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Understanding multiplication concept: Exploring PMRI-enhanced thematic learning using traditional games for primary teachers

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Abstract

Involving concrete situations and utilizing contexts that are closely related to students' daily lives is highly promising in creating enjoyable and meaningful mathematics learning experiences. One approach that incorporates these ideas is *Pendidikan Matematika Realistik Indonesia* (PMRI), which is oriented towards the mathematization of everyday experiences. This research aims to investigate how the traditional game 'maggalaceng' could support students' understanding of multiplication in thematic learning using the PMRI approach. The method employed in this study was design research in the form of workshops involving eight teachers at a public primary school in Bone, South Sulawesi. Data were collected through classroom observations, interviews, and documentation. The results show that the teachers responded positively to integrating PMRI in thematic learning, making learning more enjoyable and meaningful. Specifically, in mathematics, the designed learning trajectory fully assists teachers in exploring alternative perspectives for teaching the concept of multiplication, progressing from the informal to the formal level as a form of repeated addition.

Keywords: *maggalaceng*; multiplication concept; RME; thematic learning; traditional game

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Introduction

The transition of the Indonesian curriculum from the 'Curriculum 2013' to the '*Kurikulum Merdeka*' has tended to be controversial for many parties. Implementing the new curriculum will undoubtedly bring about many changes in the learning process. However, some things are still maintained; one is the thematic approach, previously a learning characteristic in the Curriculum 2013. The thematic approach is still used in the new curriculum but is not mandatory (Kemendikbud, 2022). It is flexible, and educational institutions can use other approaches according to their conditions and needs. In thematic learning, learning is designed by integrating some subjects related to the theme (Ain & Rahutami, 2018; Narti et al., 2016) by combining competencies from several subjects and integrating cognitive, affective, and psychomotor dimensions into a unity (Sari et al., 2018). Associating multiple subjects using themes in thematic learning could provide meaningful experiences for students (Syamsuddin et al., 2021).

Implementing thematic learning has its own consequences for teachers, who are expected to be more creative in creating active and meaningful learning. However, teachers often need help implementing thematic learning. Several previous studies reveal that teachers found multiple difficulties in selecting appropriate problems and themes within thematic learning, managing time, preparing appropriate learning media for thematic learning, creating good instruments, and formulating clear assessment criteria (Al Azami & Supriyadi, 2021; Muskania, 2019; Retnawati et al., 2017). Many teachers are still stuck using textbooks as the only source of learning without implementing other creative ways (Indriani, 2015), such as using appropriate context, innovative methods, approaches, or learning media.

Mathematics learning that is integrated with other subjects using a particular theme in thematic learning is expected to be able to foster the meaningfulness of concepts and enhance students' interest in learning mathematics (Haji, 2009). In addition, presenting mathematics learning that is enjoyable and meaningful can also be done through the involvement of contextual situations (van den Heuvel-Panhuizen, 2003) as well as the use of concrete objects or context that is close to the students' daily lives (Cumhur et al., 2022; Laurens et al., 2017; Saraswati & Dewantara, 2020). The Indonesian Realistic Mathematics Education (PMRI) is a mathematics learning approach containing such ideas.

PMRI is the Indonesian version of Realistic Mathematics Education (RME) developed by the Freudenthal Institute in the Netherlands (Afriansyah, 2016). In the PMRI theory, mathematics learning begins with contextual matters using real situations from the students' experiences (Gravemeijer, 1994; Sembiring et al., 2008) and is oriented towards the mathematization of daily experiences (Zulkardi, 2002).

One important mathematics subject that is often encountered in daily life is multiplication. Multiplication is one of the basic calculations (Dewantara & Mahmud, 2020; Retta, 2013) that supports other mathematical concepts such as division, fractions, and percentages (Meryansumayeka et al., 2011; Prahmana et al., 2012). Therefore, students will have difficulty in other mathematical topics if they need help understanding the concept of multiplication.

