THE DEVELOPING THE ABILITY TO SOLVE MATHEMATICAL PROBLEMS ON TRIGONOMETRIC FUNCTIONS IDENTITIES USING INQUIRY-BASED LEARNING (5E) CONCEPT COMBINED WITH THE TRIGONOMETRY HEXAGON TECHNIQUE FOR GRADE 11 STUDENTS

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ABSTRACT

The purpose of this research is to develop the ability to solve mathematical problems on Trigonometric Functions Identities using Inquiry-Based Learning (5E) concept combined with the Trigonometry Hexagon technique for grade 11 students of Suan Sunandha Rajabhat University Demonstration School (Secondary Department) in the second semester of the academic year 2022, one room with 20 students acquired by co-operation. The tools used in this research were the learning management plan for Trigonometry Hexagon combined with Inquiry-Based Learning (5E) concept, a mathematics learning achievement test, and a mathematical problem-solving ability test. Statistical analysis of data using percentage, mean, and standard deviation. and the sampling t-test were independent of each other.

The research results showed the ability to solve mathematics problems after receiving the learning management using Trigonometry Hexagon technique together with the Inquiry-Based Learning (5E) concept, higher than 70 percent of the test score was statistically significant at the .05 level, which was in line with the hypothesis of this research.

Keywords: Trigonometric Functions Identities, Inquiry-Based Learning (5E), Problem solving skills, Ability to solve problems.

INTRODUCTION

In the dynamic landscape of the 21st century, mathematical problems have evolved beyond traditional paradigms, reflecting the increasing interplay between mathematics and contemporary technological, scientific, and societal advancements. As we confront the challenges of our era, mathematical problem-solving takes on new dimensions, requiring interdisciplinary approaches and innovative methodologies. In the seminal work "Mathematics and the 21st Century" by Schoenfeld, the author emphasizes the need for mathematical education to adapt to the changing demands of the modern world, calling for a shift towards problem-solving that reflects real-world complexities and encourages critical thinking (Schoenfeld, 2002).

In Thailand, the teaching and learning of mathematics from the past to the present has not been as successful as it should be. Considering from the results of the basic national education test (O-NET) in the past years, it was found that the overall mathematics subject was still in very low criteria. (National Institute for Educational Testing, 2021), especially problem solving It appears that most students solve the problem. Rarely a problem from the advancement of technology and communication today and education is the cornerstone of sustainable development (UNESCO, 2011 cited in Office of education council, 2014)

Mathematical problems often demand more than just rote application of formulas; they necessitate a deep understanding of underlying principles and the ability to discern patterns and

relationships. The complexities embedded in mathematical problem-solving provide fertile ground for cultivating critical thinking skills and fostering a resilient approach to intellectual challenges. In the academic landscape, educators and researchers continue to explore innovative pedagogical approaches, such as problem-based learning and heuristic strategies, to enhance students' problem-solving abilities (Hmelo-Silver, 2004). These initiatives aim to bridge the gap between theoretical knowledge and practical application, fostering a holistic understanding of mathematics. In addition, mathematics is a field of study that is important to students both in living today and in pursuing higher education. This is because mathematics is a tool that leads to academic progress. Science, economics, society, and education are important foundations for research. All types of research (Yupin Pipitkul 1981: 11) In addition, mathematics is an important factor in human quality development Because mathematics helps develop students' minds to be able to think. systematically and reasonably and can solve problems effectively Therefore, teachers should use technology in conjunction with the analytical thinking process in learning activities for students (Montri Wongsaphan 2013, 130) to enhance students' ability to solve problems and academic achievement. Mathematics has gotten better.

Strengthening students' ability to solve math problems requires teaching strategies that help them practice thinking in an organized way and using appropriate techniques to solve math problems. Inquiry-Based Learning, often encapsulated by the 5E instructional model (Engage, Explore, Explain, Elaborate, Evaluate), represents a pedagogical approach that fosters active student engagement and critical thinking. The model, developed by Roger Bybee, emphasizes a structured yet flexible framework for educators to guide students through the learning process. The 'Engage' phase sparks curiosity, setting the stage for exploration in the 'Explore' phase, where students actively investigate concepts. The 'Explain' stage allows for the development of foundational knowledge, followed by 'Elaborate,' where students apply their understanding in real-world scenarios. Finally, 'Evaluate' ensures comprehensive comprehension assessment. This method has gained prominence in diverse educational settings due to its effectiveness in promoting deep understanding and problem-solving skills (Bybee, 2014). By encouraging students to ask questions, analyze data, and draw conclusions, the 5E model aligns with contemporary educational paradigms that prioritize student-centered, experiential learning.

