability of students taught through active learning using 21st-century media and learning resources to that of students taught through the traditional teaching method

2. To compare students' problem-solving ability before and after instruction using active learning with 21st-century media and learning resources.

III. STATEMENT OF THE PROBLEM

Thailand continues to face challenges in developing the quality of its human capital across different age groups. Educational outcomes related to problem-solving ability remain a particular concern. The development of knowledge and skills among the workforce does not fully correspond to the changing demands of the labor market, contributing to issues related to values, attitudes, and behaviors. Future development should therefore place greater emphasis on establishing a strong foundation for cultivating well-rounded individuals with essential problem-solving skills (Office of the National Economic and Social Development Council, Office of the Prime Minister, 2022).

Problem-solving ability is considered one of the essential skills required of learners in the 21st century. It is also a key component of the Programme for International Student Assessment (PISA), an international assessment developed by the Organisation for Economic Co-operation and Development (OECD) to evaluate students' knowledge and skills and their ability to apply them to real-life situations. Consequently, the development of problem-solving skills should be regarded as a critical learning outcome in contemporary education (Sangthong, 2019).

The learning outcomes of students enrolled in the Values of Happiness course revealed difficulties in using 21st-century learning media and resources, particularly in relation to problem-solving ability. Students also demonstrated limited collaboration and participation in group learning, which hindered their ability to present their work effectively and resulted in lower academic achievement.

Active learning was therefore considered an appropriate approach to address these challenges. Active learning is a learner-centered method that emphasizes students' active roles, collaboration, and participation in problem-solving activities. It provides opportunities for practice, engagement, and skill development through critical thinking, synthesis, and knowledge sharing with peers. Throughout the learning process, teachers play a vital role in offering guidance, motivation, and support to facilitate student learning.

This approach encourages students to actively participate in learning activities and integrate prior knowledge with new information, enabling them to construct and expand their own understanding. Teachers can incorporate a variety of active learning methods and techniques into lesson plans, tailored to the learning objectives, students' needs, and the nature of the activities. Such approaches foster greater participation and engagement in classroom learning (Funfuengfoo, 2019).

CONCEPTUAL FRAMEWORK

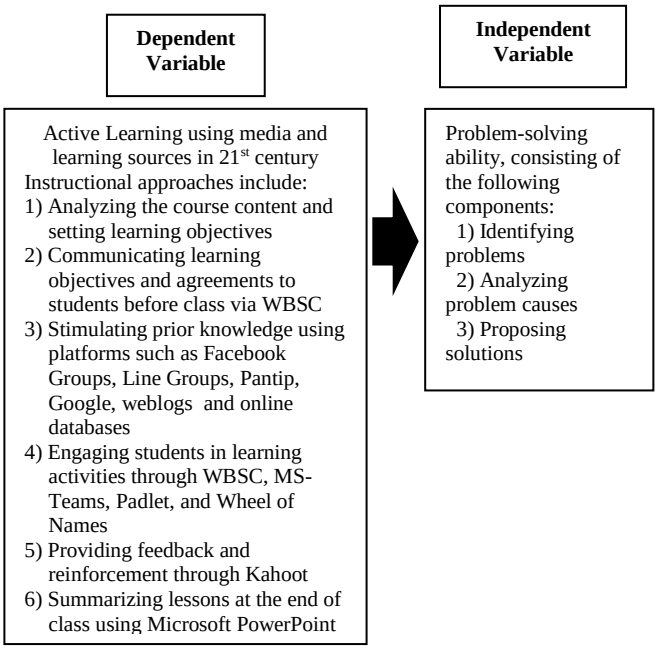

Fig 1. Conceptual framework

As this study primarily focuses on active learning as an instructional approach for enhancing students' problem-solving ability, commonly available 21st-century technologies were integrated into the learning process. These technologies included Facebook, LINE, Google, Padlet, Kahoot!, Microsoft Teams, and PowerPoint. In addition, the WBSC educational management system was incorporated as a supplementary tool to facilitate learning management and to promote students' active participation in teaching and learning activities.

