ASEAN Journal of Science and Engineering

Journal homepage: http://ejournal.upi.edu/index.php/AJSE/

How to Count Speed? Utilizing Android Applications to Support a Concept Attainment Model to Help Mathematical Thinking Skills

Zaenal Abidin[1,2], Tatang Herman[1], W. Wahyudin[1], W. Wiryanto[2], Laely Farokhah[3], Amadhila Elina Penehafo[4]*

[1]Universitas Pendidikan Indonesia, Indonesia
[2]Universitas Negeri Surabaya, Indonesia
[3]Universitas Muhammadiyah Jakarta, Indonesia
[4]Namibia College of Open Learning, Namibia
*Correspondence: E-mail: zaenal_abidin21@upi.edu

ABSTRACT

Examining and explaining the mathematical thinking skills of primary school students who employed an Android app as a concept attainment technique was the aim of this study. The inquiry used a 3 x 2 factorial design and a quantitative methodology. The study included twenty-eight fifth-grade students from two different courses. The results showed that students' mathematical thinking skills differed between those taught using a conventional strategy and those taught using a concept attainment method using an Android app and digital comic. Different mathematical thinking abilities are shown by students with levels of self-efficacy, according to the other research. This is because, in comparison to students in other groups, students with high levels of self-efficacy have more prior knowledge. Ultimate result shows no relationship between developing mathematical thinking skills and self-efficacy. This study could help educate people about various educational programs and media that can be used to enhance their capacity for mathematical thinking.

ARTICLE INFO

Article History:
Submitted/Received 03 Apr 2024
First Revised 24 May 2024
Accepted 17 Jul 2024
First Available online 18 Jul 2024
Publication Date 01 Sep 2024

Keyword:
Android application,
Concept attainment model,
Elementary school,
Mathematical thinking skill,
Speed.

1. INTRODUCTION

Mathematics is taught at all educational levels since it is a scientific subject that has a significant impact on students (Lee, 2018). Nonetheless, a lot of students feel that mathematics is a difficult subject, which deters them from being as eager to master it. Having this capacity for mathematical thought aid students in solving difficult mathematical problems and heighten their interest in the subject. Therefore, the capacity to solve a problem efficiently is referred to as mathematical thinking ability. There are many reports regarding how to improve mathematics in school (see **Table 1**).

Table 1. Research on mathematics in education.

No	Title	Reference
1.	Association of interest, attitude and learning habit in mathematics learning towards enhancing students' achievement	Hashim *et al* (2021)
2.	Prototype of greenhouse effect for improving problem-solving skills in science, technology, engineering, and mathematics (STEM)-education for sustainable development (ESD): Literature review, bibliometric, and experiment	Solihah *et al* (2024)
3.	Augmented reality for cultivating computational thinking skills in mathematics completed with literature review, bibliometrics, and experiments for students	Angraini *et al* (2024)
4.	A mathematical model for estimating the end-of-life of power transformers: From literature review to development analysis	Ajenikoko & Ogunwuyi (2022)
5.	Motivation and ICT in secondary school mathematics using unified theory of acceptance and use of technology model	Akinoso (2023)
6.	Difficulties encountered by the students in learning mathematics.	Radiamoda (2024)
7.	Global research trends of mathematics literacy in elementary school: A bibliometric analysis.	Farokhah *et al.* (2024)
8.	Bibliometric analysis using Vosviewer with Publish or Perish of mathematical proficiency.	Rohimah (2025)
9.	Learning mathematics formulas by listening and reading worked examples.	Maryati *et al.* (2022)
10.	Effect of guided inquiry and explicit-instructional strategies on lower basic students' academic performance in mathematics.	Ogunjimi & Gbadeyanka. (2023)
11.	Self-efficacy as a correlate of pupils' academic achievement in mathematics.	Obafemi *et al.* (2023b)
12.	Computational thinking in mathematics learning: Systematic literature review.	Mitrayana & Nurlaelah (2023)
13.	Improvement of students' literacies skills in the knowledge aspect through science, technology, engineering, and mathematics (STEM)-integrated module.	Fitrianti *et al.* (2024)
14.	Students' attitude towards gamification-based teaching in mathematics in basic schools.	Attah *et al.* (2024)
15.	Effect of round robin instructional strategy on pupils' academic achievement in mathematics.	Obafemi *et al.* (2024)
16.	Numerical minimum competence assessment for increasing students' interest in mathematics.	Wijaya *et al.* (2022)
17.	Examining sources of mathematics self- efficacy beliefs of senior secondary school students.	Awofala (2023)
18.	Personal and contextual factors as correlates of entrepreneurial intentions among pre-service science, technology, and mathematics teachers.	Awofala *et al.* (2023)
19.	Effect of reversed jigsaw instructional strategy on pupils academic achievement in mathematics.	Obafemi *et al.* (2023a)

DOI: https://doi.org/10.17509/ajse.v4i2.72528
p- ISSN 2776-6098 e- ISSN 2776-5938

Table 1. (Continue) Research on mathematics in education.

No	Title	Reference
20.	Primary teachers' mathematics anxiety and mathematics teaching anxiety as predictors of students' performance in mathematics.	Awofala *et al.* (2024)
21.	Enhancing pupils' academic performance in mathematics using brainstorming instructional strategy.	Obafemi (2024)
22.	Altering students' mindsets and enhancing engagement in mathematics in a problem-based learning.	Awofala & Akinoso (2024)
23.	Assessment of mathematical abilities of students with intellectual disabilities during the covid-19 pandemic.	Maryanti (2021)
24.	Developing the ability to add integer through live worksheets among grade II pupils with autism in mathematics learning.	Suprihatin *et al.* (2024)
25.	Factors that affect the performance of selected high school students from the third district of Albay in International Mathematics Competitions.	Jose (2022)
26.	Efforts to increase the interest of junior high school students in mathematics lessons using the TikTok learning tool.	Dermawan *et al.* (2022)
27.	Math readiness and its Effect on the online academic performance of science, technology, engineering, and mathematics students.	Lagcao *et al.* (2023)
28.	Assessing teachers' formative evaluation strategy as related to senior secondary school students' achievement in mathematics.	Awofala & Olaniyi (2023)
29.	Exploration of the effect of scaffolding instructional strategy on pupils' academic performance in mathematics.	Obafemi *et al.* (2024)
30.	Effect of peer-tutoring strategy on senior secondary school students' achievement in mathematics.	Awofala & Agbolade (2024)
31.	Exploring effective differentiated instruction in the teaching and learning of mathematics.	Padmore & Ali (2024)
32.	Impact of single parenting on academic performance of junior secondary school students in mathematics.	Lasisi *et al.* (2024)
33.	Bibliometric analysis using vosviewer with publish or perish of computational thinking and mathematical thinking in elementary school.	Abidin *et al.* (2025)

One of the math subjects that students in elementary school are required to master is speed. Students learn about the importance of information and how it is presented firsthand through speed. Moreover, the goal of speed in elementary schools is to assist children in building a solid reading foundation (Yorganci, 2022).

Students select a solution during the problem-solving process based on their self-efficacious thought process. Self-efficacy is the belief in oneself that one can overcome a difficult situation or complete a task. The confidence in oneself to complete a task, reach goals, or overcome challenges and problems is known as self-efficacy (Bilan *et al.*, 2023; Vecchio *et al.*, 2023). The research about mathematical thinking with technology-based learning can be an alternative (**Figure 1**).

Figure 1 shows that mathematical thinking related to computational thinking requires technology in mathematics learning. In addition, cluster 1 (test, with 520 occurrences and a total link strength of 2230), different (361 occurrences and a total link strength of 1062), and computational thinking and mathematical thinking (185 occurrences and a total link strength of 859) are the terms that were used as keywords.

The purpose of this study was to evaluate and assess primary school students' mathematical thinking abilities after they were given an Android application that measured concept achievement. This study compares students' mathematical thinking abilities based on their levels of self-efficacy and looks at the relationship between learning and self-efficacy

DOI: https://doi.org/10.17509/ajse.v4i2.72528
p- ISSN 2775-6793 e- ISSN 2775-6815

on mathematical thinking abilities. It also examines the effects of an interactive Android application-based concept attainment approach on the mathematical thinking abilities of elementary school students. The novelties of this study are (i) making the android application for finding the speed formula, (ii) showing the effect of android to mathematical elementary students, and (iii) showing the alternative learning activity for enhancing mathematical thinking.

