บทความวิจัย

ผลการเรียนรู้ของนักเรียนจากกิจกรรมการสร้างตัวแบบเชิงคณิตศาสตร์ เรื่อง ทฤษฎีบทพีทาโกรัส

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บทคัดย่อ

การออกแบบกิจกรรมให้นักเรียนเรียนรู้การสร้างตัวแบบเชิงคณิตศาสตร์มีความสำคัญ เนื่องจากการสร้างตัวแบบเชิงคณิตศาสตร์ถือเป็นเครื่องมือสำคัญในการประยุกต์ใช้แก้ปัญหาในโลกแห่งความเป็นจริง ดังนั้นเป้าหมายทางการศึกษาจึงคาดหวังว่านักเรียนจะสามารถบรรลุความสามารถนี้ อย่างไรก็ตามกิจกรรมการเรียนรู้สำหรับนักเรียนในการสร้างตัวแบบเชิงคณิตศาสตร์นั้นไม่ค่อยได้รับการออกแบบในโรงเรียนโดยเฉพาะในประเทศไทย งานวิจัยนี้มีวัตถุประสงค์เพื่อพัฒนากิจกรรมการเรียนรู้เพื่อสนับสนุนกระบวนการสร้างตัวแบบเชิงคณิตศาสตร์สำหรับนักเรียนชั้นมัธยมศึกษาปีที่ 2 ในเรื่องทฤษฎีบทพีทาโกรัส โดยมีนักเรียนร่วมวิจัยจำนวน 36 คน ได้ลงมือปฏิบัติกิจกรรมทั้งหมดจำนวน 6 กิจกรรม เพื่อสะท้อนผลการสร้างตัวแบบ มีการวิเคราะห์โปรโตคอลการทำกิจกรรมกลุ่มของนักเรียน และเพื่อสะท้อนผลของกิจกรรมต่อผลสัมฤทธิ์ของนักเรียนมีการทดสอบปรนัยเกี่ยวกับเนื้อหาก่อนเรียนและหลังเรียนจำนวน 20 ข้อ ผลจากการวิเคราะห์โปรโตคอลที่ได้นำเสนอแสดงถึงการบรรลุเป้าหมายของการวิจัยที่ต้องการให้เกิดกระบวนการสร้างตัวแบบในชั้นเรียน และจากแบบทดสอบวัดผลสัมฤทธิ์พบว่าการผนวกกิจกรรมการสร้างตัวแบบเข้าไปในห้องเรียนมีผลเชิงบวกต่อผลสัมฤทธิ์ของนักเรียน ผลการวิจัยนี้นำไปสู่แนวทางที่ครูผู้ซึ่งสนใจจะนำไปต่อยอดปรับปรุงเพื่อใช้ออกแบบกิจกรรมการสร้างตัวแบบสำหรับพัฒนานักเรียนในบริบทดังกล่าว

คำสำคัญ: การเรียนรู้โดยใช้กิจกรรมเป็นฐาน ตัวแบบเชิงคณิตศาสตร์ การสร้างตัวแบบเชิงคณิตศาสตร์

อ้างอิงบทความนี้
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Research Article

Learning outcomes of students from mathematical modeling activities on the Pythagorean theorem

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Abstract

It is essential to design activities that teach students how to construct mathematical models. This is due to the fact that mathematical modeling is an important tool for addressing real-world issues. Therefore, the educational objective is for pupils to attain this competency. In schools, particularly in Thailand, however, it is uncommon for pupils to engage in the creation of mathematical models. This study intends to design learning activities to help the mathematical modeling process for Mathayomsuksa 2 students in relation to the Pythagorean theorem. There was a total of 36 participants in the study learning modeling via six exercises. To represent the modeling findings, the student group activity was examined using the protocol technique, and 20 multiple-choice tests of pre- and post-learning material were administered to indicate the influence of the activities on student accomplishment. Incorporating modeling activities into the classroom was proven to have a favorable influence on student accomplishment, as shown by the achievement test scores. This study resulted in a methodology that interested educators may utilize to enhance and build modeling activities for student growth in this setting.