IV. RESEARCH METHODOLOGY

A. Population and Samples

The participants in this study were 53 second-year undergraduate students at Suan Dusit University enrolled in the *Values of Happiness course* (Course Code: 2500120), Section A, during the second semester of the 2022 academic year. The students were divided into two groups: an experimental group of 26 students, taught using active learning with 21st-century media and learning resources, and a control group of 27 students, taught using traditional teaching methods.

The participants represented varying levels of academic performance—high, moderate, and low achievement—based on academic records obtained from their academic advisors.

B. Research instrument

1. Lesson plan for the *Values of Happiness Course*

1.1 Conducted a preliminary study by reviewing relevant theories, concepts, prior research, and related documents concerning active learning, 21st-century media and learning resources, and problem-solving ability.

1.2 Reviewed and analyzed the course description of the Values of Happiness course to provide a framework for lesson plan development and ensure alignment with the course objectives and expected learning outcomes.

1.3 Develop a lesson plan covering the required course content and aligning with the research objectives, with a particular focus on active learning using 21st-century media and learning resources. The course consisted of 45 hours of classroom instruction, an additional 3 hours of instruction per class, and 90 hours of self-directed learning. The course did not include practical training, work-based learning, fieldwork, or internships. Content was divided into eight units:

- Unit 1: The Science and Cost of Happiness
- Unit 2: Emotional Management
- Unit 3: Techniques for Creating Happiness
- Unit 4: Techniques for Building Sustainable Relationships
- Unit 5: The Art of Living by Yourself
- Unit 6: The Art of Living with Others
- Unit 7: Aesthetics and Living for Happiness
- Unit 8: Thinking for Happiness in the Digital Era

1.4 Established objectives for active learning activities using 21st-century media and learning resources, emphasizing support for students with lower levels of problem-solving ability, fostering understanding of individual differences and behavioral change, and promoting collaborative problem-solving under the guidance of the researcher as the instructor.

1.5 The lesson plan was reviewed by three experts to assess its content validity, appropriateness, and clarity of language. The evaluation results indicated that the lesson plan was appropriate at a high to highest level, based on the mean scores.

1.6 The lesson plan was revised according to expert recommendations and pilot-tested with students not included in the experimental group to identify potential issues and areas for improvement. A focus group discussion record form was used to document and summarize discussions. The Appreciation–Influence–Control (A-I-C) process was employed to analyze, summarize, and synthesize the information obtained from the discussions. Findings were used as guidelines for the preliminary development of local wisdom in Wachiraphayaban Subdistrict, Dusit District, particularly in terms of content and language, for the development of an e-book in Thai, English, Chinese, and Japanese. The e-book was intended to provide reliable, up-to-date, and citable information.

Focus group discussion questions were developed based on information gathered from fieldwork and a review of relevant literature and documents. The questions were reviewed by three experts to assess content validity, accuracy, clarity, and appropriateness of wording. Expert evaluations were analyzed to determine the consistency between the questions and the intended content. The questions were then revised according to recommendations to ensure the validity and appropriateness of content and structure.

The Index of Item-Objective Congruence (IOC) was subsequently calculated, and questions with IOC values ranging from 0.80 to 1.00 were selected for inclusion in the instrument. The revised instrument was then pilot-tested with 30 students not included in the research sample. Reliability was assessed using Cronbach's alpha coefficient, with an overall reliability coefficient was .87.

C. Data Collection

1. Before the experiment, students in the experimental group completed a 20-item questionnaire to measure their problem-solving ability prior to instruction.

2. The experimental group was taught through online lessons combined with Active Learning, using 21st-century media and learning resources. Instruction was conducted in six sessions, three hours per session, for a total of 18 hours. Students' behaviors during the learning activities were also observed. The control group was taught using traditional teaching methods.

3. After the experiment, both the experimental and control groups completed the research questionnaire to measure their post-learning problem-solving ability.

4. The researchers developed a teaching manual for online lessons combined with active learning using 21st-century media and learning resources. The manual included teacher materials, student roles, teaching methods, and examples of teaching activities for Lessons 1 and 2, including worksheets, learning activities, and photos of classroom activities.

