Multiplication and division of integers through cultural approaches of playing *dakon*

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Abstract: Playing *dakon* has become a culture in Bengkulu. Since I was in kindergarten, *dakon* has been a fun game. It has the character of sharing fruit in each *dakon* convex (or hole). It becomes the starting-point of learning multiplication and division. The purpose of this study was to determine students' thought processes in understanding the principle of multiplication and the division of integers through the cultural approach to playing the *dakon*. To achieve the goal, achieved through qualitative-explorative research. The subjects of this study were elementary students in Bengkulu City who were selected based on assignments. It was selected from 30 students who were given assignments about multiplication and division of integers. Students are given instructions using worksheets. After students submit their assignments, they are analyzed to select 2 students who have the thought process in achieving the principle of division and multiplication appropriately. Subjects were interviewed in-depth by researchers. Data were analyzed based on the genetic decomposition of research subjects. The results of this study are Subject-1 can use the *dakon* to show the multiplicative properties of positive integers. He demonstrated that $4 \times 3$ by inserting it into four small *dakon* curves and three *dakon* seeds each. She concluded that multiplication is a repeated sum. Subject-2 uses the *dakon* to find the concept of dividing two positive integers. Subject-2 shows that $12 \div 4$ by taking *dakon* seeds from a large curvature containing twelve seeds. She concluded that the division is a repeat reduction. This research concludes that Subject-1 and Subject-2 can build an understanding of operations multiplication and division, including verbal communication, writing, and drawing based on real media from local culture, namely the *dakon* game.

1. Introduction

Numeracy is one of the competencies that elementary school students must possess [1,2]. Since elementary level 1, students have been introduced to counting. These competencies involve integer operations. That is part of arithmetic learning. Operations are mathematical objects other than facts, concepts, and principles. Students learn the operations of addition, then subtraction, multiplication, and then division [3]. These are all basic arithmetic operations. The operation is in the universe of talking of a set of real numbers [4,5].

Operations on real numbers are the rules for obtaining a single element from one or more real numbers [6]. Arithmetic operations are operations that involve the addition, subtraction, division, and multiplication of a set of real numbers [3]. The set of real numbers consists of a set of rational and irrational numbers. The set of rational numbers contains a set of integers and fractions. Integers contain
natural numbers, zero numbers, and negative integers. For each natural number n, then -n is a negative integer.

The process of connecting mathematics to real life is important. Students who are connected with real-life are generally about numbers, such as counting and shopping. This helps students see the relationship between real life and mathematics [7]. To assist students in mathematical thinking activities, contextual learning approaches are needed [8–10]. The teacher should choose a learning strategy that is suitable for the student's intellectual level [11–14]. Students do the math process easily. They can communicate [15], between ideas in the system thinking, and with peers [16,17]. The teacher assists with scaffolding techniques in the student's distressed zone [18]. This is useful to facilitate students' understanding of the relationships between different mathematical concepts, shown through connections in a set of mathematical problems [19]. There is an increase in students' mathematical processes and connections in the achievement of mathematical concepts and principles. Therefore, learning mathematics with a local cultural approach will make it easier for students to communicate verbally followed by written communication. The local cultural approach results in an increase in students' mathematical abilities, such as mathematical connections, problem-solving, critical thinking, creative thinking, understanding concepts, and other mathematical abilities [16,20–23]. Thus, we need to assist with students' mathematical thinking processes during learning.

The extra-mathematical connection approach can reduce the separation between mathematics and reality to give meaning to learning. That is to understand the world through a mathematical perspective and foster a symbiotic relationship between these two worlds [24]. Therefore, learning mathematics with a local cultural approach becomes important. That is often called the ethnomathematics approach [25]. The ethnomathematics approach to the mathematics curriculum can make school mathematics more relevant and meaningful for students. In this context, the application of the ethnomathematics perspective in the school mathematics curriculum helps develop students' intellectual, social, emotional, and political learning by using their unique cultural references to impart their knowledge, skills, and attitudes. Such a curriculum provides a way for students to maintain their identity while succeeding academically [26].