Therefore, from the problems mentioned. The researcher is therefore interested in developing a learning management plan using Inquiry-Based Learning (5E) concept combined with the Trigonometry Hexagon technique for ability to solve mathematical problems on Trigonometric Functions Identities of Grade 11 students at Demonstration School of Suan Sunandha Rajabhat University to develop the learning process of learners to participate in more teaching and learning activities foster the development of mathematical skills and processes in order to lead the learners to achieve their goals.

Objective

Compare the ability to solve mathematical problems After learning Trigonometric Functions Identities using Inquiry-Based Learning (5E) concept combined with the Trigonometry Hexagon technique.

Research Hypothesis

Ability to solve math problems after learning Trigonometric Functions Identities using Inquiry-Based Learning (5E) concept combined with the Trigonometry Hexagon technique will have a positive impact above the 70 percent threshold on exam scores, with statistical significance at the .05

Expected Benefits

1. To know the problem-solving ability of Grade 11 students from learning Trigonometric Functions Identities using Inquiry-Based Learning (5E) concept combined with the Trigonometry Hexagon technique.

2. As a guide for organizing activities for teachers of mathematics and science. To improve teaching and learning that contributes to the development of academic achievement and problem-solving abilities for students in other grades.

METHODS

This research was a quasi-experimental study to study mathematical problem-solving skills using a single group study. According to a single group experimental design Before the test and after the test (One group posttest design) with the following research methods:

Population and sample: 1) The population used in this research is grade 11 students of Suan Sunandha Rajabhat University Demonstration School (Secondary Department) in the second semester of the academic year 2022, one group, totaling 20 students. 2) The sample group used in this research is grade 11 students of Suan Sunandha Rajabhat University Demonstration School (Secondary Department) in the second semester of the academic year 2022, whose test scores on Trigonometric Functions are lower than the 60% threshold. Examination scores of 20 students by voluntary recruitment. The lesson content used in this research is in accordance with the Basic Education Core Curriculum, B.E. 2008, revised B.E. 2017, one plan, Trigonometric Functions Identities, consisting of (1) Reciprocal Identities (2) Pythagorean Identities (3) Sum and Difference Identities (4) Half- Angle Identities (5) Double Angle Identities (6) Triple Angle Identities (7) Product identities and (8) Sum of Identities

Variables studied: Consisting of the independent variable: teaching and learning using the Inquiry-Based Learning (5E) concept with the Trigonometry Hexagon technique and the dependent variable: the ability to solve mathematical problems on Trigonometric Functions Identities.

The experimental tools: Consisted of 1) learning management plan with Inquiry-Based Learning (5E) concept combined with the Trigonometry Hexagon technique on Trigonometric Functions Identities and 2) Test to measure mathematical problem-solving skills on Trigonometric Functions Identities**.**

Data collection tools for data collection: 1) Learning plan with Trigonometric Functions using Inquiry-Based Learning (5E) concept combined with the Trigonometry Hexagon technique. Take the completed learning activity plan and present it to 3 experts to check the correctness, appropriateness, feasibility, and applicability of the learning activities. The researcher brought the content validity (IOC) value to be determined by 3 experts and obtained an average value ranging from 0.50 to 1.00. The results show that the test's statements meet all criteria. It had a mean value of 0.91 and was analyzed for internal consistency using the Kuder-Richardson (KR20) method with a reliability of 0.85 to find quality and confidence. of the entire test

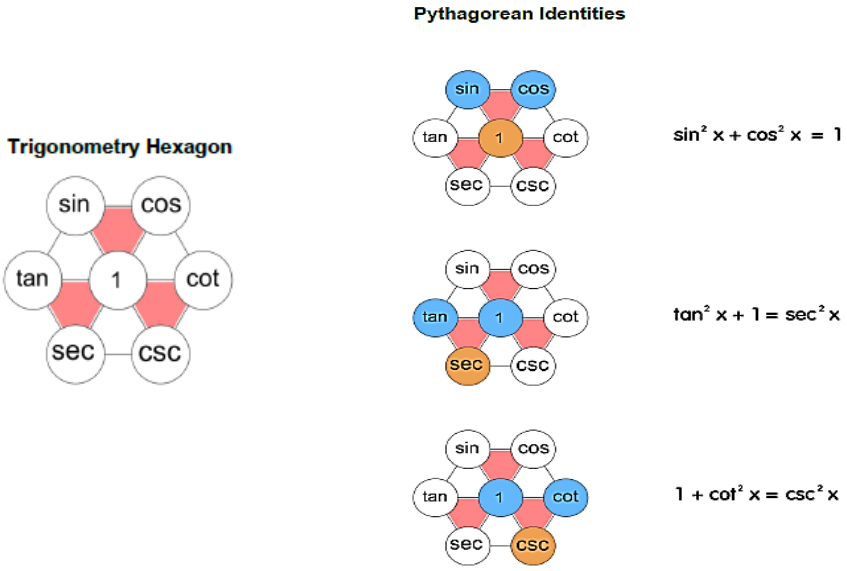

Figure 1 Using Trigonometry Hexagon technique combined with Trigonometric Functions