5. Data were collected by the researcher using the problem-solving ability questionnaire.

D. Data analysis

This study analyzed data using statistics as follows:

• The problem-solving ability of students before and after learning through active learning with 21st-century media and learning resources was compared by calculating the mean (μ) and standard deviation (σ) of scores from the problem-solving questionnaire.

• A five-level rating was employed to interpret the results:

O 4.51 – 5.00 = Highest level of problem-solving ability

O 3.51 – 4.50 = High level of problem-solving ability

O 2.51 – 3.50 = Moderate level of problem-solving ability

O 1.51 – 2.50 = Low level of problem-solving ability

O 1.00 – 1.50 = Lowest level of problem-solving ability

Since this study employed a census method, data were collected from the entire population. Therefore, population parameters were directly described using descriptive statistics, including frequency, percentage, mean, and standard deviation. Inferential statistics were not applied, as the study did not involve generalizing findings from a sample to a larger population.

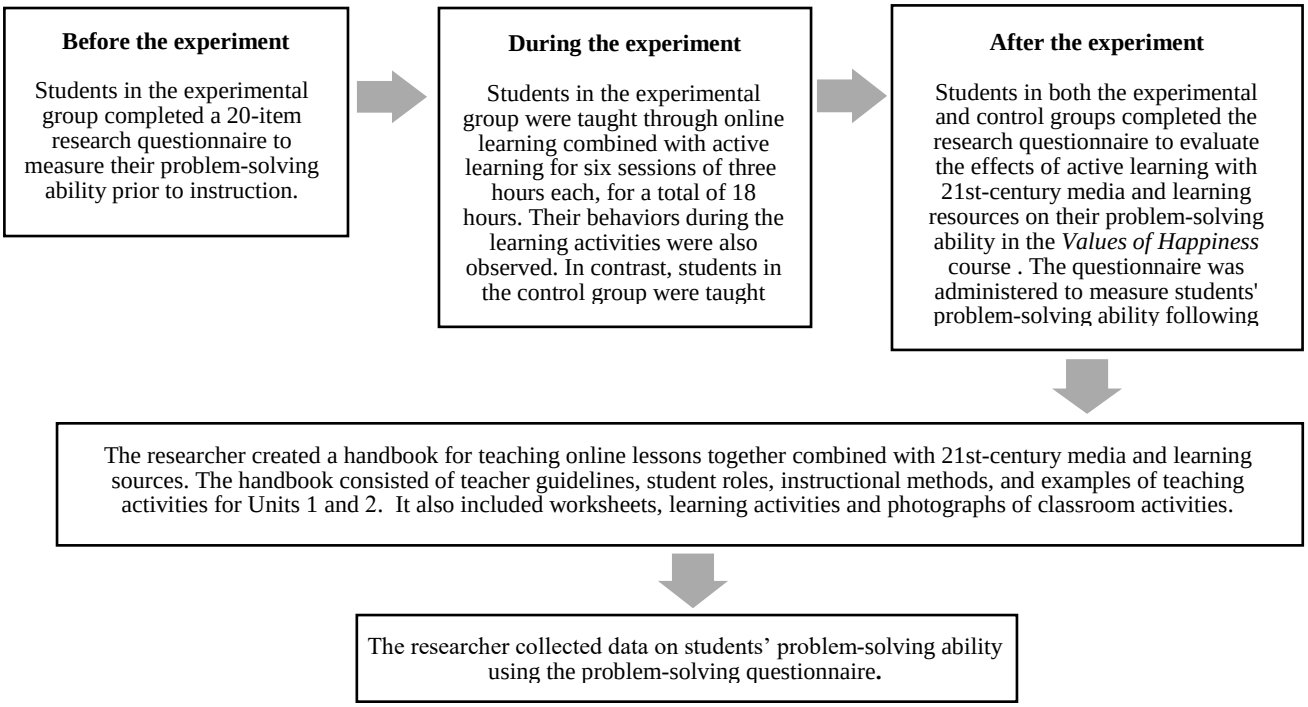

Fig. 2. Research Process from Data Collection to Data Analysis

V. RESULTS

The comparison of students' problem-solving skills after the lesson between those taught through active learning with 21st-century media and learning resources and those taught through traditional methods is presented in Table 1.

