



Developing 'Fort Defending' Game as a Learning Design for Mathematical Literacy Integrated to Primary School Curriculum in Indonesia

Endonezya'da İlkokul Müfredatı için Matematik Bilgisi Öğreniminin Entegre Tasarımı olarak 'Fortress Game' (Kale Oyunu)'nun Gelişimi

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Abstract: A development of fort defending game is used to provide a learning design based on the mathematical literacy, integrated with the primary school curriculum in Indonesia is K-13. The method applied is development research adapted from Nieveen. It has three proper stages; preliminary, prototyping and development stage. The preliminary stage is where the researcher determines what so stated as basic problems of design planning. Next, the prototyping stage is the two-step where the developmental design of the game is constructed in accordance with the aims of mathematical literacy, integrated in the Indonesia curriculum, specifically in term of basic competence lists, learning design and group activity sheet. The result of the first stage is marked as Draft I, and being validated by the expert. The Draft II is produced from the final step, is the description of developed fort defending game-based, aimed to improve mathematical literacy integrated into the Indonesia curriculum. This draft has also been validated and applied in the real-life teaching of first-grade students in primary school.

Keywords: Fort defending game; primary school, mathematical literacy

Öz. 'Fortress Game' Endonezya'daki K-13 ilköğretim müfredatına entegre matematik okuryazarlığına dayalı bir öğrenme tasarımı sağlamak için kullanılan bir kale savunma oyunudur. Geliştirme araştırmasında kullanılan yöntem Nieveen'den uyarlanmıştır. Çalışmanın ön aşamalar (analiz), ilk örnek yaratma (tasarım) ve geliştirme olarak üç aşaması vardır. Ön aşama araştırmacının tasarım planının temel sorunu olarak adlandırılan şeyi belirlemesidir. Buna ilave olarak, ilk örneği yaratma aşaması oyun geliştirme tasarımı Endonezya'daki K-13müfredatıyla entegre konsepti düşünülerek özellikle bir tema içerisinde temel beceriler, öğrenme tasarımı ve gurup çalışması tablosu dahil edilerek yapılmıştır. Birinci aşamanın sonucu taslak I olarak işaretlenmiş ve bir uzman tarafından değerlendirilmiştir. Son aşamadan üretilen taslak II geliştirilen savunma temelli oyunun bir betimlemesidir. Bu oyun Endonezya müfredatına entegre matematik bilgisini geliştirmeyi hedeflemektedir. Bu taslak da aynı zamanda bir ilkokuldaki birinci sınıf öğrencilerinin gerçek yaşamdaki öğrenimlerine uygulanmış ve değerlendirilmiştir.

Anahtar sözcükler: Fortress game, ilkokul, matematik okuryazarlığı

INTRODUCTION

Education is marked as an individual empowerment process aimed to achieve high qualified personality during the lifetime (Kaur & Puar, 2017). Moreover, hence, the curriculum is essential to determine any education quality (Hidayah & Sugiarto, 2015). The curriculum is being constructed through the direct interaction between students and the surrounding nature (Zeiny, 2012). Thus, it has to be such a setup way of transformation from the curricular design and provision into students' real competence, as they mostly need during their lifetime (Popa & Bucur, 2015). The latest curriculum in Indonesia is projected to focus and support the sustainability of learning skills development, characters nurturing and motivational persistence in the social life (Talts, Kuk, Tuisk, & Kaljuve, 2012). Along with the systematic implementation of the curriculum, the government has also launched the *sustainable development goals* (SDG) program, targeted to be achieved entirely in 2030. Through the educational wings of this program, mathematical literacy is essentially promoted and assigned (Piper, Simmons Zuilkowski, Dubeck, Jepkemei, & King, 2018). It is known as the ability to formulate, utilize and interpret math theories in various contexts (Genlott & Grönlund, 2013; Ojose, 2011; Outhwaite et al., 2017).