Keywords: Activity-based learning**,** Mathematical model**,** Mathematical modelling

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Introduction

One of an ultimate goal of learning mathematics is the teachers could prepare students to function confidently in real-world situations. Mathematical modeling is a form of real-world problem solving. A modeling approach to solve problem focuses a variety of mathematical skills on finding a solution and help students to see mathematics in a broad spectrum of applications (Cheng, 2001; Eric, 2009; Seebut, 2012).

Mathematical modeling could be defined as translating encountered problems into mathematical forms by seeing mathematics as a tool for solving problems. In fact, all mathematical concepts have roots in the real-world situations that could be translated into the mathematical models in order to use appropriate mathematical methods to find solution for those problems and classical mathematical modelling process can be showed as followed in Figure 1 (Ferri, 2017; Kang and Noh, 2012; Lingefjard, 2012; Seebut, 2012).

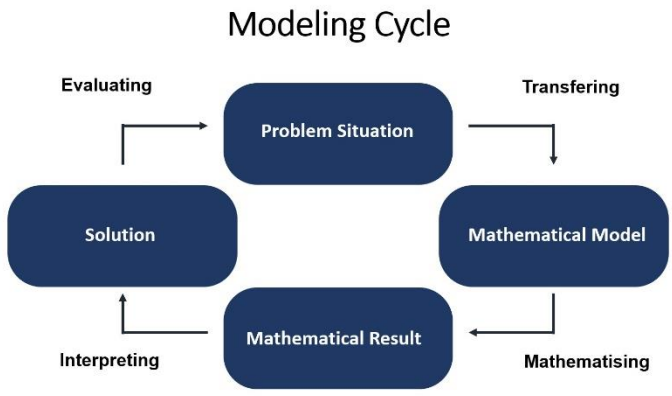

Figure 1. mathematical modeling cycle

The process of mathematical modeling consists of four main stages:

1. Observing a phenomenon, delineating the problem situation inherent in the phenomenon, and discerning the important factors that affect the problem

2. Conjecturing the relationships among factors and interpreting them mathematically to obtain a model for the phenomenon

3. Applying appropriate mathematical analysis to the model

4. Obtaining results and reinterpreting them in the context of the phenomenon under study and drawing conclusions.

This process could be repeated until mathematical model is appropriate to make prediction and conclusion of observed real world situations.

However, when contemplating the administration of mathematical model learning. The original mathematical modeling cycle has been improved to facilitate the creation of mathematical models by pupils (Blum, 2009; Ferri, 2017; Seebut, 2012). Figure 2 illustrates the mathematical modeling cycle for classroom activities.

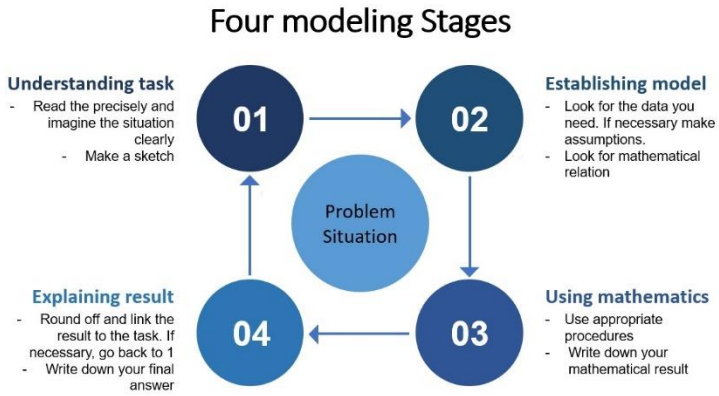

Figure 2. Mathematical Modeling Cycle for Classroom Activities

As seen in Figure 2, the mathematical modeling cycle for classroom activities is regarded to be centered on the actions that students exhibit through the mathematical modeling process. The circuit is analyzed in further depth and separated into six stages in which the behavior of the mathematical modeling process may be characterized (Blum, 2009; Chan,2009; Ferri, 2017), with a summary of the stages shown in Figure 3.