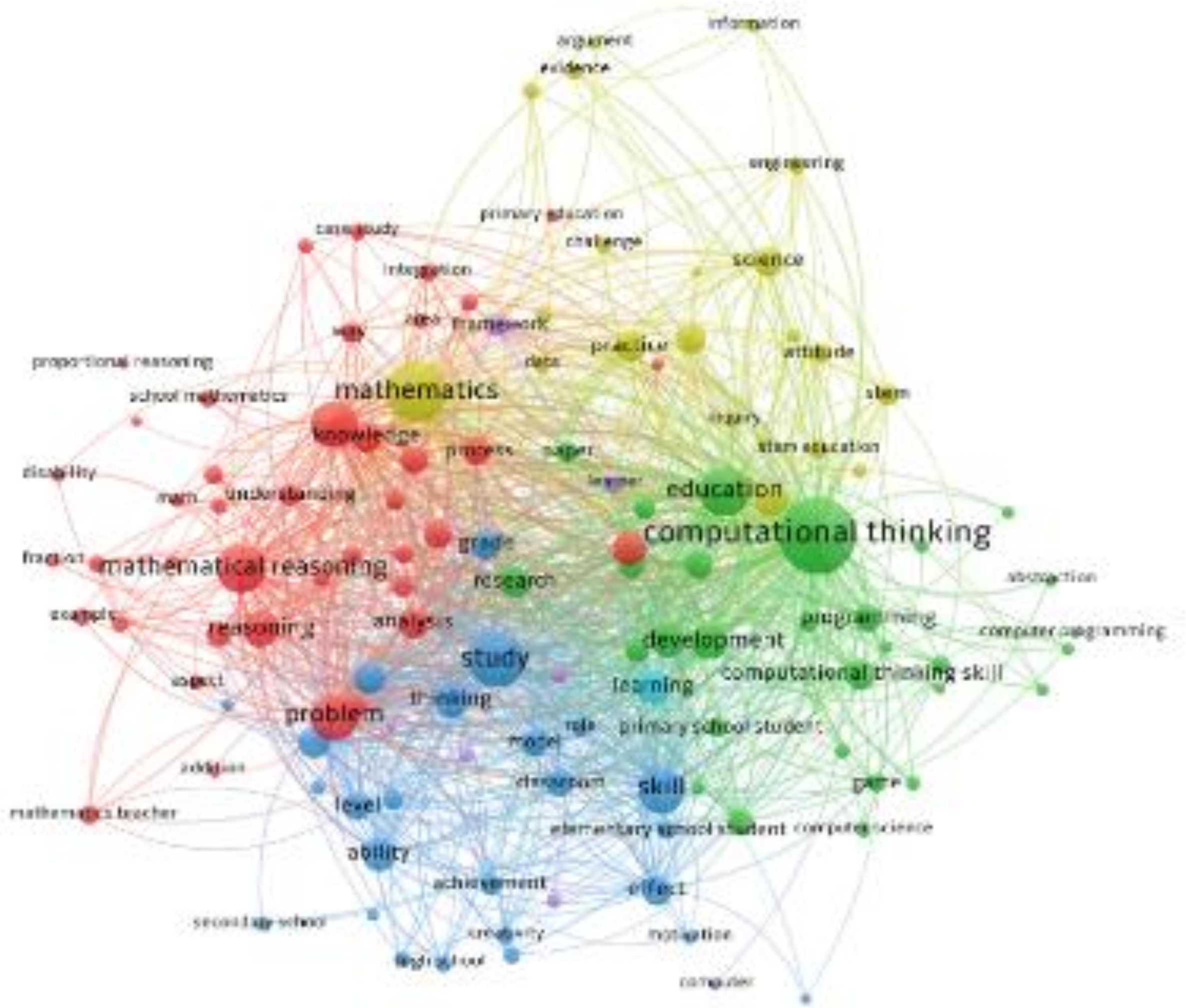


Figure 1. Network visualization of mathematical thinking. Data was obtained from our previous study (Abidin *et al.*, 2025). Detailed information regarding how to analyze data using bibliometrics is explained elsewhere (Al Husaeni & Nandiyanto, 2022).

2. LITERATURE REVIEW

2.1. Speed

The term "speed" refers to an object's velocity, which includes both its direction of motion and its numerical number (Weakley *et al.*, 2021). Thus, velocity is referred to as a vector. The tempo is simply excellent. While an object's displacement is defined as its change in position, speed is defined as displacement rather than the total distance traveled.

In the field of physics, speed has emerged as one of the key ideas for basic comprehension of motion. The advanced and enrichment material of the fragment concept in elementary school is the idea of speed (Janney *et al.*, 2022). The invention method—which enables elementary school pupils to conduct research on movement and time relevant to daily life—

DOI: https://doi.org/10.17509/ajse.v4i2.72528
p- ISSN 2776-6098 e- ISSN 2776-5938

should be used to teach speed. Through relevant learning and exploration activities, students gain a better understanding of content speed more optimally.

Since speed is an erroneous abstract idea, it becomes one of the most challenging ones for elementary school kids. However, in order to solve this issue, creative pedagogy evolved during its evolution. Learning linked to speed can be accomplished through exploration and visualization of the concept of speed (Wong & Wong, 2022). Furthermore, students' comprehension of speed-related concepts is strengthened by providing context and incorporating real-world examples. **Figure 2** is an observation and measurement activity for speed.

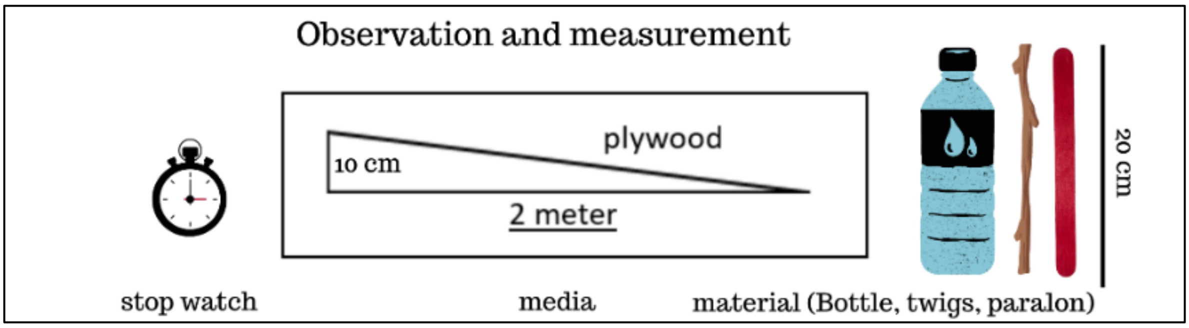


Figure 2. Observation and measurement for speed.

Multiple items that can help pupils grasp the notion of speed are needed for elementary school speed experiments (Zangori *et al.*, 2017). In this investigation, a number of nearby objects that were sorted according to shape, weight, and texture were employed. A track, the object to be measured, and a timer are among the accessories required for straightforward experiments involving the speed of moving objects.

The two meters of plywood used to make the study's track can offer a smooth surface for the movement of objects because it is lightweight. The wood is set at an angle it can apply the same pressure to all objects (Ha *et al.*, 2018). This reduces the usual difference in encouragement obtained. The students just keep the object without needing to push. As with the objects based on category groups, twigs, paralon, and used bottles are utilized for categories of objects with distinct textures. As for the category of shaped objects, little bottles that resemble tubes, small balls, and toothpaste cardboard in the shape of blocks were used. We utilize little bottles that are either empty or filled with sand or water for heavy items. Stopwatches and other time measuring tools can be used by students to calculate how long an object take to move along a certain path. **Table 2** shows several studies related to learning to increase students' understanding of speed.

Table 2. Research on speed in education.

No	Title	Reference
1.	Using different smartphone sensors to find the speed of a toy car.	Kapucu (2022)
2.	Calculation of Minimum Speed of Projectiles under Linear Resistance Using the Geometry of the Velocity Space.	Pispinis (2019)
3.	Modeling potential energy of the Gaussian gun.	Elliott *et al.* (2019)
4.	Pre-service elementary teachers' conceptual understanding of average speed: the systematicity and persistence of related and unrelated concepts.	Subramaniam *et al.* (2022)
5.	Protocol-Guided Teaching in Junior-Secondary Physics Education: An Analysis of the Learning Protocol for the Velocity Instruction Based on Real-World Circumstances.	Tang (2023)
6.	Strengthening Elementary Preservice Teachers' Physical Science Content Knowledge: a 3-Year Study.	Long, *et al.* (2023)

DOI: https://doi.org/10.17509/ajse.v4i2.72528
p- ISSN 2775-6793 e- ISSN 2775-6815

Table 2 (Continue). Research on speed in education.

No	Title	Reference
7.	The Rematch of the Tortoise and the Hare: A Story of Speed and Velocity.	Bellavia (2021)
8.	Quickly Teaching Speed, Velocity, and Acceleration—Part 2 Breadcrumb.	Hewitt (2019b)
9.	Acceleration in the City.	Kunkel *et al.* (2024)
10.	Do you want to learn physics? Please play angry birds (but with epistemic goals).	de Aldama & Pozo, (2020)

2.2. Correlation between Speed and Fraction

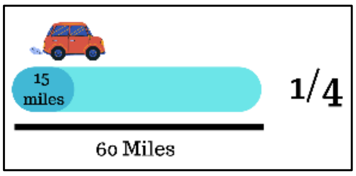
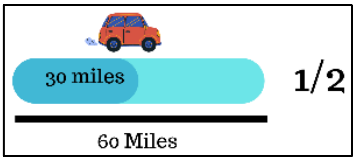
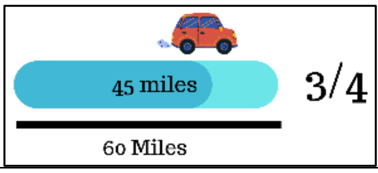
There are parallels that can be drawn between fraction and speed in elementary school science, particularly when talking about ideas like distance, time, and speed. These connections may not be stated explicitly.