In accordance with the goal, the literacy teaching in schools must be designed to drive the students into reality problems to trigger their cognitive construction (Demirbağ et al., 2017; Plomp & Nieveen, 2010; Sumirattana et al., 2017). Some specific features of human intelligence have become the main consideration to nurture student's ability to create and solve the problems (Utemov, 2017). That is why, three aspects; cognitive, affective and psychomotor are obligatorily involved during the learning time (Arslan et al., 2014). Moreover, considering kids character, students may need to actively move in order to support their cognitive development (Trnova & Trna, 2015).

The primary school stage is full of psycho-social directive driving to the development of students' emotional and their social relationship (Demirbağ et al., 2017). Thus, the stage can be positively treated by pedagogical approach aiming to support their math skills by combining it with such an interesting game.

The latest educational development demands student-centered learning style, where students are active and independently learn the materials, while teachers can contribute only as supporting facilitators (Hornáčková, Kyrálová, Plachá, & Jiroutová, 2014). Learning environmental awareness can be inserted to the activities list, in order to nurture their environmental awareness and practice direct actions towards surrounding areas (Alaydin, Demirel, Altin, & Altin, 2014). Moreover, the game is the main methodology used in teaching kids since it allows them to perform communication web one to another, and to freely express their feelings (Lucas, 2017).

The game also allows kids to learn with extremely minimized or even zero burdens (Chen, 2017; Ilgaz, 2015). The researcher has firstly assumed that the utilization 'fort defending' game to teach mathematical literacy is a beneficial solution to achieve Indonesia curriculum implementation, In this case, the Indonesia curriculum used is curriculum 2013 (K-13). "Fort defending" game as learning design plays a very important role in the curriculum in Indonesia to build mathematical literacy in first-grade elementary school students. The implementation of learning using the 2013 Curriculum (K-13) will be boring if the learning done in the classroom is done monotonously because students tend to be easily bored. The design of mathematics literacy learning developed with traditional Fort Defending games will make mathematics literacy learning in K-13 easily and pleasantly implemented, and also make students think higher in mathematical literacy. Therefore, this research is conducted to examine the benefit of modifying the game in mathematical literacy learning, assigned by K-13 curriculum.

METHOD

This study is developmental research, adopting Niemen's research theory, along with some adjustments to the practical needs by providing three stages; *preliminary*, *prototyping* stage and *development* stage (Plomp & Nieveen, 2010). This research consists of three stages because the

final product produced is a valid and practical learning design prototype. The first stage, the preliminary, consists of analyzing the gap needs of literacy problems that occur, including problems that exist in schools as a place of testing. First-class students from the Naff, a Creative Primary School in Sidoarjo. The sampling of 15 students is taken from IB class, through the interview during the preliminary stage. The second stage, prototyping, is the stage of evaluating the validity of the learning design developed. Validity assessment is obtained from the expert judgment that assesses the validity of the components of the coverage of mathematical literacy and mathematical literacy competencies in the product. The second stage results of Draft I contains a design of the game model and its supporting instruments, such as group activity sheet. The last stage, the development, is a trial to get the practicality of the product being developed. In the teacher assessment questionnaire, practicality in terms of the implementation of learning design, time allocation, and learning process. Student assessment questionnaire consists of aspects of ease in understanding and ease of completion of tasks. As a final result, this research produced a valid and practical Draft II prototype learning design.

The analysis technique used at the preliminary stage is observations related to the analysis of needs in learning mathematics literacy, including the curricula used. The results of this observation are in the form of a description of the needs analysis. In the prototyping stage, data analysis is obtained from expert judgment with questionnaires and assessments referring to the Likert scale consisting of 1 (very less valid), 2 (less valid) 3 (quite valid) 4 (valid) and 5 (strongly valid). Finally, the data analysis used in the development stage is to use the teacher's practicality questionnaire and student practicality questionnaire that refers to the Likert scale.

RESULTS

PRELIMINARY STAGE

At this stage, the teachers of first grade in Naff Creative School were interviewed, and it is revealed that the majority of them stated that students do not really have a good sense toward the learning of mathematical literacy. Having a consideration that math is difficult for them. They also can easily get bored to learn math in the classroom, since the material is mostly theoretical and less practical.

PROTOTYPING AND DEVELOPMENT STAGE

Validity result of mathematical literacy learning design integrated with K-13 curriculum is presented by Table 1.