Unfortunately, facts show that memorization -particularly memorizing the multiplication table - is the most frequently used method in teaching multiplication (Dotan & Zviran-Ginat, 2022), causing learning to become less meaningful (Dewantara & Mahmud, 2020; Prahmana et al., 2012; Tasman et al., 2011). On the other hand, according to Meryansumayeka et al. (2011), basic multiplication learning must begin with real multiplication situations so that students can manipulate and count the number of objects. One characteristic of PMRI is using context as the starting point in mathematics learning. Laurens et al. (2017) claimed that learning content and context, which are related to students' daily activities, could make students experience the ease of learning. As a starting point for learning, Mamolo (2018) also proposed that using realistic contexts would help students get involved in meaningful mathematical activities. One of the contexts that could be a situation related to students' daily lives is the game context (de Lange, 1987; Fosnot & Dolk, 2001). Some previous studies involving traditional game contexts show a positive influence on mathematics learning, such as making learning more enjoyable, meaningful, and effective to support students' understanding of a concept (Jaelani et al., 2013; Prahmana et al., 2012).

In this research, *Maggalaceng* was chosen as the traditional game context for teaching basic multiplication concepts because it is one of the traditional games that can support students' understanding of the concept of numbers and basic calculation concepts: addition, subtraction, multiplication, and division (Dewantara & Mahmud, 2020; Siregar et al., 2018). *Galaceng* or *maggalaceng* is a traditional game from the Buginese region, South Sulawesi, Indonesia, played by two people (Lestari, 2021). This game is also found in other areas of Indonesia, and it has different names, such as *congklak*, *dakon*, *dhakon*, or *dhakonan*.

Several previous studies have investigated how traditional game context could support students' understanding of mathematical concepts, such as the use of congklak in multiplication (Dewantara & Mahmud, 2020), *gasing* in time measurement (Jaelani et al., 2013), *batok kelapa* in length measurement (Fatoni et al., 2015) *dakocan* in addition up 20 (Nursyahidah et al., 2013), *congklak* in subtraction of integers (Muslimin et al., 2012), and *tepuk bergambar* in multiplication (Prahmana et al., 2012). However, more academic work goes for using traditional game contexts in thematic learning using the PMRI approach. Hence, the point of novelty of this study is integrating the PMRI approach into mathematics learning using the traditional game context of *maggalaceng*. This research investigates how the traditional game *maggalaceng* could support students' multiplication understanding in thematic learning using the PMRI approach.

Methods

This study is a design research. According to Cobb et al. (2003), design research is part of development research as it concerns learning and/or development of teaching materials. Design research consists of three main steps: preliminary design, teaching experiment, and retrospective analysis (Gravemeijer & Cobb, 2006). Preliminary design, or preparation for the experiment, was the stage where the researcher had some preparations, such as determining learning objectives, formulating local instructional theory (LIT) as the design of learning activities, and discussing the LIT conjecture to be developed. The design experiment or teaching experiment stage was implementing the prepared experimental design. Meanwhile, retrospective analysis is the stage of analyzing the data obtained in the design experiment stage.

In the context of design research, a workshop titled 'Integrating PMRI in thematic learning' was conducted. The primary objective of this study was to delve into the teaching experiment and the retrospective stage carried out during the workshop. The research involved the participation of eight elementary school teachers affiliated with IT Ash-Shiddiq Bone in South Sulawesi, Indonesia. Data collection methods included observation, interviews, and documentation. Subsequently, the collected data underwent a retrospective analysis phase using Atlas.ti 22.2.5 software to apply qualitative analysis techniques. Qualitative research focuses on extracting meaning rather than making broad generalizations (Dewantara et al., 2023). This analysis comprised three essential steps: data reduction, data presentation, and conclusion, following the method delineated by Huberman and Miles (2019).

The material was designed using the "Playing in My Environment" theme "Playing in My Friend's House" subtheme by integrating three subjects at once: mathematics with multiplication materials, Indonesian Language with reading texts about playing at a friend's house and understanding the content, and Civics with material on being united and friendly in playing activities. In mathematics learning, a modified traditional game of *maggalaceng* was used as a learning context. *Maggalaceng* is a traditional game played by two people using a *galaceng* board and 98 *galaceng* seeds. On the congklak or *galaceng* board, there are 16 holes, with 14 small holes facing each other and two large holes on either side (Siregar et al., 2018). However, the use of the traditional game context of *maggalaceng* in this research does not follow the actual *galaceng* game rules. However, it has been modified by the researcher to suit the needs of teaching multiplication concepts in the 2nd grade of elementary school.

