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Think-Pair-Share in the Development of Grade 7 Student Multiply and Divide Decimal Mathematical Achievement

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Abstract

In this study, the effectiveness of a learning management plan using the think-pair-share technique on students' learning of decimal multiplication and division was investigated. The quasi-experimental study involved 42 grade 7 students in a public school in Thailand, who were simple random sampling. The study used a learning management plan, a learning achievement test, and a scoring rubric as instruments and employed the effectiveness index and a paired samples t-test to analyze the results. The results showed that the think-pair-share technique was effective in improving the student's understanding of decimal multiplication and division and that the students demonstrated learning outcomes on most topics and met the requirements on the post-test. The study also found that there was a significant improvement in the student's scores on the pre-test and post-test.

Keywords: think-pair-share, mathematical, achievement

1. Introduction

Multiplying and dividing decimals is an essential part of mathematics education since it helps students develop their understanding of the properties and operations of decimals (Larsson, 2017). Multiplying and dividing decimals teaches students how to work with decimals in a variety of scenarios and how to correctly execute these operations. It also helps learners enhance their critical thinking and decimal problem-solving skills. Moreover, the concept is fundamental knowledge for complex mathematical topics, such as algebra and geometry (Malone et al., 2017). Therefore, learners can develop a solid foundation for future math achievement by mastering these concepts.

However, it is not simply to learn decimal multiplication and division since learners need to develop sets of knowledge and abilities to solve the mathematical problems related to the concept. First, it is important for students to understand the place value of each digit as it can be movable when being multiplied or divided. In addition, they must be able to write decimal numbers using the proper notation, including the use of a decimal point to signify the place value of each digit (Verschaffel et al., 2007). A strong foundation in basic arithmetic operations is needed as addition, subtraction, multiplication, and division are necessary to perform operations with decimals (Lortie-Forgues, 2015). Furthermore, when dealing with decimals, students should be able to utilize estimation to determine whether their solutions are reasonable. Moreover, knowledge application is an important skill. Students should be able to apply their understanding of decimals to solve real-world problems that involve decimals, such as those related to measurements or financial transactions (Stacey et al., 2001).

Therefore, those lacking one of these abilities and skills are likely to have problems learning to multiply and divide decimals. As the notion represents foundational knowledge for more complicated mathematical topics, the issue may impact students' entire mathematical learning path. Studies suggested that one of the most common problems in learning mathematics is fundamental knowledge (Akhter & Akhter, 2018; Ali & Reid, 2012). For instance, lacking knowledge of numbers (e.g., natural numbers, integers, rational numbers, irrational numbers, etc.) and basic operations (e.g., addition, subtraction, multiplication, division) with them makes it difficult for students to grasp other mathematical concepts, such as algebra and geometry, and causes them to lose interest in the subject (Akhter & Akhter, 2018).

At the contextual level, mathematics education has been one of the crucial problems in the Thai educational context (Dencha et al., 2015). Overall, the subject of mathematics has been a weak point for Thai students, as

evidenced by the results of the Ordinary National Educational Test (National Institute of Educational Testing Service, 2022), which show that they have never achieved one-third of the full mark. This trend is also reflected in international assessments such as the Program for International Student Assessment (PISA), where Thailand has consistently ranked near the bottom in mathematics (Schleicher, 2019).

Specifically, the concept of decimal multiplication and division is instructed in grade 7 as it is a gateway knowledge for other concepts in junior high school (Ministry of Education, 2008), and issues can be raised by the previous studies (e.g., Dencha et al., 2015; Leegrajang & Pluangnuch, 2012; Inprasitha, 2010). First, it seems that the context has problems with passive learning environments. Traditional teacher-centered classroom focuses on lecturing, providing examples, and assigning class work may work for students who are already good at math. However, students who struggle with the subjects might lose class attention and interest in the subject completely (Inprasitha, 2010). In addition, the teacher-student relationship in the classroom may make it difficult to teach the subject. In a passive teacher-centered classroom, instructors are typically viewed as unarguable leaders (Yagoub, 2015). This discourages students from asking questions when they do not comprehend the material and leads to unexpected consequences in class. The individual distinction is an additional difficulty in the scenario. Students with inadequate mathematics skills are prone to solve mathematical problems slowly. It takes time to assimilate material, after which the class goes on to a different topic. However, if teachers devoted excessive time to a topic, pupils with strong mathematical skills would become bored and lose interest in the class. A strategy that encourages active learning, critical thinking, and the discovery and resolution of misunderstandings appears to be necessary to improve the teaching and learning of mathematics in Thailand. Therefore, an alternative teaching method should be applied to solve the situation in the context.