Table 1. *The validity of 'fort defending' game in mathematical literacy integrated with K-13 curriculum*

No.	Assessment Aspects	Validator Score			Average	Criteria
		I	II	III		
1.	Mathematical literacy competence	8	9	10	9	Strongly Valid
2.	Scope of mathematical literacy	12	13	15	13,3	Valid
Total		67				
Average		22,3				
Criteria		Strongly Valid				

The Table presents some result stating that the aspect of mathematical literacy competence gained score from validated 1 is 8, validator 2 is 9, and validator 3 is 10. The average gains 9, which means strongly valid. For the aspect of scope mathematical literacy gained score from validator 1 to 3 is 12, 13 and 15. The average gains 13.3, which means valid. Also, the whole average and result in the form of prototyping design are categorized strongly valid. After validating Fort Defending game in mathematical literacy integrated with K-13 curriculum, the prototyping stage makes Draft 1. The next is implementing Fort Defending game to the *development* stage, and then Draft 2 is done. The practicality assessment questionnaire assessment scores from teachers and students are presented in Table 2 and Table 3.

Table 2. *Practicality of 'fort defending' game in mathematical literacy integrated with K-13 curriculum*

No.	Assessment Aspects	Validator Score		Criteria
		I		
1.	Easy learning steps	5		Strongly practical
2.	The time allocation used is sufficient	4		Strongly practical
3.	The learning process is relevant to the curriculum used	5		Strongly practical
Total			14	
Average			4,6	
Criteria		Strongly Practice		

Based on Table 2, the aspect of practicality assessment obtained from the teacher's assessment of the easy-to-implement learning step points gets a score of 5 with very practical criteria. In the second point, the time allocation used gets an assessment of 5 with practical criteria and the last relevant learning process with the curriculum used gets a very practical score. So, it can be concluded from Table 2 that the average rating obtained from the teacher's assessment questionnaire is 4.6 with a very practical category.

Table 3. *Practicality of 'fort defending' game in mathematical literacy integrated with K-13 curriculum*

No.	Assessment Aspects	Validator Score		Criteria
		15 students		
1.	Ease of understanding the game	75		Strongly Practice
2.	Ease in completing tasks	75		Strongly Practice
Total			150	
Average			75	
Criteria		Strongly Practice		

Based on Table 3, the aspects of practicality assessment obtained from the assessment of students at the point of ease in understanding the game got a score of 75 out of 15 students with very practical criteria. The second point, namely the ease of completing assignments, gets an assessment of 75 out of 15 students with very practical criteria. Thus, it can be concluded that based on table 3, the average rating obtained from student assessment questionnaires is 75 in a very practical category.

Before designing the curriculum application, some subjects containing cognitive, skills and character developments must be considered, according to the K-13 (Bülent & İlknur, 2011; Njeng, 2014). To reach mathematical literacy, KD (Basic Competence) of the first graders must be highlighted and chosen from the topic DIRIKU (My Self). Moreover, then, these basic competencies are being integrated into the material of mathematical literacy, as explained below:

Table 4. *Basic competence*

Subjects	Basic Competence
PKN (Civic)	2.3 Showing togetherness in the diversity of individual characteristics.
Matematika (Math)	4.3 Sorting numbers from the highest to the lowest value.
PJOK (Sport)	4.1 Exercising basic locomotor involving the concept of physical structure, spaces, effort and connectivity inside the traditional game
SBK (Art and Culture)	4.4 Making a creation from the natural materials.
Bahasa Indonesia	3.3 Explaining the phonetic symbols of vowels and consonants in Bahasa Indonesia.