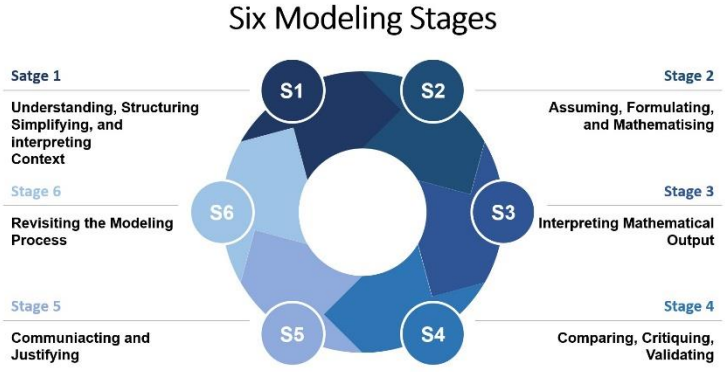

Figure 3. Mathematical modeling cycle with an emphasis on the behavior of students in performing activities

For this study, a mathematical modeling exercise on the Pythagorean Theorem was created for students to practice. The mathematical modeling cycle is then applied to the behavior of students completing activities, using video recording of the students executing the mathematical modeling task. The findings will indicate the effectiveness of a classroom where modeling activities are employed to improve pupils. In addition, this research focus on the outcomes of learning about the Pythagorean theorem in the context of learning management via mathematical modeling exercises.

Designing Learning Activities

Lesson plans for learning activities to provide fundamental information on mathematical modeling, two learning activities employing two hours of practice time were prepared and are presented in Table 1.

Table1. Activities that provide essential knowledge about mathematical modeling

Lesson Plan No.	Activity title	amount of usage hours
1	Which store to purchase?	1
2	largest pig stall	1

Lesson plans for learning activities centered on mathematical modeling and the four learning activities listed in Table 2 allocate four hours to all teaching activities. The generated lesson plan for Mathyomsuksa 2 addresses the Pythagorean Theorem.

Table 2. Lesson plans for mathematical modeling-centered learning activities

Lesson Plan No.	Activity title	amount of usage hours
1	square puzzle	1
2	right triangle puzzle	1
3	half circle puzzle	1
4	Pythagorean Theorem	1

According to Table 3, there are two plans for operational learning activities. The time spent on all instructional activities was two hours in order to evaluate the students' skills in the mathematical modeling procedure via the collection of group activities.

Table 3. Activities using operational learning in mathematical modeling

Lesson Plan No.	Activity title	amount of usage hours
1	Rim Bueng Chicken Coop	1
2	your home my home	1

Research Methodology

Research objectives

To develop learning activities to support the process of mathematical modelling for grade 8 students in Pythagoras' theorem and to assess student performance in the six stages of mathematical modelling through these learning activities.

Participants

The sample are 36 students from Lukhamhanwarinchamlab school, Warinchamlab District, the Secondary Education Office Service Area 29, Thailand, in the first academic year 2564. The

sample was obtained using cluster random sampling and was divided into 12 classroom-based cluster from a total student population of 510.

Tools

Research tools include 6 lesson plans about mathematical modelling activities on the Pythagorean theorem and related pre-posttests multiple choice test, 4 options, 20 items.

Procedures

First, students were given by pretest, and then used the lesson plans for 36 students by starting with activity to build background knowledge based on mathematical modeling process after that used the Pythagoras' theorem activities to promote students performing mathematical models, and finally students would evaluated again by posttest.

Second, by using results from test, students would be grouped with mild, moderate as well as the mix ability using. Data about group activities were collected using video record to illustrate performing and interacting of students during doing mathematical modeling activities by focusing phenomena on six modelling stages including with;

- *Understanding, Structuring, Simplifying, and Interpreting Context*
- *Assuming, Formulating, and Mathematising*
- *Interpreting Mathematical Output*
- *Comparing, Critiquing, Validating*
- *Communicating and Justifying*
- *Revisiting the Modelling Process*

Data analysis

Data from video record would be organized to illustrate students' performance about the modeling stages using protocol analysis and data from the pre-posttest would be analyzed using pair-t-test statistics.