2) Test to measure mathematical problem solving skills on Trigonometric Functions Identities. Analyze the relationship between content. Learning objectives Create a multiple-choice test, 1 set, 5 options, 15 questions, and from evaluating and revising the test of mathematical problem-solving skills. by 3 experts respectively. It was found that the index of consistency (IOC) was between 0.50 - 1.00. Then it was taken to find the difficulty value and discriminatory power. By taking a test to measure academic achievement to test (Try - out) Tairueakham S. (2008: 101 – 102) taking a test of mathematical problem-solving skills. Go experiment with students who have the same characteristics as the study group and have passed the content study. Trigonometric Functions. Scores obtained from the experiment were analyzed by measuring difficulty (p) and discriminatory power (r) between 0.25–0.80 and 0.20 – 0.75, respectively, and were analyzed for internal consistency reliability. By the Kuder-Richardson method (KR20) has a precision value (Reliability) at the level of 0.85 to determine the quality and confidence of the entire test.

Data Collection Method

The researcher proceeded as follows: 1) began recruiting a voluntary sample; 2) conducted learning using trigonometric function identities using the inquiry-based learning (5E) concept combined with hexagonal trigonometry techniques. Outside of regular class time, 20 times, 50 minutes each. 3) Take a test to measure problem-solving skills in mathematics learning. Trigonometric Functions Identities were tested on a sample group, one period for 50 minutes, respectively. After being taught using the Inquiry-Based Learning (5 E) concept combined with the Trigonometry Hexagon technique, Trigonometric Functions Identities and 4) Use the scores from the test to measure mathematical problem-solving skills on Trigonometric Functions Identities before and after conducting a learning management experiment using the Inquiry-Based Learning (5 E) concept combined with the Trigonometry Hexagon technique. Statistical analysis of results was performed to further verify the hypothesis.

Basic statistics of research tools: 1) Percentage, 2) Mean, 3) Standard Deviation, and 4) T-test for one sample.

Statistics to determine the quality of research tools: 1) the content validity of the pre-experimental and post experimental achievement test (IOC: Index of Item Objective Congruence), a formula of Lovinelli and Hambelton. (Rowinelli & Hambleton, 1977) 2)

Determination of confidence (Reliability) using Cronbach's alpha (α- Coefficient) method, which is an improvement from the KR.20 formula. using Brennan's method (Bernan 1974) and 5) determining the difficulty and determining the power of subjective exam classification. using the method of CA Drake (CADrake).

The data were analyzed as follows: 1) comparing mathematics learning achievements before and after learning by using matched pairs t-test; of Grade 11 students before and after learning management using Inquiry-Based Learning (5 E) concept combined with the Trigonometry Hexagon technique using a t-test (t - test for one sample) and 3) analyzing learning achievement. Subject mathematics increases function and decrease function of Grade 11 students before and after learning management using Inquiry-Based Learning (5E) concept combined with the Trigonometry Hexagon technique using T-test.

RESULTS

The results of developing mathematical problem-solving skills increase function and decrease function of Grade 20 students after receiving a learning management using Inquiry-Based Learning (5E) concept combined with the Trigonometry Hexagon technique. The results are shown in Table 1.

Table 1 Mean and T-test statistics of mathematical problem-solving skills on add and subtract functions. Before and after learning management using Inquiry-Based Learning (5 E) concept combined with the Trigonometry Hexagon technique.

Samples	n	Full score	$\bar{x}$	S.D.	t	p
Before	20	15	11.9	2.25	-15.02*	.000
After	20	15	24.35	2.11		

*p<0.05

From Table 1, it was found that the mathematical problem-solving skills on adding and decreasing functions of grade 11 students after receiving the learning management using Inquiry-Based Learning (5 E) concept combined with the Trigonometry Hexagon technique. were higher than the percentage criteria 70 of the test score, statistically significant at the .05, which is in accordance with the research hypothesis.