The basic competency is then being integrated, to provide a wide range of exploration by students (John, 2015; Nizaruddin, Muhtarom, & Sugiyanti, 2017). Next, these basic competencies are packed to be a unified problem through the process of mathematical literacy. During the application of 'Fort Defending' game, the mind mapping process is explained as follows:

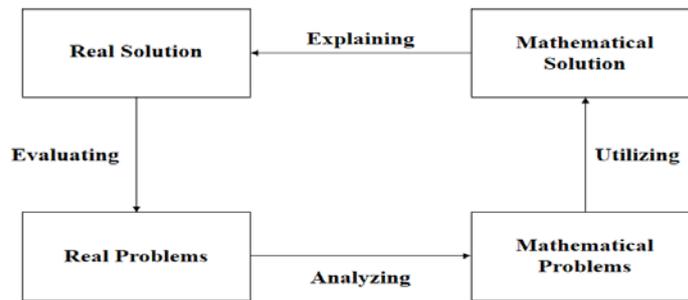


FIGURE 1. *Mathematical literacy process*

According to the figure above, a real problem is a problem consisting inside the fort. Students then collectively analyze the happening problem in each group formed previously. They will use mathematical problem-solving theory to deal with it and expected to provide a real solution for the problem (Çİmen & Üniversitesi, 2018). This mathematical literacy process is a form of an integrated curriculum which encourages them to provide a solution and creates meaningful learning.

This chronological process then will be utilized as the early blueprint of the learning process. Hence the explanation of mathematical literacy learning designs, in accordance with the K-13:

REAL PROBLEM



FIGURE 2. *The king's daughter trapped in the jungle*

Once upon a time, there was a sad King inside a royal fortress. The King had just lost his lovely beautiful daughter. As time passed away and the daughter was remaining unfounded, the King was getting sick.

In one night, the King fell asleep and dreamt about his daughter. He saw in his dream that the daughter was kidnapped by the King of Jungle and was imprisoned in the middle of the jungle. To rescue her, the King must found 8 numbers and sort it back from the lowest to the highest value. This order of numbers is the passing code to discover the name of the Jungle King. After, knowing the name, the King can rescue his daughter by finding the location in the jungle.

In the next day, the King awoke and remembered his dream. Since the King was sick, he ordered one of his people to search and rescue his lovely daughter. Those who could find his daughter first would be awarded by the King's gold, medal, and massive bounty.

The Involvement of Basic Competence

After reading the story, students who have been divided into groups are expected to analyze the problem inside the royal fortress and to find the practical solution in order to rescue the King's daughter. Lastly, students can interpret the real solution to find the Jungle King's location and rescue the daughter of the King. The involvement of basic competence can be drawn under the basic competence and mathematical literacy mapping, as explained below:

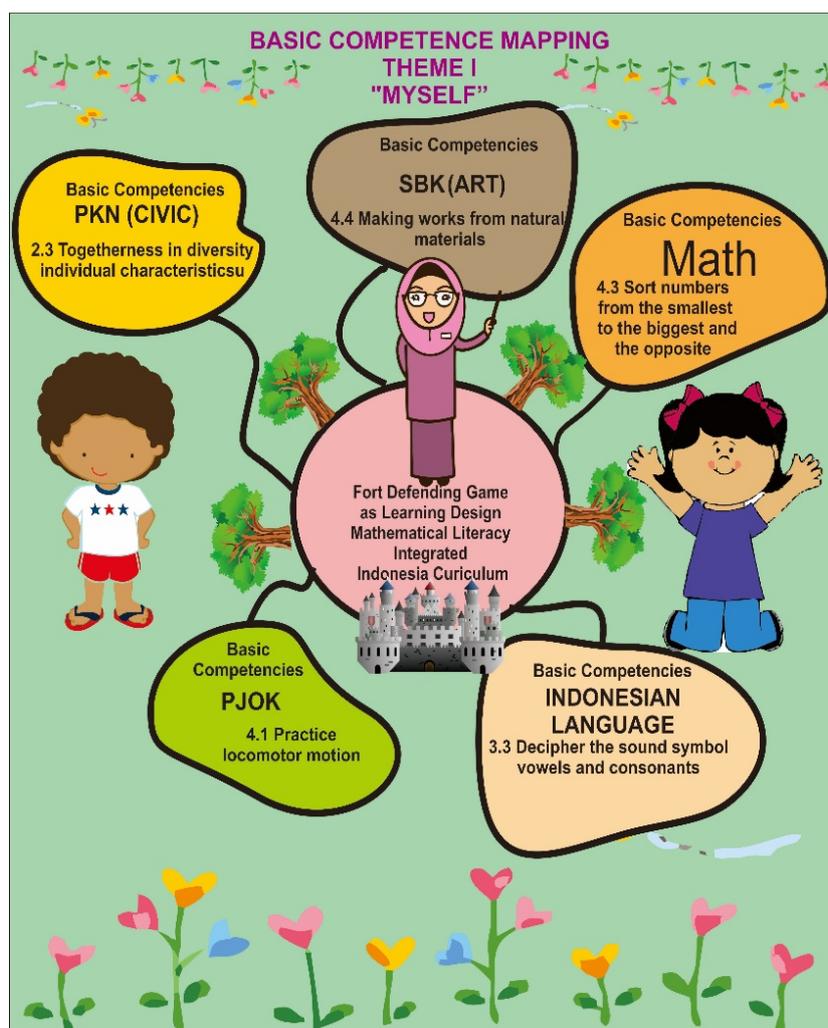


FIGURE 3. *Map of basic competence*

During the game, firstly in the basic competence of PKN (Civic), students in each group will be involved in cooperative communication, and its symbols living in diversity and in positive cooperation among them. This point is essential, according to the integrated curriculum focusing on character building through working in groups. Secondly, in the basic competence of math, students are expected to sort the numbers inside the jungle to rescue the King's daughter, and being stamped orderly in their group activity sheet.

Thirdly, in the basic competence of the Indonesian language, students in each group will cooperate to find vowel and consonant of a Jungle King's name. Fourthly, in PJOK (Sports) students will move from one location to another to seek the numbers, Jungle King's name, and his location. Finally, in the basic competence of SBK (Art and Culture), students will stick the image of Jungle King's with leaves they collect from the surrounding area. The whole achievements of each basic competence are packed in LKK (group activity sheet). Figure 4 and Figure 5 is the preview of the worksheet design:

GROUP WORK SHEET

Instructions:

1. Write the name of the group and your group members in the column provided above.
2. Work with your group to solve the problem with this LKK.
3. Paste the LKK with the number lines in your respective fortresses.
4. Below there are various kinds of integers (5, 15, 10, 14, 4, 6, 8, 9)
5. Look for the number in the box provided! The box that is getting right then the number is getting bigger. If the box is on the left, the number is smaller.
6. Each group is allowed to take one number in the box provided. After that, paste the numbers on the number lines on sheet 1. The time to take and stick is 15 seconds.
7. Repeat step number 6 with instructions given by the teacher.
8. After attaching, write the order of the numbers from the smallest to the biggest. Write in the box provided in sheet 1.
9. After finishing writing the sequence of numbers. Answer the questions listed on sheet 2.

FIGURE 4. Group activity sheet 1 part a

Sheet 1:

1. Sort from the biggest and the smallest

...
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2. Sort from the smallest and the biggest

FIGURE 5. Group activity sheet 1 part b

SHEET 2



1. What happend in the king fortress?
2. How your step to survive the princess ?
3. Who is the king forest?

FIGURE 6. Group activity sheet 2

Through the group activity sheet, the effort on integrating K-13 curriculum has resulted in a design of mathematical literacy by modifying traditional game 'Fort Defending'. Moreover, this is essential to focus on the constructivism and student-centered style.