TABLE I. COMPARISON OF STUDENTS' PROBLEM-SOLVING SKILLS AFTER THE LESSON BETWEEN ACTIVE LEARNING WITH 21ST-CENTURY MEDIA AND LEARNING RESOURCES AND TRADITIONAL TEACHING METHOD

Problem-solving ability	μ	σ	**Problem-solving ability level of control group after the lesson**	μ	σ	**Problem-solving ability level of experimental group after the lesson**
1.Students ask questions that lead to a clear understanding of the problem by explaining its importance or drawing on personal, social and societal experiences.	2.30	0.72	Low	4.27	0.67	High
2.Students create criteria for problem selection to identify the real problem and direct answers.	2.22	0.70	Low	4.19	0.75	High
3.Students plan to identify the problem according to its importance.	2.22	0.64	Low	4.27	0.53	High
4. Students work collaboratively as a team to identify possible problems involving multiple conditions.	2.63	0.49	Average	4.35	0.80	High

Problem-solving ability	μ	σ	Problem-solving ability level of control group after the lesson	μ	σ	Problem-solving ability level of experimental group after the lesson
5. Students identify the causes of problems that involve more than two conditions.	2.63	0.63	Average	4.19	0.57	High
6. Students integrate or improve the solutions by listening to others.	2.48	0.70	Average	4.38	0.70	High
7. Students identify causes of problems that align with objectives to apply them in daily life.	2.41	0.75	Low	4.27	0.67	High
8. Students rearrange the importance of problem causes rationally.	2.33	0.73	Low	4.35	0.69	High
9.Students share responsibilities in gathering data to solve problems.	2.48	0.75	Low	4.46	0.65	High
10. Students search for data from a variety of information resources.	2.30	0.82	Low	4.42	0.58	High
11. Students follow the plan and solve problems step by step using supporting data.	2.52	0.94	Average	4.46	0.65	High
12. Students create criteria for selecting problem-solving methods, apply these criteria to evaluate possible methods and identify the most appropriate solution.	2.33	0.78	Low	4.62	0.64	Highest
13. Students identify the information as alternative problem-solving methods, categorize at least two methods, and classify the information appropriately.	2.44	0.80	Low	4.46	0.58	High
14. Students and their team link the causes of problems and possible outcomes using rational supporting data.	2.48	0.75	Low	4.46	0.71	High
15. Students work together to decide on a problem-solving method based on available information, considering advantages and limitations to avoid negative impacts on themselves and others.	2.56	0.85	Average	4.23	0.65	High
16. Students plan to present their problem-solving methods in a clear step-by-step manner.	2.67	0.73	Average	4.35	0.80	High
17. Students examine their solutions for flaws and make revisions before presenting.	2.56	0.70	Average	4.42	0.64	High
18. After presenting their solutions, students can answer questions from classmates and teachers clearly and rationally.	2.33	0.70	Low	4.62	0.57	Highest
19. Students summarize and write reports accurately and clearly.	2.37	0.63	Low	4.50	0.51	High
20. Students produce work from problem-solving that is accurate and appropriate based on rationale and ethics, achieving at least 80% correctness in solved problems.	2.33	0.68	Low	4.65	0.49	Highest
Overall	**2.43**	**0.73**	**Low**	**4.40**	**0.64**	**High**

The comparison of students' problem-solving ability before and after learning through active learning using 21st-century media and learning resources. is presented in Table 2.