Mathematics teachers are challenged to deal with the cultural diversity of people that occurs in each classroom [27]. Ethnomathematics get an important role, in a meaningful mathematics curriculum. That is to explore various aspects of mathematical literacy. All of this should be implemented in learning mathematics in class. As such, we are interested in utilizing local culture in exploring students' cognitive processes to achieve the concepts of multiplication and division of positive integers.

2. Method
This study explores the way students learn multiplication and division of positive integers using the contextual media of dakons. Dakon is one of the children's games that has been entrenched in Indonesian society. That is expected to help students reach concepts in multiplication and division of two positive integers. To achieve these objectives, achieved through qualitative-explorative research. The subjects of this study were elementary school students in Bengkulu City who were selected based on assignments. It was chosen from 30 students who were given assignments about multiplication and division of integers. Students are given instructions using worksheets. After students submit their assignments, they are analyzed to select 2 students who have the thought process in achieving the principle of division and multiplication appropriately. The subjects are Rr and Hf. Subjects were interviewed in depth by the researchers. The interview was recorded with a video recorder. It is used to get complete and accurate data. The subject was asked to play the dakon together and witnessed by another friend. While playing the research team recorded and conducted in-depth interviews. Besides recording, we also make anecdotes to get additional data. Data were analyzed based on the genetic decomposition of research subjects. Genetic decomposition is a structured collection of mental and physical activities that construct certain categories and illustrate how mathematical concepts or principles are developed in individual minds [28].
3. Results and Discussion

Research involves the full potential of students, ranging from academic potential to play skills. This is a fun technique for students. Learn while playing. The game is very close to their culture. The ancestral culture of the nation that is often used by children to play and have fun is dakon. It is a "congklak" tool. Based on the Indonesian Encyclopedia [29], dakon is one type of game that can be played by boys and girls. Often adults also play it as a means of recreation. Dakon made of wood with a length of 50 cm, width 20 cm, and a thickness of 10 cm. The top of the wood is given a hole with 5 cm in diameter and 3 cm in it. The minimum number of dakon holes is 12. This game requires dakon seeds. Small sapodilla seeds or sapodilla manila are usually used for dakon seeds. Can also, small marbles. The number of players with at least 2 players. The number of dakon seeds is not determined, this is adjusted to the conditions and agreement of the players. Dakon can be seen in Figure 1.

Figure 1. Dakon (Congklak), Source: https://indonesia.go.id/ragam/seni/kebudayaan/serunya-bermain-congklak

Playing dakon is an educational game as local wisdom that can provide excitement for students. It is a game that can improve academic thought processes. This game builds student motivation. Figure 2 shows the happy feelings of girls in playing dakon. This can reduce students' anxiety about learning mathematics. Therefore, this study designed a dakon game to teach multiplication operations and the division of positive integers.

Figure 2. Playing Dakon, Source: http://pedomanbengkulu.com/wp-content/uploads/2016/01/congklak-dakon-1.jpg

Figure 2 also shows the comfort of children playing dakon. In playing the dakon, the research team asked them to empty 4 small holes and 1 large hole as dakon granaries. We will carry out the process of achieving the multiplication concept, which is 4x3. That is the dakon that can be seen in Figure 3.
Based on Figure 3, subjects were asked to play by inserting *dakon* seeds into each small hole as 3 seeds. Students are then asked to think critically about the incident. Then they (Rr and Hf) were interviewed by Q, with the following interview excerpt.

*Q:* What can you explain about the *dakon* and the *dakon* seeds?
*Rr:* We play with each other and we can arrange *dakon* seeds into small holes evenly ...
*Hf:* yes ... each hole is filled with 3 seeds and filled with 3 seeds there are four holes ...
*Q:* What do you think about this?
*Hf:* This means four holes contain 3 seeds ... That can be seen in Figure 4.

Figure 4 shows that students can try to achieve concepts through simple activities. That is done by filling four small holes with 3 seeds each. This is corresponding to the 4x3 multiplication. Pay attention to the sequel to our interview excerpt.

*Q:* What is your next explanation?
*Rr:* That sir ... means that there are 4 times out of the 3 *dakon* seeds in our game ...
*Q:* Ok ... fine ...
*Hf:* That ... also means that we can calculate ... the multiplication of 4 x 3 is the addition of four times the number 3 ... That can be chosen as in Figure 5.
Based on Figure 5 and the interview footage, it shows that students can make a property of multiplication of two positive integers. He stated that "the multiplication of 4 x 3 is the sum of four times the number 3". That means that $4 \times 3 = 3 + 3 + 3 + 3$. In another description that rectangular arrays can be used to model multiplication [30,31]. The representation of the multiplication model can be seen in Figure 6.