2. Literature Review

Considering the situation of problems in the context, we decided to employ a collaborative technique of think-pair-share (TPS) to deal with issues in teaching the concept of decimal multiplication and division. According to Kaddoura (2013), think-Pair-Share is a cooperative learning strategy that involves three stages: think, pair, and share. This strategy involves three distinct phases: (1) Think: Students are presented with a question or prompt and are given time to reflect on it individually. (2) Pair: Students then pair up with a partner or desk mate and discuss their ideas, comparing their perspectives. (3) Share: Pairs then share their thinking with the larger class, providing an opportunity for further discussion and the integration of diverse viewpoints. The theoretical framework of the techniques is presented below.

As with other cooperative learning strategies, TPS is founded on a range of complementary theoretical perspectives. From a constructivist perspective, the think-pair-share technique allows students to construct their own understanding of an idea or problem by thinking about it independently and then discussing it with a partner. This active engagement with the material helps to facilitate a deeper understanding and retention of the information (Fidrayani, 2018). In the context of collaborative learning, the think-pair-share technique involves students working together in pairs to share their thoughts and ideas, which can promote active learning and facilitate a deeper understanding of the material (Tint & Ei Nyunt, 2015). This approach is based on the idea that students can learn more effectively when they are actively engaged in the learning process and are able to interact with their peers. Sociocultural theory can also be used to describe the think-pair-share technique, as it emphasizes the role of social interaction and cultural context in learning. In the think-pair-share technique, students are given the opportunity to interact with their classmates and to consider multiple perspectives on an issue or concept. This can help to promote the development of critical thinking skills and to expand students' understanding of the material (Whipp et al., 2005).

Additionally, think-pair-share can be used as an alternative method for teaching math in Thai classrooms where the current curriculum exhibits methodological flaws. In traditional, teacher-centered classrooms in Thailand, the teacher is the primary source of information, and the primary goal is to transmit knowledge to the students (Garrett, 2008). However, research has shown that this approach is less effective at engaging students and promoting a deep understanding of the material (Matsuyama et al., 2019). By contrast, the think-pair-share method encourages students to actively engage with the material and construct their own understanding of an idea or problem (Kaddoura, 2013). This can be more effective at promoting a deeper understanding and retention of the information. In addition, the think-pair-share method can help students to develop their critical thinking and communication skills by requiring them to consider multiple perspectives and articulate and defend their own ideas (Kurjum et al., 2020). Therefore, by implementing the think-pair-share method in math classrooms, teachers can shift the focus of their classrooms from transmitting knowledge to facilitating student learning and understanding. This can help to create a more dynamic and engaging learning environment that is better suited to promoting student success (Parker & Asare, 2021).

Empirical studies show evidence to support the benefits of the TPS in mathematics education (e.g., Afthina et al., 2017; Ardiyaniet al. 2019; Kaddoura, 2013; Mundelsee & Jurkowski, 2021; Ningsih et al., 2019; Ningsih, 2019; Samsuriadi & Imron, 2019; Tanujaya & Mumu, 2019). To elaborate, the method has been used to promote mathematical thinking skills such as problem-solving (Samsuriadi & Imron, 2019) and critical thinking (Kaddoura, 2013), learning achievement (Afthina et al., 2017; Ardiyani et al. 2019; Ningsih et al., 2019; Ningsih, 2019; Tanujaya & Mumu, 2019), and class participation (Mundelsee & Jurkowski, 2021). Notable among the results of previous research is that most of them were conducted in Southeast Asian countries, which should share similarities with Thailand. Therefore, the think-pair-share strategy should likewise be effective in solving problems in the Thai environment. With these rationales, the current study employed the think-pair-share technique to design learning activities and implemented them to enhance grade 7 students' learning achievement of decimal multiplication and division. The purposes of the study were 1) to investigate the effectiveness of a learning management plan designed using the think-pair-share technique on students' learning achievement of decimal multiplication and division and 2) to compare students' learning achievement of decimal multiplication and division before and after implementing the learning management.

3. Methodology

3.1 Research Design

The study was designed with a quasi-experimental approach. The study employed a one-group pretest-posttest design (Poonputta, 2022).

Pre-test	Experiment	Post-test
T_1	X	T_2

Symbols of experimental research design

T_1 refers to pre-test

X refers to think-pair-share technique

T_2 refers to post-test

In this research design, data was collected from a single group of participants both before and after the implementation of the think-pair-share method. The purpose of the pretest was to establish a baseline measurement of the participants' initial learning achievement prior to any intervention. After the participants engaged in the think-pair-share activities, a post-test was administered to assess their learning achievement following the intervention.

3.2 Samples

The participants were 42 grade 7 students in a public school in Thailand. Simple random sampling was employed in sampling, and the educational background and participants' health were considered. None of the participants passed through a mathematics-intensive curriculum, and none of them had intellectual issues. The participants were treated anonymously considering ethical issues.