It is possible to relate speed to a situation where an automobile covers a portion of the entire distance in a shorter amount of time (Poikonen *et al.*, 2017). For instance, if a car travels ½ of the total distance in 1/2 of the total time, the speed is total of distance devide by total of time, thus 1/2 ÷ 1/2 = 1. In essence, the object moves at speed 1—that is, 1 unit per unit of time. This sums up the fundamental relationship between fracture and speed.

Additionally, graphical representations of motion—where distance is plotted against time—may be introduced to elementary school students. A graph like this one shows the speed as the curve of the line. If the diagonal line rises higher and the line has a curve of 1, the item moves at a constant speed (Bellavia, 2021; Kapucu, 2019; Hewitt, 2019a).

Fractions are typically taught to elementary school children in connection to parts of the whole. They may comprehend that 1/2 is one of two pieces that are the same, 3/4 or three of four equal pieces is what it means. Students may learn about distance and time when talking about speed. The pace at which an object shifts location in relation to time is essentially its speed. Thus, an automobile is moving at 60 miles per hour when it does so. This case involves two sizes: time (in hours) and distance (in miles). **Table 3** shows how speed and fraction are related.

Table 3. Comparison distance, time, and speed.

<table>
<tr><th>Distance</th><th>Time (hours)</th><th>Speed</th></tr>
<tr><td>15 miles

</td><td>15 minutes
$\frac{15}{60} = \frac{1}{4}$</td><td>$\frac{1}{4} \div \frac{1}{4} = 1$
miles/hours</td></tr>
<tr><td>30 miles

</td><td>30 minutes
$\frac{30}{60} = \frac{1}{2}$</td><td>$\frac{1}{2} \div \frac{1}{2} = 1$
miles/hours</td></tr>
<tr><td>45 miles

</td><td>45 minutes
$\frac{45}{60} = \frac{3}{4}$</td><td>$\frac{3}{4} \div \frac{3}{4} = 1$
miles/minute</td></tr>
</table>

DOI: https://doi.org/10.17509/ajse.v4i2.72528
p- ISSN 2776-6098 e- ISSN 2776-5938

Table 4 show several studies related to learning to improve students' understanding of fractions.

Table 4. Research on speed in education.

No	Title	Reference
1.	Supporting primary students' learning of fraction conceptual knowledge through digital games.	Zhang *et al.* (2020)
2.	Differences in high-and low-performing students' fraction learning in the fourth grade.	Pedersen *et al.* (2023)
3.	Learning trajectory-based fraction intervention: Building a mathematics education evidence base.	Martin and Hunt (2022)
4.	Learning fraction concepts through the virtual-abstract instructional sequence.	Bouck *et al.* (2020)
5.	Pedagogical suggestions to foster fraction learning.	Mousley (2021)
6.	Examining virtual manipulatives for teaching computations with fractions to children with mathematics difficulty.	Satsangi and Raines (2023)
7.	Learning obstacles on fractions: A scoping review.	Sari *et al.* (2024)
8.	At the intersection of derived relations and observational learning: Teaching fraction–percentage relations.	Verdun *et al.* (2020)
9.	Beyond linearity: Using IRT-scaled level models to describe the relation between prior proportional reasoning skills and fraction learning outcomes.	Schadl and Ufer (2023)
10.	From the expression of the ratio with two natural numbers, to its expression with a fraction. Two didactic experiences at primary school and high school.	Block Sevilla *et al.* (2023)

2.3 Speed of using android application in concept attainment model

The overall distance an object travels in a specific amount of time is its average speed. One scalar quantity is the average speed. It has no direction and is portrayed by the magnitude. Tell us how to compute average speed, the formula for calculating average speed, and how to solve average speed cases. An Android application was used in this study to examine speed. There are four primary options in the Android application: information about mathematical thinking skills, games, which include crossword and make-and-match puzzles, and games. A teaching film explaining the idea of speed may be found in the third menu. The assessment menu, which measures how well students have understood the subject matter, comes last. The Android application display is shown in **Figure 3**.

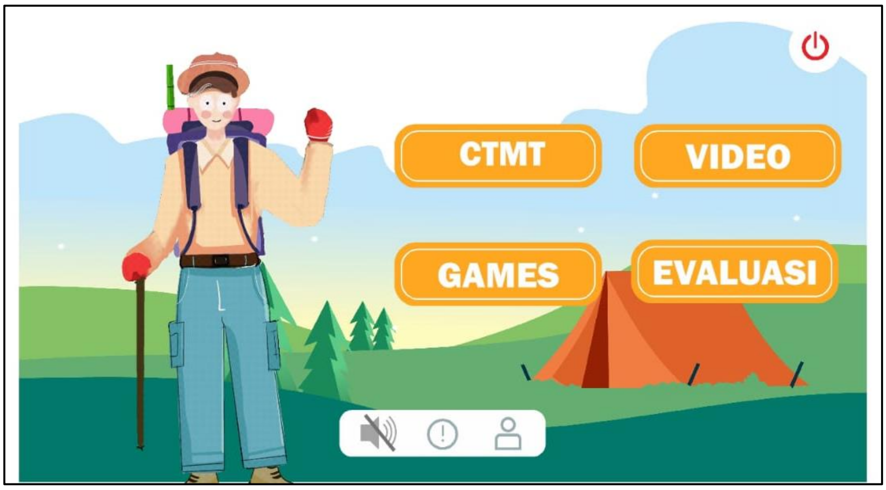


Figure 3. CTMT application.

Furthermore, students continue to engage in hands-on activity learning in addition to using the Android application. By learning the concept attainment model with the help of an Android application, they can find the speed formula through activities as in **Figure 4**.

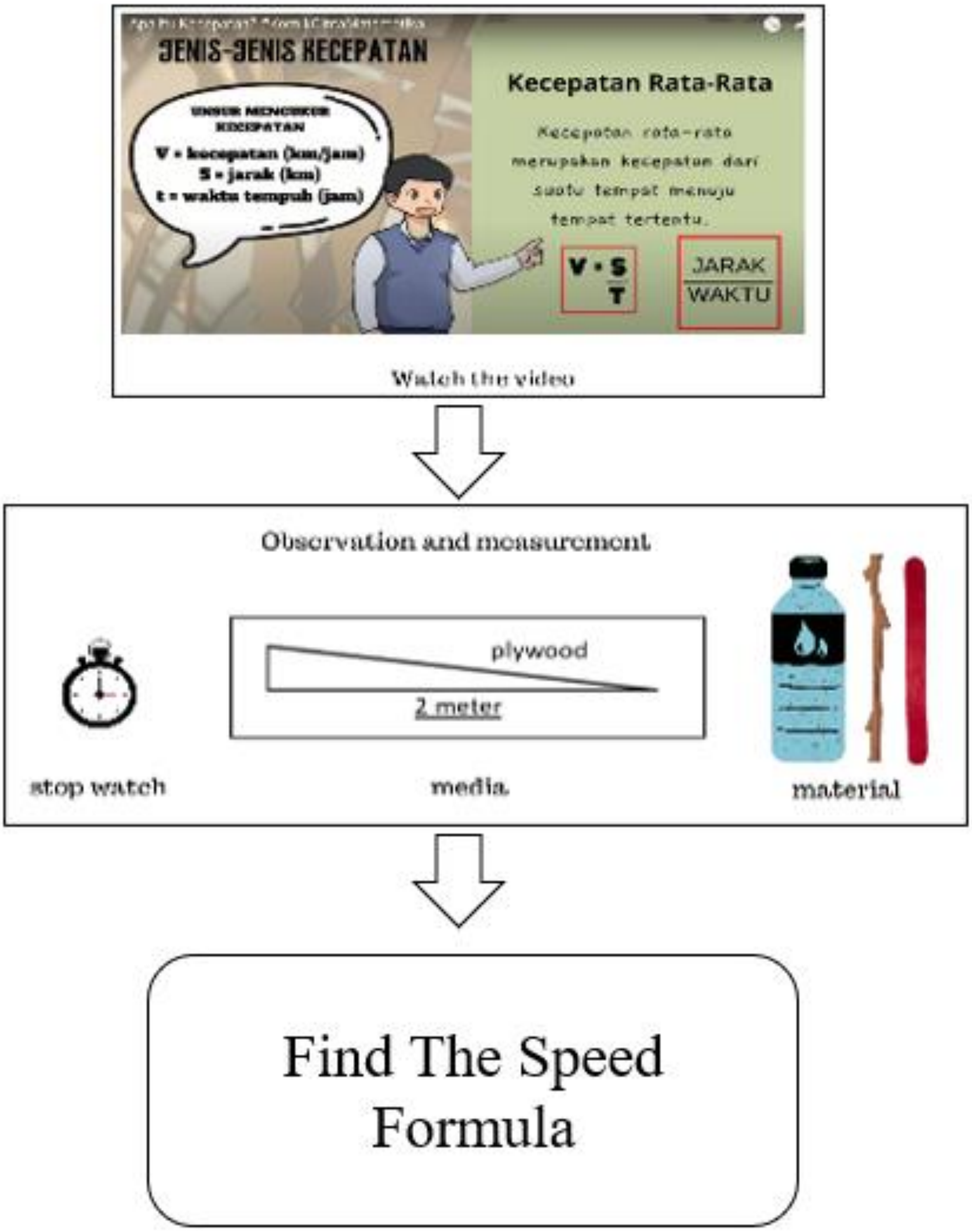


Figure 4. Activity for speed formula investigation.