GAME HINTS

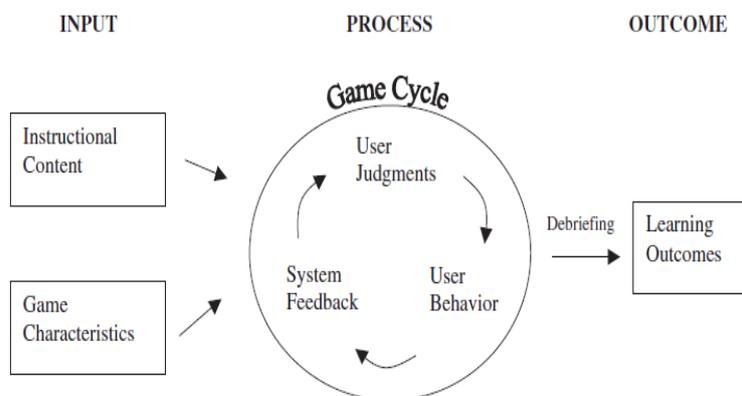


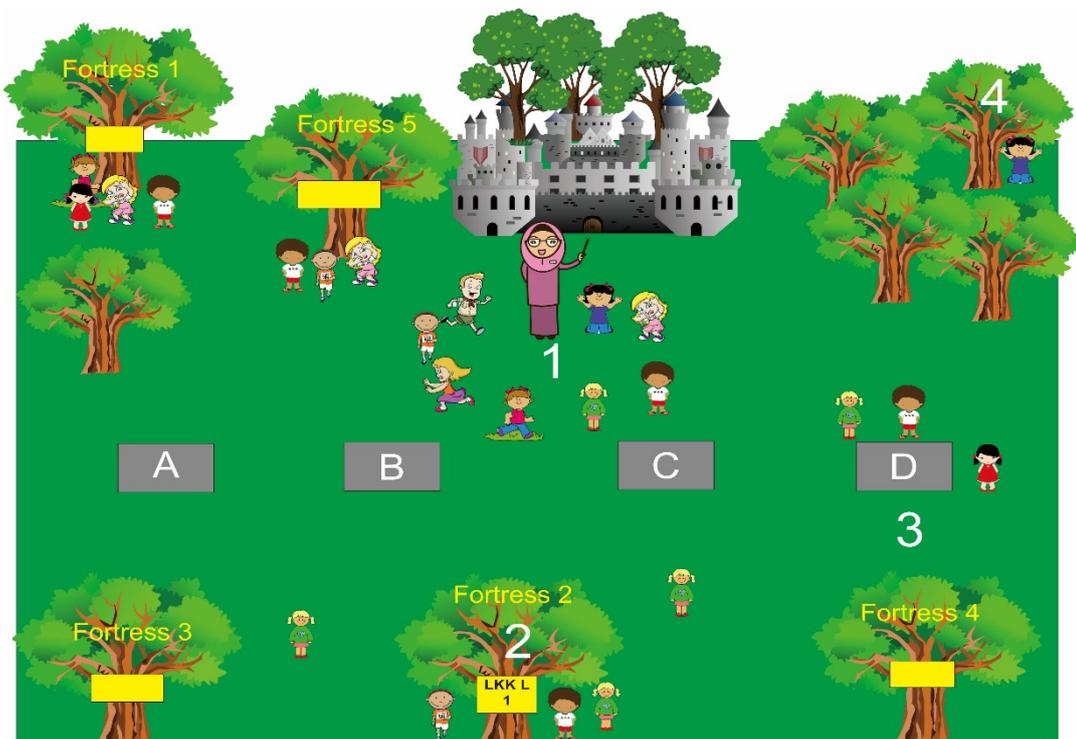
FIGURE 7. Game learning application

During the learning application, the game must contain instructional goals and the character of the game also demands a prolonging cycle and feedback. User's reactions can also indicate their excitement and persistence in finishing the task, so they can experience the valuable learning activity (Mulbar, 2017).

Mathematics literacy process is result integrated form curriculum that can make students to problem solving and make learning to be meaning (Garris & Driskell, 2002). The game is aimed to support the learning of mathematical literacy, integrated with the K-13 curriculum. The expected feedback in this game is the integrated learning experience of math, Indonesian language, PJOK (sport), SBK (art and culture) as well as PKN (civic) in one cycle activity.

After that, there are games in education can help students to increase their initiatives for learning(Qian, 2014). The game setting of 'Fort Defending' is in the open space and followed by five groups. Each member of the group must really aware of the role they are playing during the game (Walsh, 2018).