3.3 Instruments

3.3.1 The Think-Pair-Share Learning Management Plan

The learning management plan was carefully designed based on the principle of the think-pair-share technique, which is a collaborative learning approach. The plan consists of six distinct lesson topics, each with its own purpose, activities, and assessment. The six lesson topics are as follows:

1) Multiplying decimals with integers (1 hour)

2) Multiplying decimals with decimals 1 (1 hour)

3) Multiplying decimals with decimals 2 (1 hour)

4) Dividing decimals with integers (1 hour)

5) Dividing decimals with decimals 1 (1 hour)

6) Dividing decimals with decimals 2 (1 hour)

The learning management plan underwent evaluation by a panel of three experts and professional teachers. The

selection criteria for these evaluators focused on their extensive experience and expertise in mathematics education. To qualify, the evaluators were required to have a minimum of 10 years of teaching experience in mathematics, either in schools or universities. Additionally, they were expected to hold a professional teacher rank, indicating their recognized expertise in teaching mathematics within the Thai education system. For scholars among the evaluators, it was necessary for them to have a consistent track record of publishing academic work specifically related to mathematics education. By adhering to these criteria, the chosen evaluators possessed the necessary knowledge, experience, and research background to provide a comprehensive and insightful evaluation of the learning management plan's effectiveness in the context of mathematics education. The evaluation of the learning management plan by the expert panel indicated its appropriateness, as evidenced by the average rating of 4.66 (out of 5) with a standard deviation of 0.58.

3.3.2 Learning Achievement Test

1) The learning achievement test was a Math written test. The test consists of 10 items to examine students' knowledge of multiplying and dividing decimals. Throughout the test development, 16 test items were created. However, only 15 items passed the content validity criteria of 0.5-1.0 examined by Item Objective Congruence. 10 items were selected and employed in the current study. The test was used as both pre and post-tests throughout data collection.

2) Rubric scoring

The rubric scoring was used to rate students' scores on pre and posttests. In detail, 2 points were given when students provide correct answers and solutions. 1 point was given when students provide either correct answers but wrong solutions or correct solutions but wrong answers. 0 points were given when students provide both incorrect solutions and answers. (Table 1)

Table 1. The rubric scoring was used to rate students' scores on pre and posttests

Rubric scoring	Score
students provide correct answers and solutions	2
students provide either correct answers but wrong solutions or correct solutions but wrong answers	1
students provide both incorrect solutions and answers	0

3.4 Data Collection

The data collection process involved administering a pretest to assess the participants' initial learning achievement. Following that, the participants engaged in the learning management plan utilizing the think-pair-share technique, and their scores in completing various activities were collected. Finally, a post-test was conducted to evaluate the participants' learning achievement after the implementation of the learning management plan.

3.5 Data Analysis

1) The effectiveness of the learning management plan utilizing the think-pair-share technique was evaluated using the effectiveness index introduced by Promwong (2013). This index was determined by analyzing two factors: the participants' average score during the learning process (referred to as process effectiveness or E1) and the participants' score on the post-test (referred to as product effectiveness or E2). To meet the criteria of the effectiveness index, both E1 and E2 needed to exceed 70%. This criterion served as an indicator of the learning management plan's efficacy in enhancing the participants' achievement in multiplying and dividing decimals.

2) The comparison of the students' achievement before and after the treatment was analyzed using a paired samples t-test, and the effect size of the difference was calculated based on Cohen's methodology.

4. Result

1) The result of the study indicates that participants' learning achievement reached the determining criteria of 70 in most of the lesson plans. The second lesson plan - Multiplying decimals with decimals 1 was the only one in which the participant failed to complete the criteria ($\bar{x}$ = 28.71, S.D = 12.64). Overall, the participant's average score in learning activities was 230.24 (S.D = 32.73) out of the maximum points of 300. This accounts for 76.75% of the full marks show in Table 2.

Table 2. Participants' learning achievement while participating in the learning management plan

Lesson plan	Full marks	Minimum	Maximum	Median	Mean	SD	%
Multiplying decimals with integers	50	21	49	43	40.62	7.88	81.24
Multiplying decimals with decimals 1	50	9	49	31	28.71	12.64	57.43
Multiplying decimals with decimals 2	50	9	49	43	41.33	7.24	82.67
Dividing decimals with integers	50	17	49	37	36.29	8.00	72.57
Dividing decimals with decimals 1	50	15	49	43	41.00	6.94	82.00
Dividing decimals with decimals 2	50	23	49	42	42.29	5.77	84.57
Total	300	110	288	232	230.24	32.73	76.75

In addition, the participants' average score in the post-test was 14.02 (S.D = 4.99). The number accounts for 70.12 % of the maximum point. Therefore, the effectiveness index of learning management plan was 76.75/70.12 reaching the determining criteria of 70/70. It could be interpreted that think-pair-share techniques as the main principle in learning management design could lead to expected outcomes of participants' learning achievement of decimal multiplication and division in both on-process and end-product show in Table 3.