The steps of the concept attainment model are included. The phases of data identification, idea testing, and thought analysis make up the concept attainment model (Usmeldi *et al*., 2017). To identify the data, this experiment starts with certain temporary assumptions that serve as a reference in the video. In the meantime, students conduct three stages of

DOI: https://doi.org/10.17509/ajse.v4i2.72528
p- ISSN 2776-6098 e- ISSN 2776-5938

experiments during the subsequent identification phase. Students attempt to compare speeds based on texture on an inclined plane.

The steps of the concept attainment model are included into this experiment. The phases of data identification, idea testing, and thought analysis make up the concept attainment model (Warner & Kaur, 2017). To identify the data, this experiment starts with certain temporary assumptions that serve as a reference. In the meantime, students conduct three stages of experiments during the subsequent identification phase. Students attempt to compare speeds based on texture on an inclined plane in the first level. The items measured were 20-centimeter length branches, 20 cm long paralon, and 20 cm long little bottles. Subsequently, the second experiment proceeded by substituting the objects under measurement, which were cardboard blocks measuring 20 cm in length, with 20 cm long bottles and 10 cm diameter balls. Three bottles were used in the final experiment; they weighed varied amounts: 125 grams for a bottle filled with water, 248 grams for a bottle filled with sand, and 3 grams for an empty bottle.

Students complete the experimental report format under the teacher's guidance after completing the experiment. Students must engage in methodical thought processes and advanced thought analysis as part of this process. Students are expected to be able to describe which one is faster throughout this procedure. What makes it faster? What does "speed" mean? Students engage in analytical thinking after having talks with their groups, when they share the results of their experiments and contrast them with those of other groups. During this phase, which is known as reflecting in mathematical thinking, students revisit the concepts they have developed. To accomplish a mutually agreed-upon goal—in this example, the idea of average speed—the teacher brainstorm till then. **Table 5** shows several studies related to learning using Android applications as learning media.

Table 5. Research on Android application in education.

No	Title	Reference
1.	Android-Based Animation for Chemical Elements and Experiments as an Interactive Learning Media.	Saputra *et al.* (2021)
2.	Android-Based Mathematics Learning Media Assisted by Smart Apps Creator on Self-Regulated Learning.	Mahuda *et al.* (2022)
3.	Development of Android-Based Offline Test Model in Physics Subjects.	Darmawan *et al.* (2023)
4.	Application for Regulating the Number of Calories in Eating Per Day.	Hajar & Nandyanto (2022)
5.	Smart learning media based on Android technology.	Novaliendry *et al.* (2020)
6.	Meta-Analysis Study: The Effect of Android-Based Learning Media on Student Learning Outcomes.	Romadiah *et al.* (2022)
7.	Android Application Development: Permutation of the Same Elements Based on Realistic Mathematics Education.	Hilda and Siswanto (2021)
8.	Mathematics mobile blended learning development: Student-oriented high order thinking skill learning.	Fisher (2022)
9.	The Development of Android-Based Learning Mobile App to Practice Critical Thinking Skills for Elementary School Students.	Isrokatun *et al.* (2023)
10.	Digital Game-Based Learning in an Introductory Accounting Course: Design and Development of an Instructional Game.	HajiMoradkhani *et al.* (2023)

A thorough instrument that matches students' growth and encompasses all areas of learning is needed to assess students' grasp of speed (Piscová *et al*., 2023). Students' speed-related exploration activities are evaluated based on performance, which provides valuable

DOI: https://doi.org/10.17509/ajse.v4i2.72528
p- ISSN 2775-6793 e- ISSN 2775-6815

insight into how well students understand the subject of speed. The collaborative approach students use to measure speed-related projects is another performance that may be quantified. **Figure 5** shows how students discover the concept of speed by inquiries.

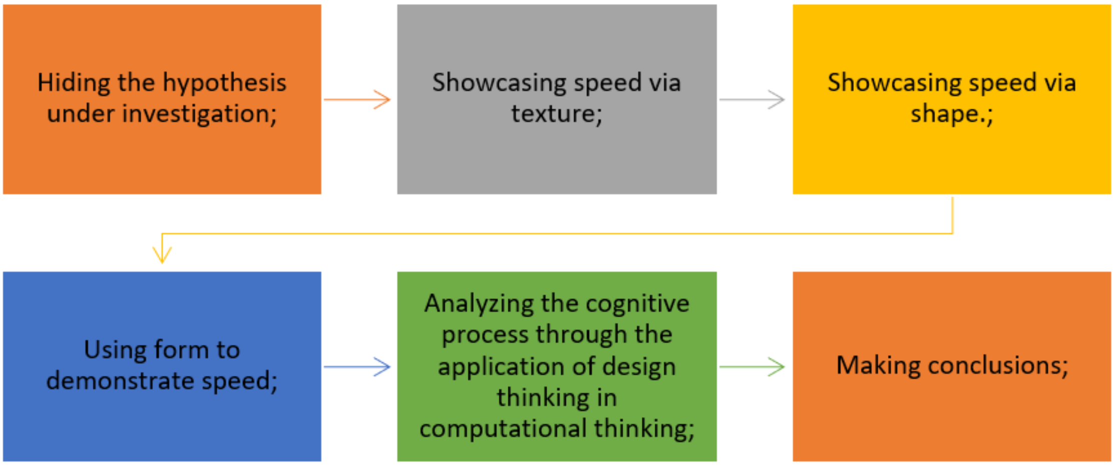


Figure 5. Concept attainment learning step for speed.

3. METHODS

A 3 x 2 Factorial Design study design was used by the researcher. Learning and degree of self-efficacy were the two independent factors in this study. When learning, students are divided into two groups: those who were given a concept attainment model with an android application and those who are given a concept attainment without Android. Meanwhile, there were three levels of self-efficacy for students: high, medium, and low. Research on mathematical thinking skill scores included the following 3 x 2 factorial designs. The study was conducted in multiple phases.

This study collects data regarding self-efficacy and mathematical thinking skills. Both test and non-test procedures were used in the collection of these data. The test approach was used to collect information on the capacity for mathematical thought. In the meanwhile, the non-test approach was used to gather information on students' self-efficacy. Exam questions about mathematical thinking skills were presented as descriptions of ten problems. Indicators for mathematical thinking instruments were problem-solving, conceptual understanding, metacognitive skills, and mathematical fluency. To classify levels of students, a self-efficacy questionnaire was created. An indicator grid found in the operational definition of self-efficacy served as the foundation for the questionnaire's development. According to this study, a student's self-assessment of confidence in their mathematical abilities to plan or take action to solve certain mathematical problems is known as operational self-efficacy. Indicators of self-efficacy for this study include beliefs, activity choice, effort, perseverance, and curiosity.

DOI: https://doi.org/10.17509/ajse.v4i2.72528
p- ISSN 2776-6098 e- ISSN 2776-5938

4. RESULTS AND DISCUSSION

4.1 Overview of Mathematical Thinking Skill

For students who have been learning using the concept attainment approach with Android application and without application, **Table 6** describes the mathematical thinking skills. Moreover, it explains mathematical thinking capacity as perceived from a self-efficacy perspective.

Table 6. Overview of mathematical thinking.

Class	Self-efficacy	Mean	Std. Deviation	N
Concept attainment	Low	60.25	2.588	7
with Android	Medium	72.00	4.174	12
application	High	84.00	3.536	7
	Low	54.50	2.865	7
Concept attainment	Medium	67.67	4.924	12
	High	75.00	2.479	7

Table 6 shows that students who receive instruction using a concept attainment model without an Android application have a lower average mathematical thinking ability than students who receive instruction using a concept attainment model with an Android application. The average mathematical thinking ability score for students who receive instruction using a concept attainment model with an Android application is 72.08 with a standard deviation of 3.432.

The description of the score states that using Android application media and a concept attainment approach to learning can support the development of mathematical thinking abilities. Students are not required to study since the concept attainment approach allows them to develop plans for completion from a context based on their lines of reasoning (Mateus-Nieves & Rojas-Jimenez, 2020; Hardman & Lilley, 2023; Shogren *et al*., 2019). Students can make fascinating and imaginative diagrams in the interim with interactive Android application materials (Arista & Kuswanto, 2018).