Results

The learning activities designed in the preliminary design stage were implemented in the teaching experiment stage in the form of a workshop. The collected data from the teaching experiments were then analyzed with the following results.

Activity 1. Reading and understanding the narrative text

There were several learning objectives to be achieved in this first activity. Namely, students could read and understand the content of a narrative text well. They could identify various play activities in a friend's environment as the learning objectives of the Indonesian Language subject. Another aim was the elaboration of Civic's learning objectives in which students can carefully answer questions related to being united in diversity at home.

The first activity was designed to achieve the set learning objectives by instructing participants to read a narrative text and then understand its content. The context used in this learning activity design was Upin and Ipin playing with their friends. Upin and Ipin were chosen as learning contexts because they are cartoon characters familiar to elementary school children. So, by presenting Upin, Ipin, and their friends, students were expected to be more enthusiastic and motivated in learning (Figure 1). In addition, Upin and Ipin enjoyed playing with their friends in a peaceful and united atmosphere, which aligned with the indicators and learning objectives to be achieved in Civic.

Figure 1. Types of games played by Upin and Ipin

One of the materials in the first activity was the introduction of various types of simple traditional games. In this session, teachers as participants were very enthusiastic to mention one by one the types of simple and traditional games played by Upin, Ipin, and their friends (Figure 1). Participants' answers were different. Some answered jump rope, hide and seek, and others played congklak.

Next, one of the traditional games displayed and focused on further discussion was the traditional congklak game. However, in this case, the researcher uses a different term, namely *galaceng* or *maggalaceng*, as the local language in Buginese, where this research was conducted. The researchers explored the participants' knowledge about this traditional game because this game would be discussed further in learning activities 2 and 3.

Activity 2. Playing modified *maggalaceng* game

In the second activity, the participants play in pairs; one plays as player A and the other as player B. At the beginning of the activity, one pair was asked to demonstrate the game in front of the class while the other participants were asked to observe.

One example of an activity instruction demonstrated by the participants was in step 1, player A filled seven holes in the board with grains, so that each hole contains 3 grains of *galaceng*. In step 2, player B took the other grains and added 1 grain to each hole that was previously filled by the first player. Then, to count the total number of *galaceng* grains that had been placed in the holes, the researcher tried to explore the strategy used by the participants. Some answered "7 × 4." Other participants answered, "4 × 7". These two different answers indicated that there were still participants who were still confused about distinguishing between the concepts of "7 × 4" and "4 × 7". To respond the participants' answers, the researcher said that in this case we assume that we do not know yet the concept of multiplication. "Now, we play the role of elementary school students and do not know yet the concept of multiplication. So, what strategy is used to count the *galaceng* grains?" One participant answered, "counted one by one." Another participant supported this by adding, "$4 + 4 + 4 + 4 + 4 + 4 + 4$, we already know that each hole contains 4, so if there are 7 holes, it would be $4 + 4$ as many as 7 times." Based on the various answers, the researcher gave scaffolding questions, "How many *galaceng* grains are in each hole? Are the 7 holes all the same amount?" All the participants simultaneously agreed that all 7 holes had the same amount, which is 4 grains. So, the total number of *galaceng* grains can be written as $4 + 4 + 4 + 4 + 4 + 4 + 4$.