TABLE 2. COMPARISON OF MEAN, STANDARD DEVIATION, AND PROBLEM-SOLVING ABILITY LEVELS BEFORE AND AFTER LEARNING IN THE EXPERIMENTAL GROUP

Problem-solving ability	μ	σ	**Problem-solving ability level of experimental group before the lesson**	μ	σ	**Problem-solving ability level of experimental group after the lesson**
1.Students ask questions that lead to a clear understanding of the problem by explaining its importance or drawing on personal, social and societal experiences.	2.13	0.54	Low	4.27	0.67	High
2.Students create criteria for problem selection to identify the real problem and direct answers.	2.08	0.41	Low	4.19	0.75	High
3.Students plan to identify the problem according to its importance.	2.50	0.51	Low	4.27	0.53	High
4. Students work collaboratively as a team to identify possible problems involving multiple conditions.	2.38	0.58	Low	4.35	0.80	High
5. Students identify the causes of problems that involve more than two conditions.	2.33	0.57	Low	4.19	0.57	High
6. Students integrate or improve the solutions by listening to others.	2.08	0.50	Low	4.38	0.70	High
7. Students identify causes of problems that align with objectives to apply them in daily life.	2.08	0.41	Low	4.27	0.67	High
8. Students rearrange the importance of problem causes rationally.	2.42	0.65	Low	4.35	0.69	High
9.Students share responsibilities in gathering data to solve problems.	2.42	0.50	Low	4.46	0.65	High
10. Students search for data from a variety of information resources.	2.33	0.70	Average	4.42	0.58	High
11. Students follow the plan and solve problems step by step using supporting data.	2.21	0.42	Average	4.46	0.65	High
12. Students create criteria for selecting problem-solving methods, apply these criteria to evaluate possible methods and identify the most appropriate solution.	2.00	0.30	Low	4.62	0.64	Highest
13. Students identify the information as alternative problem-solving methods, categorize at least two methods, and classify the information appropriately.	2.42	0.58	Low	4.46	0.58	High
14. Students and their team link the causes of problems and possible outcomes using rational supporting data.	2.46	0.51	Low	4.46	0.71	High
15. Students work together to decide on a problem-solving method based on available information, considering advantages and limitations to avoid negative impacts on themselves and others.	2.21	0.51	Low	4.23	0.65	High
16. Students plan to present their problem-solving methods in a clear step-by-step manner.	2.00	0.42	Low	4.35	0.80	High
17. Students examine their solutions for flaws and make revisions before presenting.	2.04	0.20	Low	4.42	0.64	Highest
18. After presenting their solutions, students can answer questions from classmates and teachers clearly and rationally.	2.42	0.50	Low	4.62	0.57	Highest
19. Students summarize and write reports accurately and clearly.	2.46	0.51	Low	4.50	0.51	High
20. Students produce work from problem-solving that is accurate and appropriate based on rationale and ethics, achieving at least 80% correctness in solved problems.	2.12	0.54	Low	4.65	0.49	Highest
Overall	**2.25**	**0.49**	**Low**	**4.40**	**0.64**	**High**

In summary, the findings revealed that the experimental group, who learned through active learning using 21st-century media and learning resources in the Values of Happiness course, demonstrated higher problem-solving ability after learning compared to before learning.

From Tables 1 and 2, the results are as follows:

The comparison of problem-solving skill after learning between students taught by active learning with 21st-century media and learning resources and those taught through traditional methods revealed that the control group's problem-solving ability after the Values of Happiness course was at a low level. When considering each item, six aspects were at the average level, ranked from most to least as follows:

- Students plan to present their problem-solving methods in a clear, step-by-step manner.
- Students identify the causes of problems that involve multiple conditions.
- Students work together as a team to identify possible problems involving multiple conditions.
- Students work collaboratively to decide on a problem-solving method based on available information, considering advantages and limitations to avoid negative impacts.
- Students examine their solutions for defects and make revisions before presenting.
- Students follow the plan and solve problems at each step using supporting data.

The remaining aspects were at the low level.

In contrast, the experimental group's problem-solving ability after learning the Values of Happiness course was at a high level. When considering each item, three aspects were at the highest level, ranked from most to least as follows:

- Students work from problem-solving that is accurate and appropriate, based on rationale and ethics, achieving at least 80% correctness in solved problems.
- Students establish criteria for selecting problem-solving methods, apply these criteria to evaluate possible methods, and identify the most appropriate solution.
- After presenting their solutions, students answer questions from classmates and teachers clearly and rationally.