4.2 The differences in mathematical thinking based on learning activity

Descriptive data indicate on average, students who follow the concept attainment learning model are able to think mathematically more than students who follow the scientific learning model; however, this has to be proven through average exam results. With learning and self-efficacy acting as independent factors, the average test outcome from the two-way ANOVA test is shown in **Table 7**.

Table 7. The differences in mathematical learning.

Source	Type III Sum of Squares	df	Mean Square	F	Sig.
Corrected Model	5308,634	5	928,106	71.322	0.000
Intercept	382126.565	1	352242.425	20475,665	0.000
Class	1252,122	1	1253,398	81.912	0.000
SE	2862.819	2	2432.856	120,961	0.000
Class * SE	65,812	2	21,969	1.609	0.156

Students receiving concept attainment models with Android applications and without exhibit varying capacities for mathematical reasoning. Since the score is less than = 0.05 and

DOI: https://doi.org/10.17509/ajse.v4i2.72528
p- ISSN 2775-6793 e- ISSN 2775-6815

the significance of 0.000 is shown, the research hypothesis (H1) is approved. Consequently, one may contend that students who are taught using a concept attainment method with an android application and those who are taught scientifically have distinct mathematical thinking skills.

According to their thinking, students who get instruction through an interactive Android application medium and a concept attainment approach are more equipped to carry out the reasoning process (Abidin *et al*., 2023). As a result, learners who possess a variety of thought processes and backgrounds are more likely to learn (Su *et al*., 2021). Additionally, because interactive Android application materials incorporate technological elements into the learning process, they are very suitable for students' interests. As a result, students are enthusiastic about their studies because the media they are using has cultivated a tendency toward productivity (Leszczynski *et al*., 2017).

Students' tasks also involve making Android application bar charts and putting together presentations that utilize the diagrams they have developed. To increase students' understanding and guarantee that material is stored in long-term memory, mathematical action activities are essential. In Fig. 6, there is an example of an image from an Android application about speed. **Figure 6** is an android application designed to facilitate the student's mathematical thinking process. Students can access it using an android gadget without having to connect to data. On the main menu there are 4 important points that consist of information related to mathematical thinking, videos about material one of them about speed, games consisting of 3 kinds of games, and about evaluation.

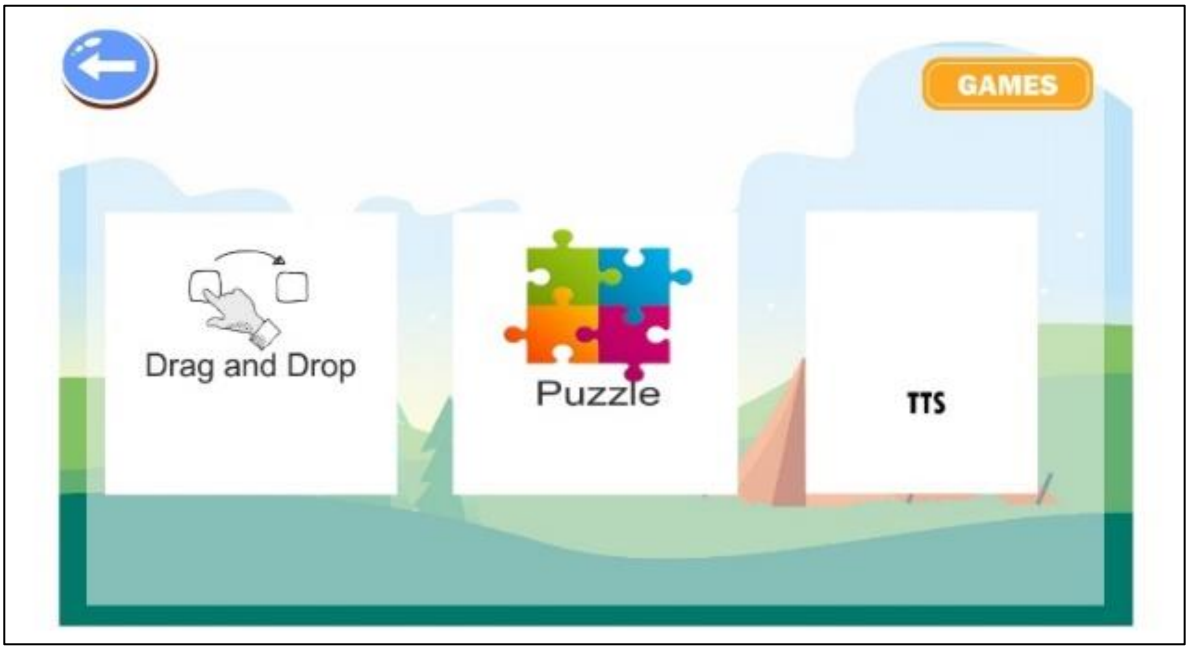


Figure 6. Activity in android application for mathematical thinking.

Moreover, the research hypothesis (H1) is that there are variations in students' mathematical thinking abilities which has a significance of 0.000 and a score of less than = 0.05. As a result, H1 is recognized. This could lead to differences in the self-efficacy of pupils' mathematical thinking skills. The result also shows the variations in the groups' mathematical thinking skills to determine which group is the most proficient at it. Since self-efficacy affects learning success, it is crucial for learning (Roick & Ringeisen, 2018). Pupils who believe in their abilities are more likely to be motivated to learn and have positive attitudes. Youngsters with

DOI: https://doi.org/10.17509/ajse.v4i2.72528
p- ISSN 2776-6098 e- ISSN 2776-5938

high levels of self-efficacy are also more resilient and autonomous when presented with challenges (Damayanti & Sumardi, 2018).

In a scientifically methodical lecture, high self-efficacious students did better than moderate and low self-efficacious pupils. Students who perform better than those who have low levels of self-efficacy are those who have intermediate levels of self-efficacy. Learning using the concept attainment method with the Android application is especially appropriate for students with varying degrees of self-efficacy since it gives them the freedom to use their preferred mode of thinking (Marsh *et al*., 2018). As a result, it is possible to determine students' constructive attitudes regarding learning mathematics (Samuel & Warner, 2021). As demonstrated in earlier research, this information is also helpful for enhancing the methods currently used to learn mathematics (Khawas & Shah, 2018). This enhance and contribute knowledge to the process of teaching and learning, particularly in light of the pandemic situation (Furner, 2016). In addition, this study can give new ideas regarding mathematics in education, adding new information in previous reports (Obafemi *et al*., 2023; Mitrayana & Nurlaelah, 2023; Wijaya *et al*., 2022; Awofala, 2023; Awofala *et al*., 2024; Obafemi, 2024).

4.3 Overview of Mathematical Thinking Skill

According to **Table 7**, there is no correlation between learning and self-efficacy and the mathematical thinking of primary school students. The Anoway output in the Class*Self Efficacy row has a significance of 0.156 and a score larger than = 0.05. Additionally, **Figure 7** shows the line that denotes no connection between learning and self-efficacy.

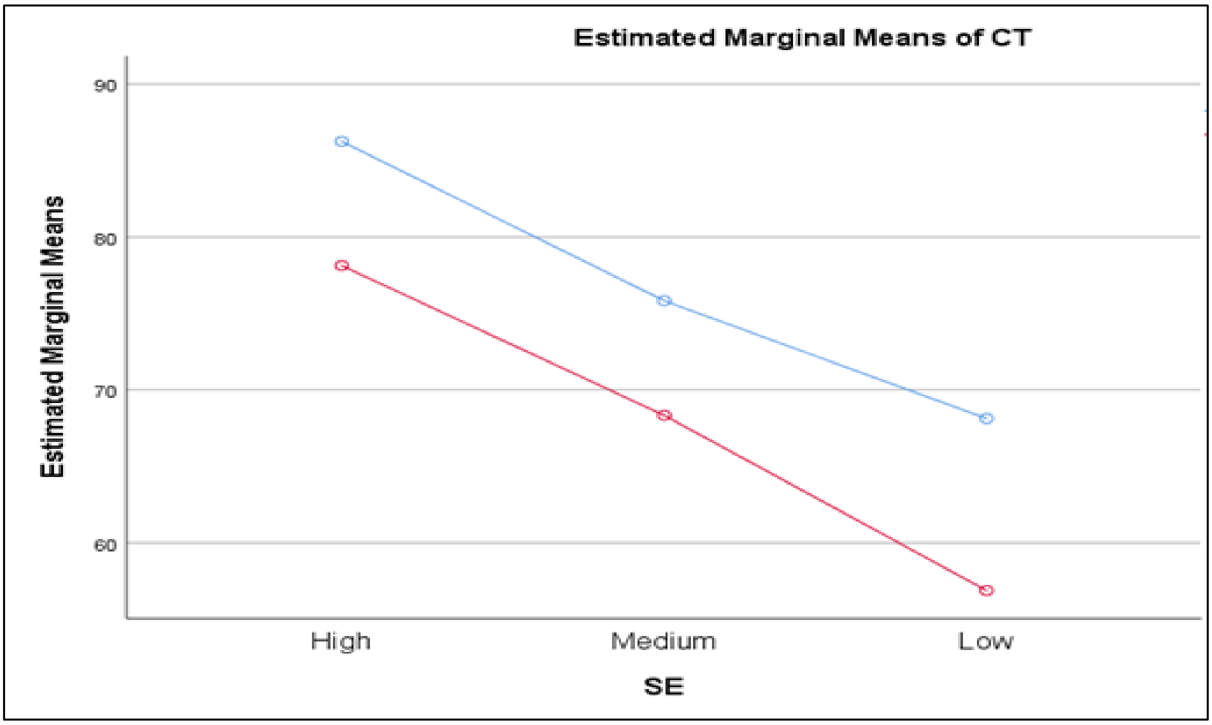


Figure 7. Connection between concept attainment model and self-efficacy.