The researcher then provided scaffolding questions again to guide the participants in discovering the concept of multiplication as a form of repeated addition on their own. The following is conversation of researcher (R) and the participants (P 01, P 02, P 03):

R	:	*"In the sentence $4 + 4 + 4 + 4 + 4 + 4 + 4$, how many fours are there?"*
P 01	:	*"Fours?" (Some teachers asked. It seems that some participants were confused by the term 'fours')*
R	:	*"Yes, fours…the number 4" (the researcher explained in simpler language).*
P	:	*"7" (the participants answered in union)*
R	:	*"Can you repeat it in a complete sentence, how many fours are there?" (The researcher asked the participants to repeat it in a complete sentence)*
P 01	:	*"There are seven."*
R	:	*"How many times you take 'a four'?" (Scaffolding question)*
P 02	:	*"Oh, I understand. There are seven times four."*
P 02	:	*"That means we take four seven times."*
P 03	:	*"That means seven times four. (Making conclusion)"*

The researcher then confirmed the answers of several participants and asked one of the participants to conclude it more clearly that "$4 + 4 + 4 + 4 + 4 + 4 + 4 = 7 \times 4$, because there are seven fours." From this conclusion, the participants understood the meaning of the word 'times' and the concept of multiplication as a form of repeated addition.

Activity 3. Playing *galaceng* cards

In activity 3, the participants are invited to play using a card media called '*galaceng* cards'. There are three types of cards provided:

1. "*Galaceng* Grain Picture" card. Card containing circles that represent the image of *galaceng* holes and grains inside them.
2. "Addition Form" card. Card containing repeated addition sentences, such as "$9 + 9 + 9 + 9$"; "$7 + 7 + 7$", and so on.
3. "Multiplication Sentence" card. Card containing multiplication sentences from 1 to 10, such as "9×3"; "3×9"; "7×3"; "3×7", and so on.

Each pair group were given several cards for each type. The task of the participants in each group was to write the addition form as a representation of the grain image. From that addition form, the participants could write it in the form of a multiplication sentence (or vice versa). For example, if a player gets a *galaceng* card like (see Figure 2), then the player's task should write the addition form: $5 + 5 + 5 + 5 + 5$. The addition form then could be represented in the form of a multiplication sentence as 5×5, and the result is 25.

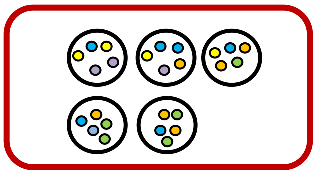

Figure 2. Illustration of *galaceng* card

In this activity, the researcher explained that the relationship between the cards is loose. In other words, one card has no relationship with another card. So, they need to not match or match each card, but write the addition and multiplication sentences from the grain image, or vice versa. Activity 3 ended with a conclusion given by one of the participants. From the activity, the participants were able to understand the concept of multiplication as a form of repeated addition. Participants were also able to distinguish the conceptual meaning of the multiplication forms '$a \times b$' and '$b \times a$'.

At the end of the teaching experiment activity, the researcher conducted additional interviews with 4 teachers to learn more about their responses to implementing the PMRI approach integrated into thematic learning. All four participants gave very positive responses to the learning that had been carried out. The workshop participants were very enthusiastic in the activities, due to the fact that PMRI was regarded as new learning approach for them to implement. The integration of PMRI into thematic learning became a new reference for them to teach mathematics in a fun and more meaningful way. This is shown by the interviewee's statement in the following interview fragment.

R	:	*"What is your opinion about the integration of PMRI in thematic learning?"*
P 02	:	*"Amazing. A lot of new knowledge. Usually I teach thematic learning only based on the text book. But through the simulation we did just now, I learned new knowledge about how to teach thematic learning using the PMRI approach. This is something new for me teach math using PMRI approach."*
P 04	:	*"The learning simulation earlier was very fun. I just found out about PMRI. Hmm ... if I ever hear RME, but if PMRI, I just found out."*
P 05	:	*"The most interesting thing is that we start learning from something real. For me, usually I only give a brief introduction linking the material with real things in everyday life. Even to teach multiplication, I link it with real things only at the end of learning, when giving multiplication story problems. But the PMRI that we simulated earlier was very interesting."*
P 07	:	*"For me, the most impressive thing is when through the game we can distinguish the meaning of* 3×8 *and* 8×3*. Honestly, in class, I never taught that concept to students. It never crossed my mind, it turns out it can be taught with a very interesting method through the PMRI approach."*

In addition, according to the four informants, thematic learning becomes more meaningful and enjoyable. In this case, participants are stimulated and encouraged to be actively involved in every learning activity provided. This was stated by one of the informants (P-02) that,"*We as teachers who participated in the simulation just now were very enjoy, very active, even though the material is easy, just multiplication, but with the activities provided, learning becomes more enjoyable and all participants are encouraged to be actively involved.*"

Discussion

Three activities designed in the preliminary design are intended to help participants actively engage in achieving the established learning objectives. These three designed learning activities have different achievement goals. The first activity is designed to achieve the learning objectives of Indonesian Language and Civics subjects through reading and understanding the text. Activities 2 and 3 are intended to help students achieve the learning objectives of mathematics, in particular multiplication material.