![Figure 6. 5x3 rectangular array [32]](image)

Next, consider our follow-up interview.

**Q**: Ok ... continue your explanation?

**Rr**: Because of that ... I was able to collect dakon seeds into the biggest hole ... 

**Hf**: ... ok ok ... let me count the seeds in the big hole ... One two Three, .... and finally twelve ... this means there are twelve seeds.

**Hf**: .. thus $4 \times 3 = 3 + 3 + 3 + 3 = 12$ ... yes this is multiplication is a repeated sum ... please look at Figure 7.

![Figure 7. Large hole dakon containing 12 seeds](image)

Based on interview excerpts and Figure 7, it means that students can reach concepts in multiplication operations of two integers. They are able to make the statement that $4 \times 3 = 3 + 3 + 3 + 3 = 12$. Students state that integer multiplication is a repeated sum. Thus, it can be concluded that through the play of the students' dakon can carry out the process of achieving concepts in the operation of positive integer multiplication that is multiplication is a repetitive sum. Students begin to think critically and rationally in a relaxed atmosphere of the play. That results in a good mathematical process. In line with this, there is an interaction between the development of fundamental arithmetic concepts and relational thinking. Students develop concepts related to arithmetic operations such as addend and sum; minuend, subtrahend and difference; multiplicator and product; and dividends, dividers, and profit-sharing [33].

Next, we explore the ability of students in the process of achieving concepts for the division of positive integers. Students are triggered by using the media for achieving the concept. They were asked to play dakon by using twelve dakon seeds as shown in Figure 8 for 12 divided by 4.
Starting from the *dakon* as in Figure 8, in the game two research subjects played the *dakon* based on twelve seeds in a big hole. They play to share it into small holes with each hole as much as four seeds. The following is our interview with the following research subjects.

**Q**: What is the explanation of the next game?
**Rr**: We distributed twelve seeds into the small hole of the *dakon* ...
**Hf**: ... yes ... this is the first time I am playing the sharing, see as in Figure 9.

Figure 9 and the interview excerpt indicate that students can begin the twelve division process with the first four seeds. In the big hole, there are still eight seeds. Next, we consider the following snippet.

**Q**: Ok ... ???
**Rr**: ... then it was my turn to distribute it to the end, ... apparently, three small holes were containing four seeds each, and a large empty hole ...
**Rr**: this means that $12-4-4-4 = 0$ ... this means that there are 3 holes filled with 4 seeds each ... this means that $12: 4 = 3$.
**Hf**: ... With this result, we declare that the division of positive integers is a repeat reduction ... consider Figure 10.
Based on Figure 10 and the interview excerpt, it was revealed that the 12: 4 division operation is 12 - 4 - 4 - 4 = 0. That means that 12: 4 = 3. The concept in the division operation is a repeat reduction. Other research results that students can use these concepts effectively. Students feel the same sign not only finding results but also as symbols used to build relationships between operations and expressions [33].

According to McLellan et al. [32] that mathematicians seldom use the symbol ÷ for the division. Instead, they use fractional notation. Writing a small portion is another way to write a division. So 12 ÷ 4 is equivalent to writing 12/4, where the numerator, 12, is a dividend and the denominator, 4, is the divisor.

In arithmetic operations, arithmetic priority rules that allow us to do calculations involving parentheses, strengths, +, -, ×, and ÷. Calculations that involve positive and negative numbers, and generate and use rules to add, subtract, multiply, and divide them [34]. In arithmetic learning, verbal information content, and the type of addition and subtraction operations affect student reasoning [35].

After students become fluent with the concepts of multiplication and division the symbolic notation, x for multiplication, and ÷ for division can be introduced. Initially, ideas will be explored through conversation, then written into words, followed by a combination of words and numbers, and finally using numbers and symbols. At each step, when the child is ready, the use of symbols can reflect the child's ability to deal with abstract concepts [32]. Thus, the process of achievement by students in multiplication and division operations can be done well by students. It is utilizing media that is close to their culture. They play dakon in a relaxed and highly motivating way to play while learning.