The remaining aspects were at high level.

Overall, the experimental group demonstrated high problem-solving ability after learning, whereas the control group remained at a low-level.

The comparison of problem-solving skill between students taught through active learning with 21st-century media and learning resources before and after learning revealed that the experimental group's problem-solving ability in the Values of Happiness course was at a low level prior to instruction.

When considering each aspect, all 20 indicators were at the low level. The top three, ranked from highest to lowest were as follows:

- Students plan to identify the problem according to its importance of the problem.
- Students and their team link the cause of the problem to possible outcomes using rational supporting data.
- Students summarize and write reports accurately and clearly.

After instruction, the experimental group's problem-solving ability in the Values of Happiness course was at a high level. When comparing the data, students in the experimental group who studied through active learning with 21st-century media and learning resources demonstrated higher problem-solving ability after lessons than before.

VII. DISCUSSION AND CONCLUSION

A. Comparison Of Problem-Solving Ability Before Learning Between the Experimental and Control Groups

The comparison of students' problem-solving ability after the learning intervention revealed that those in the experimental group, who were taught through active learning using 21st-century media and learning resources, demonstrated higher problem-solving ability than students in the control group, who were taught using traditional teaching methods. This finding was consistent with the research hypothesis

The result aligns with Phorka (2019)**,** who conducted a study entitled *The Effect of Organizing Learning Activities Based on Constructivist Theory Together with the GeoGebra Program on Analytic Geometry and Problem-Solving Ability*. The study showed that students who participated in learning activities based on Constructivist Theory combined with the GeoGebra program demonstrated higher problem-solving ability than those who received conventional instruction, with statistical significance at the .05 level. Furthermore, the development of problem-solving ability among students who in the Constructivist Theory and GeoGebra program group was greater than that of students taught through conventional methods.

Similarly, Boedeker et al. (2024) conducted a two-day randomized crossover trial involving 146 second-year medical students. The study compared traditional lecture-based instruction with interactive large-group learning using identical case studies. Results indicated that students in the active learning condition achieved knowledge test scores approximately 0.27 standard deviations higher than those in the traditional learning condition. They also reported stronger perceptions of their own learning, with a difference of 0.56 standard deviations. Notably, students with lower prior academic achievement benefited the most from the active learning approach.

The findings were also consistent with Kozanitis and Nenciovici (2023), who conducted a meta-analysis entitled Effect of Active Learning versus Traditional Lecturing on the Learning Achievement of College Students in Humanities and Social Sciences: A Meta-Analysis. The meta-analysis examined 104 studies comparing the academic achievement of university students in the humanities and social sciences who participated in active learning and those who received traditional lecture-based instruction. Results indicated that student performance was higher under active learning, with a mean effect of 0.489 standard deviations, representing a statistically significant difference ($Z = 6.521$, $p < .001$) across 111 comparison groups involving 15,896 participants. The study further found that the benefits of active learning were

particularly pronounced in sociology, psychology, language, education, and economics, and were greater in smaller classes of 20 students or fewer.

The higher problem-solving ability observed among students in the experimental group may be explained by the learner-centered nature of active learning. Organizing students into small groups and providing opportunities to share opinions, discuss problems, exchange ideas, and providing feedback encourages active participation in the learning process. These activities allow students to exchange knowledge, consider different perspectives, and develop appropriate approaches to problem-solving. In addition, teachers can serve as facilitators by providing guidance, learning resources, and feedback throughout the process.

The integration of 21st-century media and learning resources further supports active learning by providing students with access to diverse sources of information and opportunities for communication and collaboration. Students can use these resources to search for information, discuss possible solutions, share ideas with peers, and apply knowledge to problem-solving activities. Such learning experiences can promote critical thinking, collaboration, knowledge sharing, and independent learning. Therefore, the use of active learning combined with 21st-century media and learning resources contributed to the higher problem-solving ability observed among students in the experimental group compared with those in the control group. These findings support active learning as an effective instructional approach for developing students' problem-solving ability in higher education.