Two key points emphasized in the second activity are that the participants understood the given instructions well in doing math activities and understood the concept of multiplication as repeated addition. The first point was shown at the beginning of the activity, where participants were asked to read the game instructions carefully and attentively before simulating the *maggalaceng* game. In this case, participants were accustomed to understanding all instructions that follow any given math activity. It cannot be denied that one of the weaknesses of many students today is difficulty in understanding narrative information that requires reasoning. In the context of math learning, this is also a difficulty for many students. Njagi (2015) stated that one of the common mathematical difficulties students face is difficulty understanding instructions from story problems.

The next focus in the 2nd activity was helping participants understand the meaning of the term 'times' and the concept of multiplication as a form of repeated addition. To build this understanding, participants were stimulated to construct their own understanding through the *maggalaceng* game activity. It was depicted when participants were not directly asked to state the result of the multiplication $7 \times 4 = 28$, but they were asked to start the activity by counting the number of *galaceng* seeds in 7 holes, where each hole contains 4 seeds. Gradually, participants were given scaffolding questions, starting with how to effectively count the total number of *galaceng* seeds.

The answers from participants stating that the total number of *galaceng* seeds can be written as $4 + 4 + 4 + 4 + 4 + 4 + 4$ become the starting point for the concept of repeated addition to be introduced. In this stage, the researcher does not directly direct the participants to the final conclusion that $7\, x\, 4 = 4 + 4 + 4 + 4 + 4 + 4 + 4 = 28$ and lead them to the basic concept of multiplication as repeated addition. On the other hand, the participants were directed and stimulated to discover the concept themselves through the activities and scaffolding questions proposed by the researcher. By answering the scaffolding questions, participants were able to construct ideas and eventually discover the concept of multiplication as a form of repeated addition on their own. This is a characteristic of PMRI, which involves using students' own creation and contribution and involves interactivity in the learning process (Putri, 2019; Sembiring et al., 2008). Participants are given the opportunity to construct and determine the strategies used in problem-solving.

In the modified *galaceng* game activity, it is also apparent that participants were given the opportunity to express as many possible problem-solving strategies as they could think of in solving a problem. The various strategies that emerge were then discussed together. They were directed to discuss the various strategies that emerge during the problem-solving process. It indicated another characteristic of PMRI, interactivity - interaction between students and between students and teachers (Putri, 2019; Sembiring et al., 2008). Interactivity is created between students-teachers and among students. This finding supports the previous study's claim that PMRI could encourage students to develop various strategies that enabled them to grasp specific mathematical concepts on their own (Ekawati & Kohar, 2016).

In activity 2, participants were not directly given an explicit explanation that $3 \times 4 = 12$, but they were directed to discover on their own that $3 \times 4 = 4 + 4 + 4 = 12$, which means that multiplication is a form of repeated addition. This is in line with the concept of multiplication proposed by van den Hauvel-Panhuizen (2001) that multiplication refers to the word 'times', which can be translated as 'add so many times'. Tasman et al. (2011) supports this findings that multiplication is carried out by adding a certain number of times, so multiplication can b interpreted as a form of repeated addition. Therefore, the basic concept of multiplication as a form of repeated addition can be discovered by workshop participants through activity 2 (modified *maggalaceng* game activity) in this research.

Another characteristic of PMRI that appears in the learning activity in this research is the intertwining of various learning strands or units (Putri, 2019; Sembiring et al., 2008). The mathematics learning activity was carried out by integrating various concepts, aspects, or mathematics topics into a learning activity. The *maggalaceng* game supports multiplication learning and is closely related to other materials, such as addition. In addition, mathematics learning could be integrated with other subjects in a thematic learning.