Each group contains three students and has a fort as headquarter of the group. The first group will be marked as 'Fort 1', the second 'Fort 2', the third 'Fort 3', the fourth 'Fort 4' and fifth 'Fort 5'. The design of open space as a playground is set as explained below:



Information:

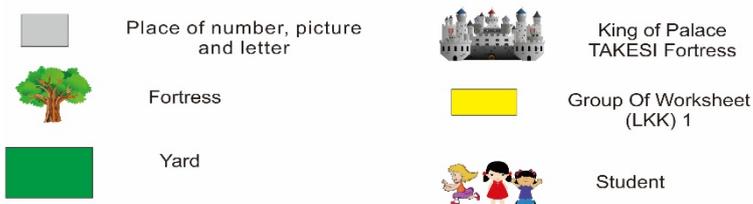


FIGURE 8. *Open space design for developmental 'fort defending' game*

According to the above figure, the game rules are explained in detail as follows:

Early Stage

- All groups gather in a field and listen to the problems that are explained by the teacher (Figure 1)
- Group leader receives Group Activity Sheet which contains questions and game hints.
- Each group back to their fortress.
- They put the Group Activity Sheet 3 in their fortress (Figure 2)
- They discuss to formulate the existed problem in their fortress, then try to find the solution in order to rescue the King's daughter.
- They do the task in Group Activity Sheet 3
- After that, they submit Sheet 3.

Main Stage

- Each group does the task in Sheet 1.
- They seek 8 numbers in ABCD box. The numbers are random and they have to pick 1 number within 15 seconds. Next, one from each group back to their fortress and put the picked number orderly from the lowest to highest one. (Figure 3)
- This main stage is repeated 8 times in line with the number of needs.
- After that, they have to solve the puzzle of the name Jungle's King, then look for the letters that will be arranged in one word for changing the name of Jungle's King in ABCD box randomly. Each group is allowed to take one letter in one box and put it in their own fortress. The time is 10 seconds to find each word of Jungle's King.
- The fourth step is repeated 4 times until they complete the word "SINGA".

- The teacher just gives 5 minutes for each group to decide which the vowels and consonants letters in that word.
- Later, they seek a figure of “SINGA” in ABCD box within 10 seconds, then put it in Sheet 3.
- Each group gathered leaves around them within 15 seconds.

The last step, they have to glue the figure of SINGA using leaves within 15 minutes. After finish, they go to the Raja Hutan’s cave to determine who has the right to save the King’s daughter first.

DISCUSSION and CONCLUSION

Based on the results of the research and various findings in this study, it can be concluded that the integration of mathematical literacy and game can be applied to the 2013 curriculum in Indonesia, especially in first-grade students of elementary school. The results of the study (Burke & Welsch, 2018; Leyva, 2018; Pensiero & Green, 2018) show that the integration of literacy and play in a curriculum can develop students' mathematical performance in terms of numeracy, writing ability and mathematics. The game also plays an important role in the development of the age of children to train their motor balance (Akbari et al., 2009), seen from the psychological perspective of the children's need to play. By playing, children will practice balance, both gross and fine motorize, controlling limbs, agility and eye and hand coordination. Learning that has elements of the game integrated into a curriculum as a design of mathematics literacy learning encourages the collaboration of students to discuss each other in learning mathematics (Altura & Curwood, 2015).

The results of this study affirm the research of (Akbari et al., 2009; YAVUZ et al., 2017) which show that to improve mathematics learning achievement, a real connection in learning involved in a real problem is needed. Fortress games integrated with the 2013 curriculum and mathematical literacy in this study support mathematics learning achievement because the implementation is based on the context of the problem in real conditions. Mathematical literacy is a form of problem-solving factors that can be implemented into daily problem solving that supports students' mathematics learning motivation so that mathematics does not seem scary (Arslan et al., 2014).

After finishing the whole study and investigation, the researcher concludes that the ‘Fort Defending’ game can be modified and integrated with the learning process of mathematical literacy in accordance with K-13. It is scientifically proven that the game deserves a celebration as an innovative learning design and can be used as a cognitive competition field. The presence of the game provides a possibility for students to examine their thinking process in solving a problem related to the mathematical literacy, by connecting between problem and solution (Lämsä et al., 2018). Thus, they are not only learning about math theory but also some other material through their active interaction, such as vowel and consonant utilization, making handicraft, exercising locomotors and nurturing the value of tolerance and life in diversity. The entire design in the prototyping stage has been validated, and hence considered as strongly valid. In this stage of development, the result shows that teacher and student consider it as highly practical. Finally, this modified fort defending game can be a new design in learning mathematical literacy.

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