B. Comparison of Pretest and Posttest Problem-Solving Ability of the Experimental Group

The comparison of students' problem-solving ability before and after participating in active learning using 21st-century media and learning resources revealed that students in the experimental group enrolled in the *Values of Happiness* course demonstrated higher problem-solving ability after the learning intervention than before. This finding was consistent with the research hypothesis.

The result aligns with Laoha et al. (2019), who conducted a study entitled *The Development of an Instructional Design for a Flipped Classroom Model Using a Virtual Classroom System with Problem-Based Learning to Develop Problem-Solving Ability and Critical Thinking among Higher Education Students*. Their findings indicated that students' overall problem-solving ability improved across all learning units. In particular, students demonstrated greater development in the brainstorming stage, in which they identified and analyzed problems, and in the evaluation stage, in which they assessed possible solutions and selected the most appropriate one. These results suggest that learning approaches that provide opportunities for students to actively analyze problems and evaluate alternative solutions can enhance problem-solving ability.

The findings were also consistent with Ursua (2023), who investigated *The Impact of the Flipped Classroom on Civil Engineering Students' Learning of Differential Calculus*. The pretest–posttest experimental study involved 42 first-year civil engineering students and found that the flipped classroom approach improved students' problem-solving ability and their mastery of solving differential calculus problems.

In addition, Ke et al. (2023) conducted a quasi-experimental pretest–posttest study involving 303 second-year nursing students. The experimental group (n = 152) received instruction through a task-oriented flipped classroom, while the control group (n = 151) received traditional lecture-based instruction. The findings showed that the experimental group demonstrated greater improvement in self-directed learning, problem-solving, and critical thinking skills than the control group.

The findings of the present study may be explained by the active participation and collaborative learning observed during the learning activities. Students who engaged in active learning using 21st-century media and learning resources participated in online teamwork to solve problems based on the given case studies. They worked in small groups to exchange ideas, share knowledge, and develop solutions collaboratively. The students also participated in decision-making and problem-solving activities, allowing them to learn from one another and apply their knowledge in practical situations.

Observation of students' learning behaviors further indicated that collaborative activities encouraged active participation in the learning process. Working in small groups provided opportunities for students for communication, discussion of different perspectives, decision-making, and joint development of solutions. These activities may have strengthened students' problem-solving ability by allowing them to practice analyzing problems, evaluating possible solutions, and applying knowledge in varied contexts.

Therefore, the findings suggest that integrating active learning with 21st-century media and learning resources can provide a flexible and collaborative learning environment that supports the development of students' problem-solving ability. Teachers may apply small-group activities, flexible learning arrangements, online collaboration, case-based problem-solving, and digital learning resources to encourage students to participate actively, exchange knowledge, and develop problem-solving skills.

VIII. SUGGESTIONS

A. Suggestions for Teaching and Learning Management

When implementing active learning with 21st-century media and learning resources, teachers should actively facilitate students' learning and provide guidance and feedback throughout each stage of the learning process. The following steps are recommended:

(1) Analyze course content and establish clear learning objectives that are consistent with the expected outcomes.

(2) Inform students of objectives and establish learning agreements before the beginning of each lesson.

(3) Activate prior knowledge by using diverse media and learning resources, such as Facebook Groups, LINE Groups, Pantip, Google, Facebook, and online databases.

(4) Organize active learning activities through digital platforms such as Microsoft Teams, Weblogs, Padlet, and Wheel of Names.

(5) Provide timely feedback and reinforcement through digital tools such as Weblogs and Kahoot!.

(6) Summarize the key content at the end of each lesson using Microsoft PowerPoint.

(7) Assess learning outcomes through Microsoft Teams to determine whether students have achieved the learning objectives established in the lesson plan.

B. Suggestions for Future Comparative Studies

Future studies should compare the effectiveness of active learning using 21st-century media and learning

resources with both traditional teaching methods and web-based learning approaches. Such studies should also consider the differences in learners' characteristics, backgrounds, learning styles, and levels of prior academic achievement.