According to the interviewees, thematic learning became more meaningful and enjoyable through the teaching experiment. In this case, participants are not passively receiving material. On the contrary, participants are stimulated to be actively involved because they are given the most comprehensive opportunity to construct and determine problem-solving strategies, as is characteristic of PMRI, which involves the contribution and interactivity of students in the learning process (Putri, 2019; Sembiring et al., 2008). Integrating PMRI into thematic learning becomes a new reference in teaching mathematics in a fun and more meaningful way.

All the interviewees said that they have started learning multiplication by involving real examples so far. However, afterward, students tend to be taught multiplication in the formal form directly and are then directed to practice problems. On the other hand, through the PMRI approach, participants are actively invited to construct ideas and stimulated to discover the concept of multiplication by starting from real problems.

Even, one of the interviewee participants admitted that through PMRI learning he was finally able to distinguish $'a \times b'$ and '$b \times a$'. Where 3×7 is different in concept from 7×3, because 3×7 means there are 3 'sevens' and 7×3 means there are 7 'threes'. What he understood so far was that the meaning of both was the same, 7×3 and 3×7 were the same because the result was the same, 21. This result is in line with the research conducted by Dewantara & Mahmud (2020) that the congklak game can be a context in helping students effectively distinguish the difference in concept between '$a \times b$' and '$b \times a$' in multiplication. The learning activities of multiplication using PMRI approach in thematic learning can be visualized in an iceberg. Figure 3 below presents the iceberg of learning activities using *maggalaceng* from the informal to formal mathematics stage (Dewantara & Mahmud, 2020).

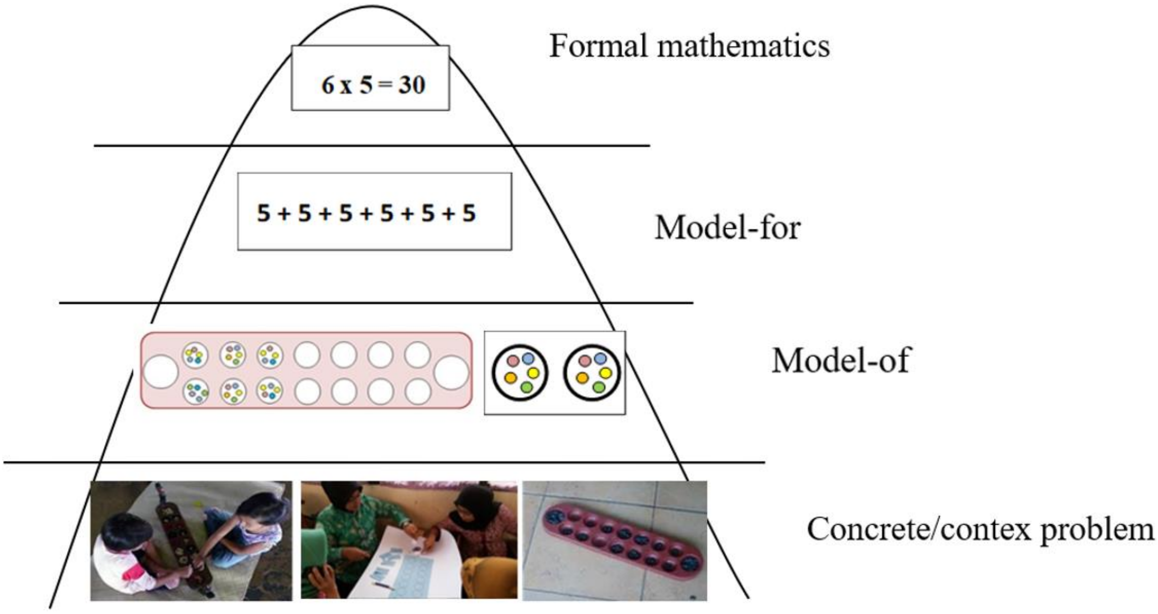

Figure 3. Iceberg of multiplication learning

Figure 3 presents the process of introducing the basic concept of multiplication starting from using concrete and contextual problems, namely the use of modified *galaceng* or congklak media that can be visualized by participants until the formal mathematical stage of writing the form of multiplication a × b. In other words, the activity of playing *galaceng* in this study can direct participants to reach a more formal stage in understanding the concept of multiplication as a form of repeated multiplication.