Results and Discussions

Mathematical model constructed by students would be presented to illustrate some focusing phenomena on mathematical modeling based on modelling stages and then pair t-test statistics would be presented.

Stage1: Understanding, Structuring, Simplifying, and Interpreting Context

Teacher: How to find out if the triangle is right-angled?

The student No. 1: measuring the angles.

The student No. 1, 2, and 3: to measure the angles within a triangle.

Teacher: let the students measure the width of lines in the 3 square shapes that form a right-angled triangle.

Teacher: Ask the students how long it is after measuring the width of each side in a square shape?

The first student: answers 9 centimeters

Teacher: How long it is after measuring each side in the square shape?

The student No.1: They all are equal.

Teacher: Asks the question, what type of the square shape that consists of right-angled in every angle?

Student No. 1: answers it's the square shape?

Figure 4 depicts an image of the atmosphere created by what teachers and students discuss at this stage.

Figure 4. Student performing in the modelling stage about understanding, structuring, simplifying, and interpreting context in classroom

Stage2: Assuming, Formulating, and Mathematising

Teacher: Let students write the length of square shapes that measured.

Student No. 1, 2, 3, 4: Students write the length of square shapes that are measured.

Student No. 4: Set the square shapes to be right-angled triangle.

Student No. 3: Use ruler to measure the length of square shapes.

Student No. 1: Write text that shows how the length of each side in square shapes is long.

Figure 5 depicts the results of the teacher and students working together to create a mathematical model at this stage.

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Figure 5. Student working through the modelling stage about assuming, formulating, and mathematising

Stage3: Interpreting Mathematical Output

Teacher: Ask, after everybody writes the length of each side in square shapes, what shape it is after set of square shapes?

Students No. 1, 2, 3, and 4: It's a right-angled triangle.

Teacher: What shape is on each sides of right-angled triangle?

Students No. 1, 2, 3, and 4: They are square shapes.

Teacher: Let students draw what you understand on your paper.

Students No. 1, 2, 3, and 4: Draw on paper what you understand.

The results of the modeling process that have been produced up to this point are shown in Figure 6.

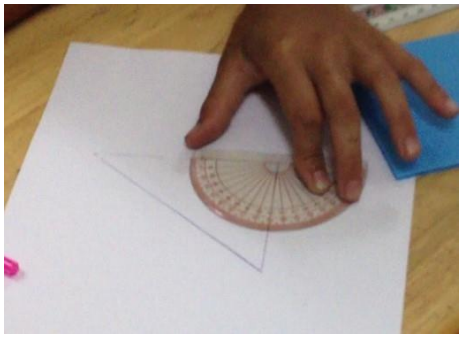

Figure 6. Student performing in mathematical modelling stage about interpreting mathematical output

Stage4: Comparing, Critiquing, Validating

Teacher: Let students take the picture to find out relation between square shapes and right-angled triangle.

Students No. 1, 2, 3, and 4: take the picture to compare.

Teacher: Students try to find out square shapes area that are on the length of sides of right-angled triangle.

Students No. 1, 2, 3, and 4: Calculate to find out square shapes area that is on the length of sides in right-angled triangle.

Teacher: Ask what the relation of three-square shapes area is.

Students No. 1: One of square shapes area is equal double right-angled triangle.

Students No. 2: Calculation to find out relation of square shapes.

Students No. 3: To show how to calculate relation of square shapes.

Figure 7 depicts how the individual student works are analyzed, compared, and revised in order to arrive at a group consensus, which is depicted as the work of two students.