According to the degree of self-efficacy, **Figure 7** illustrates how the idea attainment model with and without an Android application is highly advantageous for students with high levels of self-efficacy. In the concept attainment model using an Android application, students with high self-efficacy outscored students with moderate and low self-efficacy by a large margin. Students with moderate levels of self-efficacy outperformed those with low levels. In an

DOI: https://doi.org/10.17509/ajse.v4i2.72528
p- ISSN 2775-6793 e- ISSN 2775-6815

android application-free concept attainment model lesson, high self-efficacious students fared better than moderate and low self-efficacious students. Students with moderate levels of self-efficacy outperformed those with low levels.

Self-efficiency, or the conviction that one can succeed in a certain task or situation, directly affects academic performance, therefore it is impossible to overstate the significance of self-effectiveness in mathematics for elementary school pupils (Ogle *et al*., 2017). Mastering the fundamentals of mathematics in primary school is essential for establishing a strong sense of self-effectiveness, which serves as a basis for learning more complex subjects in the future (Koyuncu & Dönmez, 2018). Due to their increased enthusiasm for learning mathematics, confidence in their ability to handle new tasks, and capacity for problem-solving, children with high self-efficiency have a higher probability of succeeding academically (Lee *et al*., 2022; Sağkal & Sönmez, 2022).

Children's levels of self-efficiency in mathematics during their elementary school years also have a substantial long-term impact on their academic and professional development (Lu *et al*., 2023; Algarni & Lortie-Forgues, 2023). Early poor self-effectiveness in arithmetic may have a detrimental effect on a person's interest in and performance in math later in life, as well as their desire to pursue a profession in STEM (Hand *et al*., 2017; Živković *et al*., 2023).

5. CONCLUSION

This study utilized an Android app and digital comic as a concept attainment tool to examine and clarify the mathematical thinking skills of primary school students. Utilizing a quantitative methodology, the investigation employed a 3 x 2 factorial design. 27 fifth-grade students from two distinct courses participated in the study. The findings demonstrated that students taught with a traditional approach and students taught with a concept attainment method utilizing an Android app have different mathematical thinking abilities. This is to allow students to arrange and solve issues based on their interests and cognitive processes when they are taught using a concept attainment model of learning. This is because students who have high levels of self-efficacy have more prior knowledge than students in other groups. The result demonstrates that self-efficacy and the development of mathematical thinking abilities are unrelated. People could benefit from this study by learning about different educational resources and media that can be used to improve their ability to think mathematically.

6. ACKNOWLEDGMENT

We are grateful to the following organizations for their support of the first author and presenter's studies: (1) Balai Pembiayaan Pendidikan Tinggi (Center of Higher Education Fund) – BPPT, The Ministry of Education, Culture, Research, and Technology, Republic of Indonesia; and (2) Lembaga Pengelola Dana Pendidikan (Indonesia Endowment Fund for Education) – LPDP, Ministry of Finance Indonesia.

7. REFERENCES

Abidin, Z., Herman, T., Wahyudin, W., and Farokhah, L. (2025). Bibliometric analysis using vosviewer with publish or perish of computational thinking and mathematical thinking in elementary school. *ASEAN Journal for Science Education, 4*(1), 7-16.

Abidin, Z., Herman, T., Wahyudin, W., and Penehafo, A.E. (2023). Computational thinking with an open-ended approach using interactive powerpoint media: An experiment in elementary schools. *Journal of Engineering Science and Technology, 18*(3), 1685-1695.

Ajenikoko, G. A., and Ogunwuyi, O. J. (2022). A mathematical model for estimating the end-of-life of power transformers: From literature review to development analysis. *ASEAN Journal of Science and Engineering, 2*(3), 285-294.

Akinoso, S. O. (2023). Motivation and ICT in secondary school mathematics using unified theory of acceptance and use of technology model*. Indonesian Journal of Educational Research and Technology, 3*(1), 79-90.

Al Husaeni, D. F., and Nandiyanto, A. B. D. (2022). Bibliometric using VOSviewer with publish or perish (using google scholar data): From step-by-step processing for users to the practical examples in the analysis of digital learning articles in pre and post covid-19 pandemic. *ASEAN Journal of Science and Engineering, 2*(1), 19-46.

Algarni, B., and Lortie-Forgues, H. (2023). An evaluation of the impact of flipped-classroom teaching on mathematics proficiency and self-efficacy in Saudi Arabia. *British Journal of Educational Technology, 54*(1), 414-435.

Angraini, L. M., Susilawati, A., Noto, M. S., Wahyuni, R., and Andrian, D. (2024). Augmented reality for cultivating computational thinking skills in mathematics completed with literature review, bibliometrics, and experiments for students. *Indonesian Journal of Science and Technology, 9*(1), 225-260.

Arista, F. S.; and Kuswanto, H. (2018). Virtual physics laboratory application based on the android smartphone to improve learning independence and conceptual understanding. *International Journal of Instruction, 11*(1), 1-16.

Attah, J. O., Ogunlade, O. O., and Falade, A. A. (2024). Students' attitude towards gamification-based teaching in mathematics in basic schools. *Indonesian Journal of Teaching in Science, 4*(2), 121-128

Awofala, A. O. A. (2023). Examining sources of mathematics self- efficacy beliefs of senior secondary school students. *ASEAN Journal of Science and Engineering Education, 3*(3), 229-244.

Awofala, A. O. A., Akinoso, S. O., Adeniyi, C. O., Jega, S. H., Fatade, A. O., and Arigbabu, A. A. (2024). Primary teachers' mathematics anxiety and mathematics teaching anxiety as predictors of students' performance in mathematics. *ASEAN Journal of Science and Engineering Education, 4*(1), 9-24.

Awofala, A. O. A., and Agbolade, F. O. O. (2024). Effect of peer-tutoring strategy on senior secondary school students' achievement in mathematics. *ASEAN Journal for Science Education, 3*(1), 1-12.

Awofala, A. O. A., and Akinoso, S. O. (2024). Altering students' mindsets and enhancing engagement in mathematics in a problem-based learning. *ASEAN Journal of Science and Engineering Education, 4*(2), 193-210.

Awofala, A. O. A., and Olaniyi, A.O. (2023). Assessing teachers' formative evaluation strategy as related to senior secondary school students' achievement in mathematics. *ASEAN Journal for Science Education, 2*(2), 77-86.

DOI: https://doi.org/10.17509/ajse.v4i2.72528
p- ISSN 2775-6793 e- ISSN 2775-6815

Awofala, A. O. A., Olabiyi, O. S., Ojo, O. T., Oladipo, A. J., Fatade, A. O., and Udeani, U. N. (2023). Personal and contextual factors as correlates of entrepreneurial intentions among pre-service science, technology, and mathematics teachers. *ASEAN Journal of Science and Engineering Education, 3*(3), 265-278.

Bellavia, L. (2021). The rematch of the tortoise and the hare: A story of speed and velocity. The Physics Teacher, 59(2), 128-129.

Bilan, Y., Mishchuk, H., and Samoliuk, N. (2023). Digital skills of civil servants: Assessing readiness for successful interaction in e-society. *Acta Polytechnica Hungarica, 20*(3), 155-174.

Block Sevilla, D., Ramos Banda, D., and Sosa, J. J. (2023). From the expression of the ratio with two natural numbers, to its expression with a fraction: Two didactic experiences at primary school and high school. *Educación matemática, 35*(3), 82-111.

Bouck, E. C., Park, J., Cwiakala, K., and Whorley, A. (2020). Learning fraction concepts through the virtual-abstract instructional sequence. *Journal of Behavioral Education, 29*(3), 519-542.

Damayanti, H. T., and Sumardi, S. (2018). Mathematical creative thinking ability of junior high school students in solving open-ended problem. *JRAMathEdu (Journal of Research and Advances in Mathematics Education), 3*(1), 36-45.

Darmawan, J., Saragih, A. H., and Sani, R. A. (2023). Development of Android-Based Offline Test Model in Physics Subjects. *International Social Sciences and Humanities, 2*(3), 1022-1029.

de Aldama, C., and Pozo, J. I. (2020). Do you want to learn physics? Please play angry birds (but with epistemic goals). *Journal of Educational Computing Research, 58*(1), 3-28.