C. Suggestions for Further Research

Further research should investigate the effects of active learning using 21st-century media and learning resources on students' problem-solving ability and explore alternative digital media and learning resources beyond those employed in the present study. Such investigations may provide additional guidelines for designing effective learning activities to enhance students' problem-solving ability.

REFERENCES

[1] N. Blair (2023). Technology integration for the new 21st century learner [Online]. Available: http://www.naesp.org/principal-januaryfebruary-2012-technology/technology-integration-new-21st-century-learner

[2] P. Boedeker., T. Schlingmann, J. Kailin, A. Nair, C. Foldes, D. Rowley, K. Salciccioli, R. Maag, N. Moreno and N. Ismai. (2024). Active versus passive learning in large-group sessions in medical school: A randomized cross-over trial investigating effects on learning and the feeling of learning. Medical Science Educator. https://doi.org/10.1007/s40670-024-02219-1

[3] W. Chompoosaen, K. Panitcharoen and C. Prommas . (2020). Effect of active learning approach on problem-solving ability and achievement in health education and physical education of grade 7 students [Master thesis]. Burapha University.

[4] Freeman, S., Eddy, S. L., McDonough, M., Smith, M. K., Okoroafor, N., Jordt, H., & Wenderoth, M. P. (2014). Active learning increases student performance in science, engineering, and mathematics. Proceedings of the National Academy of Sciences, 111(23), 8410–8415. https://doi.org/10.1073/pnas.1319030111

[5] V. Funfuengfu. (2019). "The success of active learning management. Valaya Alongkorn Review" Humanities and Social Science, 9(1), 135-145.

[6] L. Ke, L. Xu, L. Sun, J. Xiao, L. Tao, Y. Luo, Q. Cao and Y. Li. (2023). "The effect of blended task-oriented flipped classroom on the core competencies of undergraduate nursing students: A quasi-experimental study." BMC Nursing, 22, Article 8. https://doi.org/10.1186/s12912-022-01080-0

[7] T. Kirkland. (2023). Active learning. [Online]. Available: https://teaching.washington.edu/engaging-students/active-learning/#:~:text=Active%20learning%20is%20an%20instructional,to%20what%20they%20already%20know

[8] A. Kozanitis and L. Nenciovici. (2023). "Effect of active learning versus traditional lecturing on the learning achievement of college students in humanities and social sciences: A meta-analysis." Higher Education, 86(6), 1377–1394. https://doi.org/10.1007/s10734-022-00977-8

[9] R. Laoha, T. Jantakoon and K. Chinsook (2019). The Development Instructional Design Flipped Classroom Model Using Virtual Classroom System with Problem-Based. Maha Sarakham: Faculty of Science and Technology, Rajabhat Mahasarakham University.

[10] S. Phorka (2019). The effect of organizing learning activities based on constructivist theory together with GeoGebra Program on Analytic Geometry on problem-solving ability [Master thesis]. Ubon Ratchathani University eleventh-grade students. Journal for Social Sciences Research, 10(2), 113-129.

[11] Office of the National Economic and Social Development Council. (2022). 20-Year National Strategy. [Online]. Available: https://www.dga.or.th/wp-

[12] Sangthong, A. (2019). "Development of problem sloving ability using psychomotor skills learning management with problem solving process and jigsaw technique in culinary arts for 5th grade secondary school students." Journal of Social Science Research, 10(2), 113-129.

content/uploads/2018/08/file_32600e26a233b3fc9c88e48300c10334.pdf

[13] L. Silberman, Melvin. (1998). Active Training : Handbooks of Techniques, Design, Case Examples, and Tips. 2nd. ed. California: Jessey–Bass Pfeiffer.

[14] J. R. Ursua. (2023). "Impact of the flipped classroom on civil engineering students' learning of differential calculus." Psychology and Education: A Multidisciplinary Journal, 8(8), 909–913. https://doi.org/10.5281/zenodo.7922341