The results of this study indicate that Subject-1 subjects can use dakon to show the multiplicative nature of positive integers. He demonstrated the 4x3 by inserting it into four small dakon curves and three dakon seeds each. Next, he gathered all the dakon seeds into a large tub and he stated the number of twelve seeds. Subject-1 concludes that 4 x 3 = 3 + 3 + 3 + 3 = 12, and multiplication is an iterative number. Subject Subject-2 uses the dakon to find the concept of dividing two positive integers. Subject-2 shows that 12:4 by taking dakon seeds from a large curvature containing twelve seeds. He took four seeds and then placed them in a small basin, four more seeds, and placed it in a small basin as well, and so on until the seeds in the large basin were used up. Subject-2 states that there are three small tubs, each containing four seeds. He concluded that 12: 4 = 3, because 12 - 4 - 4 - 4 = 0, and division is a repeat reduction.

4. Conclusion
The need for learning with an ethnomathematics approach becomes very important to be applied in the abstraction process of mathematical concepts. Like dakon toys as one of the cultures that are close to students, it becomes a learning media for multiplication and division.
of positive integers. This study concludes that Subject-1 and Subject-2 can build an understanding of learning messages, including verbal communication, writing, and drawing based on real media from local culture, namely the dakon game. That is to produce the correct concept of multiplication operations as repetitive addition and division is an iterative subtraction.