Dermawan, R., Muktiarni, M., and Mupita, J. (2022). Efforts to increase the interest of junior high school students in mathematics lessons using the tik tok learning tool. *ASEAN Journal for Science Education, 1*(2), 81-88.

Elliott, L. A., Bolliou, A., Irving, H., and Jackson, D. (2019). Modeling potential energy of the gaussian gun. *The Physics Teacher, 57*(8), 520-522.

Farokhah, L., Herman, T., Wahyudin, W., and Abidin, Z. (2024). Global research trends of mathematics literacy in elementary school: A bibliometric analysis. *Indonesian Journal of Educational Research and Technology, 4*(3), 279-290.

Fisher, D. (2022). Mathematics mobile blended learning development: Student-oriented high order thinking skill learning. *European Journal of Educational Research, 11*(1), 69-81.

Fitrianti, A., Suwarma, I. R., and Kaniawati, I. (2024). Improvement of students' literacies skills in the knowledge aspect through science, technology, engineering, and mathematics (STEM)-integrated module. *Indonesian Journal of Teaching in Science, 4*(1), 41-46.

Furner, J. M. (2016). Every student can be an einstein: addressing math anxiety in today's classrooms. *Transformations, 2*(2), 22-45.

Ha, C. S., Lakes, R. S., and Plesha, M. E. (2018). Design, fabrication, and analysis of lattice exhibiting energy absorption via snap-through behavior. *Materials and Design, 141*, 426-437.

DOI: https://doi.org/10.17509/ajse.v4i2.72528
p- ISSN 2776-6098 e- ISSN 2776-5938

Hajar, Y. S., and Nandyanto, A. B. D. (2022). Application for regulating the number of calories in eating per day. *ASEAN Journal of Community Service and Education, 1*(2), 83-88.

HajiMoradkhani, H., Mashayekh, S., and Khodabandelou, R. (2023). Digital game-based learning in an introductory accounting course: design and development of an instructional game. *International Journal of Game-Based Learning (IJGBL), 13*(1), 1-21.

Hand, S., Rice, L., and Greenlee, E. (2017). Exploring teachers' and students' gender role bias and students' confidence in STEM fields. *Social Psychology of Education, 20*, 929-945.

Hardman, J., and Lilley, W. (2023). iLearn? Investigating dialogical interaction with tablets in mathematics lessons. *Technology, Pedagogy and Education, 32*(3), 321-335.

Hashim, S., Masek, A., Mahthir, B. N. S. M., Rashid, A. H. A., and Nincarean, D. (2021). Association of interest, attitude and learning habit in mathematics learning towards enhancing students' achievement. *Indonesian Journal of Science and Technology, 6*(1), 113-122.

Hewitt, P. G. (2019a). Quickly Teaching Speed, Velocity, and Acceleration—Part 2 Breadcrumb. *The Science Teacher, 86*(7), 10-15.

Hewitt, P.G. (2019b). Quickly teaching speed, velocity, and acceleration-Part 1. *The Science Teacher, 86*(6), 10-11.

Hilda, A. M., and Siswanto, R. D. (2021). Android application development: Permutation of the same elements based on realistic mathematics education. *Mathematics Teaching Research Journal, 13*(4), 170-180.

Isrokatun, I., Hanifah, N., Abdul, Y. R., Rosmiati, R., and Khoerunnisah, R. (2023). The development of android-based learning mobile app to practice critical thinking skills for elementary school students. *Pegem Journal of Education and Instruction, 13*(2), 161-172.

Janney, B. A., Sobotka, A. J., and Kidd, A. E. (2022). Decontextualizing velocity and acceleration in a concrete (and sweet) eating activity. *The Clearing House: A Journal of Educational Strategies, Issues and Ideas, 95*(5), 202-209.

Jose, M. T. N. S. (2022). Factors that affect the performance of selected high school students from the third district of Albay in International Mathematics Competitions. *ASEAN Journal for Science Education, 1*(1), 9-16.

Kapucu, S. (2019). Discovering quantities of circular motion of a light-emitting toy train using a smartphone light sensor. *The Physics Teacher, 57*(7), 480-482.

Kapucu, S. (2022). Using different smartphone sensors to find the speed of a toy car. *The Physics Teacher, 60*(6), 430-432.

Khawas, C., and Shah, P. (2018). Application of firebase in android app development-a study. *International Journal of Computer Applications, 179*(46), 49-53.

Koyuncu, B., and Dönmez, P. (2018). Predictive value of sense of self-efficacy and attitudes of high school students for their resistance to mathematics. *Universal Journal of Educational Research, 6*(8), 1629-1636.

Kunkel, M. W., Riedl, K. A., and Stickle, D. F. (2024). Acceleration in the City. *The Physics Teacher, 62*(2), 108-109.

DOI: https://doi.org/10.17509/ajse.v4i2.72528
p- ISSN 2775-6793 e- ISSN 2775-6815

Lagcao, Y. G. D., Dechavez, J. P. A. D., Goleng, D. J. G., Lagca, Y. G. D., Tangkli, K. Y. M., and Vicera, W. J. C. (2023). Math readiness and its Effect on the online academic performance of science, technology, engineering, and mathematics students. *ASEAN Journal for Science Education, 2*(1), 33-38.

Lasisi, A. K., Hassan, A. A., and Abdulkareem, H. B. (2024). Impact of single parenting on academic performance of junior secondary school students in mathematics. *ASEAN Journal for Science Education, 3*(2), 129-138.

Lee, J., Lee, H. J., and Bong, M. (2022). Boosting children's math self-efficacy by enriching their growth mindsets and gender-fair beliefs. *Theory into Practice, 61*(1), 35-48.

Lee, M. Y. (2018). Further investigation into the quality of teachers' noticing expertise: A proposed framework for evaluating teachers' models of students' mathematical thinking. *EURASIA Journal of Mathematics, Science and Technology Education, 14*(11), 1570-1584.

Leszczynski, E., Monahan, C., Munakata, M., and Vaidya, A. (2017). The windwalker project: An open-ended approach. *Journal of College Science Teaching, 46*(6), 27-33.

Long, C. S., Harrell, P., Subramaniam, K., Pope, E., and Thompson, R. (2023). Strengthening elementary preservice teachers' physical science content knowledge: A 3-Year Study. *Research in Science Education, 53*(3), 613-632.

Lu, H., Chen, X., and Qi, C. (2023). Which is more predictive: Domain-or task-specific self-efficacy in teaching and outcomes?. *British Journal of Educational Psychology, 93*(1), 283-298.

Mahuda, I., Nasrullah, A., Mubarika, M. P., Meilisa, R., and Fajari, L. E. W. (2022). Android-based mathematics learning media assisted by smart apps creator on self-regulated learning. *Online Submission, 3*(3), 160-165.

Marsh, H. W., Pekrun, R., Murayama, K., Arens, A. K., Parker, P. D., Guo, J., and Dicke, T. (2018). An integrated model of academic self-concept development: academic self-concept, grades, test scores, and tracking over 6 years. *Developmental Psychology, 54*(2), 263-280.

Martin, K., and Hunt, J. H. (2022). Learning trajectory based fraction intervention: Building a mathematics education evidence base. *Investigations in Mathematics Learning, 14*(3), 235-249.

Maryanti, R. (2021). Assessment of mathematical abilities of students with intellectual disabilities during the covid-19 pandemic. *Indonesian Journal of Community and Special Needs Education, 1*(2), 47-52.

Maryati, W. E., Retnowati, E., and Thoe, N. K. (2022). Learning mathematics formulas by listening and reading worked examples. *Indonesian Journal of Teaching in Science, 2*(1), 61-74.

Mateus-Nieves, E., and Rojas-Jimenez, C. A. (2020). Mathematical generalization from the articulation of advanced mathematical thinking and knot theory. *Acta Scientiae, 22*(3), 65-81.

DOI: https://doi.org/10.17509/ajse.v4i2.72528
p- ISSN 2776-6098 e- ISSN 2776-5938

Mitrayana, M., and Nurlaelah, E. (2023). Computational thinking in mathematics learning: Systematic literature review. *Indonesian Journal of Teaching in Science, 3*(2), 133-142.

Mousley, K. (2021). Pedagogical suggestions to foster fraction learning. *American Annals of the Deaf, 166*(3), 342-351.

Novaliendry, D., Darmi, R., Hendriyani, Y., Nor, M., and Azman, A. (2020). Smart learning media based on android technology. *International Journal of Innovation, Creativity and Change, 12*(11), 715-735.

Obafemi, K. E. (2024). Enhancing pupils' academic performance in mathematics using brainstorming instructional strategy. *ASEAN Journal of Science and Engineering Education, 4*(2), 99-106.

Obafemi, K. E., Fajonyomi, A., and Ola-Alani, E. K. (2023a). Effect of reversed jigsaw instructional strategy on pupils academic achievement in mathematics. *ASEAN Journal of Science and Engineering Education, 3*(3), 297-304.