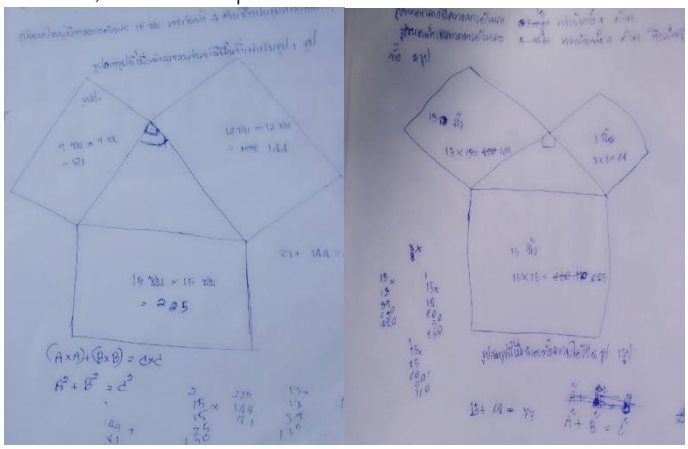

Figure 7. Mathematical models from two students

Stage5: Communicating and Justifying

Teacher: What do you conclude the relation of square shapes on right-angled triangle.

Students No. 1, 2, 3, and 4: write the conclusion on paper and discuss about each conclude.

Figure 8 provides a glimpse into the ambiance of the modeling carried out up to this point.

Figure 8. Student presenting, communicating, and justifying in mathematical models

Stage6: Revisiting the Modelling Process

Teacher: If square shapes don't give the length of sides and measurement instrument as ruler, how will you use symbol?

Students No. 2: Using the A B C

Teacher: Then, how do you write relation of length of sides in square shapes?

Students No. 1: Answer, A power two is B power two plus C powers two.

Figure 9 depicts the outcomes that were reached after carrying out the mathematical modeling processes up to this point.

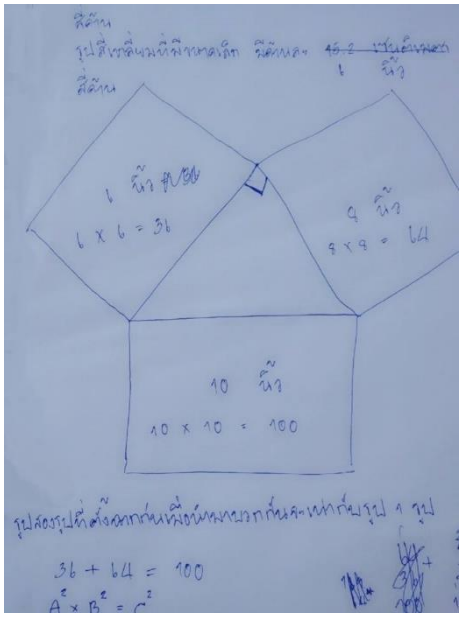

Figure 9. Revising the modelling process if model is inappropriate

Pre-Test and Post-Test Scores

Result from comparison of pretest and posttest by using paired sample t-test statistics (Table 4). The test revealed that the post-test scores higher than pre-test score at statistically significant level of 0.05.

Table 4. A comparison of academic achievement on the Pythagorean Theorem before and after learning activities

Test	Number of students	mean	S.D.	df	t
pretest	36	6.97	1.92	35	124.35*
posttest	36	14.81	1.99	-	-

* Significant statistically at the .05 level

Scaffoldings Strategies for preplanning anticipate what obstacles students will face in the mathematical modeling process has a great effect on encouraging students to achieve their goals in mathematical modeling activities on the Pythagorean theorem. The design of mathematical modeling activities in this research considers and operates in accordance with this principle. Research has outlined the importance of Scaffolding strategies for success in promoting mathematical modeling (Geiger *et al*., 2021; Greefrath and Vorhölter 2016; Schukajlow *et al*., 2015).

Conclusions

Learning through mathematical modeling activities on Pythagoras' theorem takes a lot of benefit for students. Students are motivated to perform skills about constructing mathematical models that their experiences can apply for solving problems in any area. Moreover, from observations of students' learning in Pythagoras' theorem via developed activities, the result revealed that these activities have a positive effect on students' achievement. For educators who are interested in using these findings to educate kids. Activities should be regarded contextually suitable. Begin with exercises to prepare fundamental modeling knowledge, then prepare to know about the subject, and lastly employ modeling activities on subject to grow pupils as required.

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