The iceberg (Figure 3) also shows one characteristic of PMRI: the use of models and symbols for progressive mathematization. Models and symbols are used as a bridge from situational problems to formal knowledge. To reach the formal mathematical concept, there are four levels of emergent modeling known in PMRI: situational level, referential level (model-of), general level (model-for), and formal level (Putri, 2019; Sembiring et al., 2008).

The use of *galaceng* cards (*galaceng* seed pictures, forms of addition, and forms of multiplication) shows the level of modeling (emergent modeling) in PMRI. The cards containing *galaceng* seed pictures as a form of model-of, then cards containing forms of repeated addition as model-for, finally reached the formal (formal level) stage when participants wrote them in the formal notation for multiplication. In other words, using modified *galaceng* media and *galaceng* card media supports participants in understanding the concept of multiplication from the informal to the formal level.

Therefore, the activity of playing modified *galaceng* (activity 2) and *galaceng* cards (activity 3) provides a perspective for teachers on how to teach the concept of multiplication to students in a more meaningful way, not directly to the formal level, by not directly asking students to memorize multiplication, but starting from the concrete level to the formal level through four levels of learning in PMRI (Gravemeijer, 1994). This result is in line with several previous relevant studies that also used traditional games in learning with the PMRI approach (Edo et al., 2015; Fatoni et al., 2015; Saraswati & Dewantara, 2020), where the results showed that the use of the PMRI approach using traditional game contexts and concrete media is very powerful to support the mathematical understanding from an informal level to a formal level.

PMRI learning levels that appear in the learning activity include situational level by using *galaceng* media that can be seen or imagined by students, model-of in the form of *galaceng* model represented through *galaceng* card pictures, model-for through the use of repeated addition cards as a representation of the amount of *galaceng* seeds in model-for pictures, and formal level when students can recognize the formal form of multiplication. These stages or levels are characteristics of PMRI, namely the use of models and symbols for progressive mathematization, where models and symbols are used as a bridge from situational problems to formal knowledge (Sembiring et al., 2008).

Conclusion

Using traditional games in real-life contexts, closely related to everyday life, is an enjoyable and meaningful way to improve math learning. The study shows that employing the traditional game "galaceng" with the PMRI approach effectively supports participants in understanding the basic concept of multiplication, moving from an informal to a formal level. Additionally, integrating the galaceng game into thematic learning, which combines math, Civic education, and the Indonesian language, makes learning more enjoyable. The designed learning activities include trajectories that help achieve the learning objectives. In the realm of mathematics, two activities (playing modified galaceng and galaceng cards) play a crucial role in guiding participants to develop their own understanding of multiplication as repeated addition. These activities bridge participants' comprehension from concrete to abstract and informal to formal levels through four stages of emergent modeling: situational, referential, general, and formal. The designed learning activities also enable participants to distinguish between the concepts of 'a × b' and 'b × a.' The effectiveness of using various traditional games to enhance students' understanding of a wide range of mathematical concepts is a promising area for further research.

The study's limitations include its focus on the specific traditional game *galaceng* and a particular group of elementary school teachers, potentially limiting the generalizability of findings to other games or populations. However, the research underscores the effectiveness of using traditional games, like *galaceng*, in a PMRI approach, offering an engaging and meaningful way to bridge the gap from concrete to abstract understanding. These findings have broader implications for math education and suggest the promising exploration of using various traditional games to enhance comprehension across diverse mathematical concepts, warranting further research.

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Conflicts of Interest

The authors declare no ethical conflict, including plagiarism, misconduct, data fabrication and/or falsification, double publication and/or submission, and redundancies, regarding the publication of this manuscript.

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Author Contributions

Zakaria: Conceptualization, writing**; Andi Harpeni Dewantara:** Collecting the data, writing, editing, translating.

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