5. References
[1] Van Luit J E H and Schopman E A M 2000 Improving early numeracy of young children with special educational needs Remedial Spec. Educ.
[2] Nguyen T, Watts T W, Duncan G J, Clements D H, Sarama J S, Wolfe C and Spitler M E 2016 Which preschool mathematics competencies are most predictive of fifth grade achievement? Early Child. Res. Q.
[3] Widodo S, Rahayu P, Adjie N, Widodo S A and Setiadi B R 2018 The development of arithmetic gamification using digital dice Int. J. Eng. Technol.
[4] Widada W 2007 Development of triad level theory of calculus for mathematics students J. Inspirasi 5 1–12
[5] Soedjadi 1993 Simplify Some Concept In Mathematics For School Mathematics And Its Impact (Surabaya: IKIP Surabaya)
[6] Widada W 2017 Beberapa Dekomposisi Genetik Siswa dalam Memahami Matematika J. Pendidik. Mat. Raflesia 1 44–54
[7] Baki A, Çatlioğlu H, Coştu S and Birgin O 2009 Conceptions of high school students about mathematical connections to the real-life Procedia - Soc. Behav. Sci. 1 1402–7
[8] Wawan, Ningsih E F, Widodo S A, Leonard, Sary R M and Retnowati E 2019 The Cognitive Load of Learners in the Learning Process of the Rotating Object Volume Journal of Physics: Conference Series
[9] Trisniawati, Titi Muanifah M, Rhoysida N, Adi Widodo S and Ardiyaningrum M 2019 Exploration towards attitude of students in elementary school teacher education in mathematics learning Journal of Physics: Conference Series
[10] Widodo S A, Darhim D and Ikhwandundit T 2018 Improving mathematical problem solving skills through visual media Journal of Physics: Conference Series vol 948
[11] Widada W, Herawaty D, Mundana P, Agustina, Putri F R and Anggoro A F D 2019 The REACT strategy and discovery learning to improve mathematical problem solving ability The REACT strategy and discovery learning to improve mathematical problem solving ability J. Phys. Conf. Ser. Pap. 1318 1–5
[12] Herawaty D, Sarwoedi S, Marinka D O, Febriani P and Wirne I N 2019 Improving student’s understanding of mathematics through ethnomathematics Improving student’s understanding of mathematics through ethnomathematics J. Phys. Conf. Ser. Pap. 1318 1–5
[13] Widodo S A, Istiqomah, Leonard, Nayazik A and Prahmana R C I 2019 Formal student thinking in mathematical problem-solving J. Phys. Conf. Ser. 1188 012087
[14] Kember D and Kwan K-P 2002 Lecturers’ Approaches to Teaching and their Relationship to Conceptions of Good Teaching Teacher Thinking, Beliefs and Knowledge in Higher Education
[15] Taylor J M and Rowe B J 2012 The “Mozart effect” and the mathematical connection J. Coll. Read. Learn. 42 51–66
[16] Widada W, Herawaty D, Nugroho K U Z and Anggoro A F D 2019 The ability to Understanding of the Concept of Derivative Functions for Inter-Level Students During Ethnomathematics Learning J. Phys. Conf. Ser. 1179 1–6
[17] Herawaty D, Gusri S A, Saputra R, Liana E and Aliza F 2019 The mathematics communication of students in learning based on ethnomathematics Rejang Lebong The mathematics communication of students in learning based on ethnomathematics Rejang Lebong J. Phys. Conf. Ser. Pap. 1318 1–8
[18] Ormond C 2016 Scaffolding the mathematical “connections”: A new approach to preparing teachers for the teaching of lower secondary algebra Aust. J. Teach. Educ. 41 122–64
[19] Lui M, Tissenbaum M and Slotta J D 2010 Helping students make mathematics connections: Collaborative visualizations in smart classrooms. Pap. Present. AERA Annu. Meet. 05/04/10, Denver, CO. 1–3
[20] Widada W, Agustina A, Serlis S, Dinata B M and Hasari S T 2019 The abstraction ability of students in understanding the concept of geometry The abstraction ability of students in understanding the concept of geometry J. Phys. Conf. Ser. 1318 1–7
[21] Nugroho K U Z, Widada W and Herawaty D 2019 The Ability To Solve Mathematical Problems Through Youtube Based Ethnomathematics Learning Int. J. Sci. Technol. Res. 8 1232–7
[22] Widada W, Nugroho K U Z, Sari W P and Pambudi G A 2019 The ability of mathematical representation through realistic mathematics learning based on ethnomathematics The ability of mathematical representation through realistic mathematics learning based on ethnomathematics J. Phys. Conf. Ser. 1318 1–8
[23] Widada W, Herawaty D, Rahman M H, Yustika D and Elsa P 2020 Overcoming the difficulty of understanding systems of linear equations through learning ethnomathematics IOP Conf. Ser. J. Phys. Conf. Ser. 1470 012074 doi10.1088/1742-6596/1470/1/012074 1470 1–14
[24] Quirós N S and De Gamboa G 2016 Extra-mathematical connections: Connecting mathematics and real world 1–23
[25] D’Ambrosio U 1989 Ethnomathematics, Link between Traditions and Modernity (ROTTERDAM: SENSE PUBLISHERS)
[26] Rosa M and Orey D C 2011 Ethnomathematics: the cultural aspects of mathematics Rev. Latinoam. Etnomatemática 4 32–54
[27] François K 2010 The Role of Ethnomathematics Within Mathematics Education Proc. Cerme 1517–26
[28] Widada W, Efendi S, Herawaty D and Nugroho K U Z 2020 The genetic decomposition of students about infinite series through the ethnomathematics of Bengkulu , Indonesia IOP Conf. Ser. J. Phys. Conf. Ser. 1470 012078 doi10.1088/1742-6596/1470/1/012078 1470 1–9
[29] Sadhily H 1999 Ensiklopedi Indonesia (Jakarta: Ichtiar Baru-Van Hoeve)
[30] Armstrong B E and Vacc N N 1995 Teaching Patterns, Relationships, and Multiplication as Worthwhile Mathematics Tasks Teach. Child. Math.
[31] Shanty N O and Wijaya S 2012 Rectangular array model supporting students’ spatial structuring in learning multiplication J. Math. Educ.
[32] McLellan J A, Dewey J, McLellan J A and Dewey J 2011 Multiplication and division. Psychol. number its Appl. to methods Teach. Arith. 207–26
[33] Kızıltoprak A and Köse N Y 2017 Relational thinking: The bridge between arithmetic and algebra Int. Electron. J. Elem. Educ. 10 131–45
[34] Anonymous 2009 Rules of arithmetic Order A J. Theory Ordered Sets Its Appl. 1–9
[35] Moutsios-rentzos A and Stamatis P J 2015 Non-verbal communication in thinking about arithmetic problems Quad. di Ric. Didatt. 23 23–36