Table 3. The effectiveness index of the learning management

Effectiveness	Full marks	$\bar{x}$	S.D.	Percentage
Process effectiveness (E1)	300	230.24	32.73	76.75
Product effectiveness (E2)	20	14.02	4.99	70.12
Effectiveness index = 76.75/70.12				

2) The result of the study indicates an improvement in participants' learning achievement. Table 3 shows that there was a significant difference between participants' average scores in the pre-test ($\bar{x}$ = 0.76, S.D = 1.62) and the post-test ($\bar{x}$ = 14.02, S.D = 4.99), t=17.74, p=0.00, d=3.71. It could be interpreted that the think-paired-share technique positively affected participants' knowledge of decimal multiplication and division with a large effect size show in Table 4.

Table 4. The comparison between the participant's pre-test and post-test

	N	Score	Mean	S.D.	Paired Differences		t	df	Sig.	Effect size (Cohen's)
					$\bar{X}$	S.D.				
Pre-test	42	20	0.76	1.62	13.26	4.84	17.74	41	0.00	3.71
Post-test	42	20	14.02	4.99						

5. Discussion

Therefore, the results of the study reveal that think-pair-share is an effective collaborative learning strategy for enhancing participants' understanding of multiplying and dividing decimals. During the implementation of the learning management plan, the participant attained learning outcomes for most topics. They also met the requirement on the post-test. This result is accompanied by a comparison of the pre-test and post-test scores of the participants.

These results align with the findings of previous investigations on the benefits of the think-pair-share technique in mathematics education (e.g., Afthina et al., 2017; Ardiyani et al. 2019; Kaddoura, 2013; Mundelsee & Jurkowski, 2021; Ningsih et al., 2019; Ningsih, 2019; Samsuriadi & Imron, 2019; Tanujaya & Mumu, 2019). This can be explained by the way the technique encourages active participation by requiring them to think critically about and engage with the concept of multiplying and dividing decimals rather than just passively receiving information. Working in small groups also provided the opportunity for students to interact with and support each other, which can be particularly beneficial for those who may be struggling with the material (Kaddoura, 2013). Additionally, the technique's effectiveness may be related to how it allows learners of different abilities to work at their paces before receiving support from their peers, which can be particularly helpful for students who may need extra assistance or who may be ahead of their classmates (Tint & Ei Nyunt, 2015).

Moreover, the result of the study might be due to the effectiveness of the techniques in solving problems in mathematics classes in the Thai context. In detail, Thai mathematics classes are passive teacher centered (Dencha et al., 2015; Leegrajang & Pluangnuch, 2012; Inprasitha, 2010). The classes lack student engagement, make it difficult for students to learn a new mathematic concept, and disallow critical thinking, and. This class setting could not meet the needs of all students. By implementing the think-pair-share technique, the participants could develop their learning achievements in decimal multiplication and division. Therefore, it could be interpreted that the technique can contribute to active, collaborative, and supportive learning environments in the educational context of similar characteristics.

6. Conclusion

This research aimed to evaluate the impact of a teaching approach that used the think-pair-share technique on the academic performance of students in decimal multiplication and division. The study compared the students' learning outcomes before and after the implementation of the teaching approach and utilized a quasi-experimental design. The study participants were 42 seventh-grade students at a public school in Thailand. Data was collected using a learning management plan, an achievement test, and a scoring rubric. The results of the study indicated that the think-pair-share technique was an effective collaborative learning strategy for improving the student's understanding of decimal multiplication and division. The students demonstrated significant learning progress on most topics and met the requirements of the post-test. The study also found that there was a significant improvement in the student's scores on the pre-test and post-test.

One limitation of this study is that it employed only one group of participants utilizing the think-pair-share method. By not including a second group using a traditional teaching method as a comparison, we were unable to directly measure and demonstrate the relative effectiveness of the think-pair-share approach compared to the traditional method. Having a second group would have allowed for a more robust analysis and a direct comparison of the two instructional methods, providing clearer insights into the advantages of think-pair-share in terms of enhancing learning achievement.

The implications of this study's findings for education are numerous. First, the fact that the think-pair-share strategy is successful in enhancing students' knowledge of decimal multiplication and division shows that this technique could be a valuable tool for teachers in assisting students with the acquisition of other mathematical concepts. Second, the positive difference between the pre-and post-test scores of the students indicates that the think-pair-share strategy was effective in boosting long-term retention and learning. Given that the ability to execute decimal multiplication and division is a core skill required for success in higher-level mathematics courses, this is particularly crucial. The findings of this study imply that the think-pair-share strategy could be a useful addition to the teaching toolbox of educators working in a range of settings and with students of varying ages and abilities. Further research is recommended to explore the generalizability of these findings and the potential impact of the technique on other mathematical concepts and learning styles.

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