CONCLUSION AND FUTURE WORK

According to the research on the effect of learning management using Inquiry-Based Learning (5E) concept combined with the Trigonometry Hexagon technique on ability to solve mathematical problems on functions of Grade 11 students at Suan Sunandha Rajabhat University Demonstration School. Because students can understand the use of the Trigonometry Hexagon and able to review knowledge Change the variables in the study subject. Until the knowledge of the content is obtained This is because learning management plan created by the researcher, there are teaching and learning activities that focus on students working together Help each other as a group according to Inquiry-Based Learning (5 E) collaborative techniques. Students who have studied Trigonometry Hexagon. Able to research conclusions and various knowledge, resulting in achievement of learners' mathematical problem-solving skills higher than before. and likely because of the following reasons the research results can be discussed as follows.

Mathematics problem solving skills on Trigonometric Functions Identities of Grade 11 students after receiving the learning management using Inquiry-Based Learning (5E) concept combined with the Trigonometry Hexagon technique was higher than the criteria of 70 percent of the test scores at a statistical significance at the .05 , which was in accordance with assumptions shows that Learning management with the Inquiry-Based Learning (5E) concept will help the learner to level up in the process of systematic thinking and create knowledge by yourself. By using questions (Inquiry) for them to bring the experiences they have learned or practice to think and act until it becomes learning from their own understanding. The important characteristics of 5E learning management are: 1) Engage - stimulates children's interest as much as possible by using methods that must be related to the lesson. 2.) Explore - gives children the opportunity to build knowledge and understanding of themselves. 3) Explain - gives them the opportunity to communicate what they have learned. and what has been discovered. 4) Extend - knowledge can be put to practical use. and 5) Evaluate - teachers and children evaluate their understanding of what has been learned. This is consistent with the guidelines for developing mathematical reasoning that it should be a learning arrangement with time for students to analyze problems on their own. Avoid telling students how to solve problems when they are unsuccessful (National Council of Teachers of, M, 2 0 0 0) . Additionally, students should be encouraged to experience Through exchanging ideas, speaking, explaining, and clarifying with reasons, activities should be organized using an investigative approach. For students to have the opportunity to search, predict, find methods of proof, observe patterns, teachers should also create an atmosphere for students to feel brave in expressing their opinions in various cases and teach students to express their opinions in support or opposition by giving Reasoning in mathematics appropriately and logically (The Institute for the Promotion of Teaching Science and Technology (IPST), 2015). This is in line with the research of (Chuicomwong N, 2022) The student's abilities in mathematical problem solving for sixth grade students after learning management by using the Model Inquiry Method (5E) higher at the .05 level. Including research by Yonwilad, Wannatida, et al., 2022 findings show that experienced undergraduate students can solve mathematical problems as a proportion of the overall score when using the virtual 5E instructional organization.

The application of artificial intelligence technology principles AI in this research for the benefit of teaching and learning, including the preparation of teaching plans. problem solving in the classroom teaching system and further development of a group of students with knowledge and abilities So that teachers can arrange teaching and learning to match their knowledge and abilities. and needs of most learners Because students can understand the use of the Wolfram Alpha program. being used as a problem-solving tool and develop analytical thinking used to create strategies to solve complex problems and develop a deep understanding A new form of education was born. arouse interest in students Make the learners have a better understanding of the lesson. not monotonous This is because the learning plan created by the researcher has teaching and learning activities that focus on students being able to explore conclusions and various knowledge by themselves.

The application of the inquiry-based learning concept (5 E) together with the hexagonal trigonometry technique in this research. For the benefit of teaching Including the preparation of teaching plans. Solving problems in the classroom teaching system and further developing groups of students with knowledge and abilities and allowing teachers to organize teaching and learning to match their knowledge and abilities. and the needs of most learners. In addition, students can understand the use of Trigonometry Hexagon as a tool for solving problems and develop analytical thinking used to create strategies to solve complex problems and develop deeper understanding. A new type of education was born and stimulated the interest of students. Makes the learners have a better understanding of the lesson, not repetitive, because the

learning plan created by the researcher has teaching activities that focus on allowing the students to research conclusions and various knowledge by themselves.

Recommendations

1. Suggestions for implementation

1.1. Inquiry-Based Learning (5E) concept combined with the Trigonometry Hexagon technique students must exchange ideas and present their work in front of the class. Teachers should encourage students to have courage. Express this with reinforcement such as rewards, praise, applause, and use open-ended questions to encourage reasoning.

1.2. Teachers should supervise and encourage group members to be responsible. There is unity in the group. Known to be a good leader and follower**.**

2. Suggestions for further research

2.1. There should be an improvement and development of a learning management plan in the garden where the situation should be a situation that is close to the students' daily lives. for students to realize and be able to

2.2. The results of learning activities using the Inquiry-Based Learning (5E) concept combined with the Trigonometry Hexagon technique should be studied in normal groups of students compared to the weak group of students that can develop problem-solving skills or other mathematical skills and processes that are not different.

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