Obafemi, K. E., Saadu, U. T., Adesokan, A., Yahaya, O., Sulaimon, J. T., Obafemi, T. O., and Yakubu, F. M. (2023b). Self-efficacy as a correlate of pupils' academic achievement in mathematics. *Indonesian Journal of Teaching in Science, 3*(2), 113-120.

Obafemi, K. E., Saadu, U. T., Yahaya, O., Obafemi, T. O., and Yakubu, F. M. (2024). Exploration of the effect of scaffolding instructional strategy on pupils' academic performance in mathematics. *ASEAN Journal for Science Education, 2*(2), 121-128.

Obafemi, K. E., Yahaya, O., Yakubu, F. M., and Obafemi, T. O. (2024). Effect of round robin instructional strategy on pupils' academic achievement in mathematics*. Indonesian Journal of Teaching in Science, 4*(2), 129-134

Ogunjimi, M. O., and Gbadeyanka, T. A. (2023). Effect of guided inquiry and explicit-instructional strategies on lower basic students' academic performance in mathematics. *Indonesian Journal of Teaching in Science, 3*(1), 23-32.

Padmore, E. A., and Ali, C. A. (2024). Exploring effective differentiated instruction in the teaching and learning of mathematics. *ASEAN Journal for Science Education, 3*(1), 41-54.

Pedersen, P. L., Aunio, P., Sunde, P. B., Bjerre, M., and Waagepetersen, R. (2023). Differences in high-and low-performing students' fraction learning in the fourth grade. *The Journal of experimental education, 91*(4), 636-654.

Piscová, V., Lehotayová, J., and Hreško, J. (2023). Environmental education in the school system at elementary schools in Slovakia. *European Journal of Science and Mathematics Education, 11*(4), 650-671.

Pispinis, D. (2019). Calculation of minimum speed of projectiles under linear resistance using the geometry of the velocity space. *European Journal of Physics Education, 10*(3), 1-9.

Poikonen, S., Wang, X., and Golden, B. (2017). The vehicle routing problem with drones: Extended models and connections. *Networks, 70*(1), 34-43.

Radiamoda, A. A. (2024). Difficulties encountered by the students in learning mathematics. *Indonesian Journal of Educational Research and Technology, 4*(1), 63-70.

DOI: https://doi.org/10.17509/ajse.v4i2.72528
p- ISSN 2775-6793 e- ISSN 2775-6815

Rohimah, S. M. (2025). Bibliometric analysis using Vosviewer with Publish or Perish of mathematical proficiency. *Indonesian Journal of Educational Research and Technology, 5*(1), 9-18.

Roick, J., and Ringeisen, T. (2018). Students' math performance in higher education: Examining the role of self-regulated learning and self-efficacy. *Learning and Individual Differences, 65*, 148-158.

Romadiah, H., Dayurni, P., and Fajari, L. E. W. (2022). Meta-analysis study: the effect of android-based learning media on student learning outcomes. *International Journal of Asian Education, 3*(4), 253-263.

Sağkal, A. S., and Sönmez, M. T. (2022). The effects of perceived parental math support on middle school students' math engagement: the serial multiple mediation of math self-efficacy and math enjoyment. *European Journal of Psychology of Education, 37*(2), 341-354.

Samuel, T. S., and Warner, J. (2021). "I can math!": Reducing math anxiety and increasing math self-efficacy using a mindfulness and growth mindset-based intervention in first-year students. *Community College Journal of Research and Practice, 45*(3), 205-222.

Saputra, D., Gürbüz, B., and Haryani, H. (2021). Android-based animation for chemical elements and experiments as an interactive learning media. *Journal of Science Learning, 4*(2), 185-191.

Sari, I. P., Suryadi, D., Herman, T., Dahlan, J. A., and Supriyadi, E. (2024). Learning obstacles on fractions: A scoping review. *Infinity Journal, 13*(2), 377-392.

Satsangi, R., and Raines, A. R. (2023). Examining virtual manipulatives for teaching computations with fractions to children with mathematics difficulty. *Journal of Learning Disabilities, 56*(4), 295-309.

Schadl, C., and Ufer, S. (2023). Beyond linearity: Using irt-scaled level models to describe the relation between prior proportional reasoning skills and fraction learning outcomes. *Child Development, 94*(6), 1642-1658.

Ogle, J. P., Hyllegard, K. H., Rambo-Hernandez, K., and Park, J. (2017). Building middle school girls' self-efficacy, knowledge, and interest in math and science through the integration of fashion and STEM. *Journal of Family and Consumer Sciences, 109*(4), 33-40.

Shogren, K. A., Burke, K. M., Antosh, A., Wehmeyer, M. L., LaPlante, T., Shaw, L. A., and Raley, S. (2019). Impact of the self-determined learning model of instruction on self-determination and goal attainment in adolescents with intellectual disability. *Journal of Disability Policy Studies, 30*(1), 22-34.

Solihah, P. A., Kaniawati, I., Samsudin, A., and Riandi, R. (2024). Prototype of greenhouse effect for improving problem-solving skills in science, technology, engineering, and mathematics (STEM)-education for sustainable development (ESD): Literature review, bibliometric, and experiment. *Indonesian Journal of Science and Technology, 9*(1), 163-190.

DOI: https://doi.org/10.17509/ajse.v4i2.72528
p- ISSN 2776-6098 e- ISSN 2776-5938

Su, A., Wan, S., He, W., and Dong, L. (2021). Effect of intelligence mindsets on math achievement for chinese primary school students: Math self-efficacy and failure beliefs as mediators. *Frontiers in Psychology, 12*, 1-10.

Subramaniam, K., Harrell, P. E., Long, C. S., and Khan, N. (2022). Pre-service elementary teachers' conceptual understanding of average speed: The systematicity and persistence of related and unrelated concepts. *Research in Science and Technological Education, 40*(2), 189-206.

Suprihatin, S., Yufitriani, Y., and Mulyeni, T. (2024). Developing the ability to add integer through live worksheets among grade II pupils with autism in mathematics learning. *Indonesian Journal of Community and Special Needs Education, 4*(2), 95-102

Tang, Q. (2023). Protocol-guided teaching in junior-secondary physics education: An analysis of the learning protocol for the velocity instruction based on real-world circumstances. *Science Insights Education Frontiers, 16*(2), 2565-2575.

Usmeldi, U., Amini, R., and Trisna, S. (2017). The development of research-based learning model with science, environment, technology, and society approaches to improve critical thinking of students. *Jurnal Pendidikan IPA Indonesia, 6*(2), 318-325.

Vecchio, G. M., Zava, F., Gerbino, M., Baumgartner, E., and Sette, S. (2023). Childcare providers and COVID-19: The role of regulatory emotional self-efficacy in sustaining subjective well-being. *Early Education and Development, 34*(8), 1749-1760.

Verdun, V. R., Chiasson, B. A., and Fienup, D. M. (2020). At the intersection of derived relations and observational learning: Teaching fraction–percentage relations. *Journal of Behavioral Education, 29*, 741-762.

Warner, S., and Kaur, A. (2017). The perceptions of teachers and students on a 21st century mathematics instructional model. *International Electronic Journal of Mathematics Education, 12*(2), 193-215.

Weakley, J., Mann, B., Banyard, H., McLaren, S., Scott, T., and Garcia-Ramos, A. (2021). Velocity-based training: From theory to application. *Strength and Conditioning Journal, 43*(2), 31-49.

Wijaya, H., Maryanti, R., Wulandary, V., and Irawan, A.R. (2022). Numerical minimum competence assessment for increasing students' interest in mathematics. *ASEAN Journal of Science and Engineering Education, 2*(3), 183-192.

Wong, K.S.; and Wong, H. (2022). Understanding the law of conservation of momentum in one-dimensional collisions between two objects using the velocity space approach. The Physics Teacher, 60(2), 94-96.

Yorganci, S. (2022). The interactive e-book and video feedback in a multimedia learning environment: Influence on performance, cognitive, and motivational outcomes. *Journal of Computer Assisted Learning, 38*(4), 1005-1017.

Zangori, L., Vo, T., Forbes, C. T., and Schwarz, C. V. (2017). Supporting 3rd-grade students model-based explanations about groundwater: A quasi-experimental study of a curricular intervention. *International Journal of Science Education, 39*(11), 1421-1442.

DOI: https://doi.org/10.17509/ajse.v4i2.72528
p- ISSN 2775-6793 e- ISSN 2775-6815

Zhang, L., Shang, J., Pelton, T., & Pelton, L. F. (2020). Supporting primary students' learning of fraction conceptual knowledge through digital games. *Journal of Computer Assisted Learning, 36*(4), 540-548.

Živković, M., Pellizzoni, S., Doz, E., Cuder, A., Mammarella, I., and Passolunghi, M. C. (2023). Math self-efficacy or anxiety? The role of emotional and motivational contribution in math performance. *Social Psychology of Education, 26*(3), 579-601.

DOI: https://doi.org/10.17509/ajse.v4i2.72528
p- ISSN 2776-6098 e- ISSN 2776-5938