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The Effectiveness of Race Track Games on Counting Ability and Child Learning Motivation

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***Abstract*—Fun arithmetic learning can be done with program-fun game, exciting learning atmosphere and motivating children to learn. This study aims to determine the effectiveness of the game track race on the ability to count and motivation to learn children. The type of research used is quantitative method with experimental type by using game of race track. Based on the results of data analysis, it is found that there is a significant influence on the ability to calculate and motivate children's learning. Thus, it is concluded that by using the game the race track is very effective against the ability to count children.**

Keywords—games, race track, counting, motivation of learning.

I. INTRODUCTION

Kindergarten educators can emphasize that mathematical activities need to be embedded in everyday situations [1]. Mathematics is a subject that requires conceptual, procedural, and declarative knowledge [2]. Conceptual knowledge involves understanding of relationships and correlations among numbers. On the other hand, procedural knowledge is based on the ability to follow the process steps to find the final product. Finally, declarative knowledge is the ability to solve mathematical problems accurately and automatically [3]. The development of mathematical competence on a regular basis begins long before children go to school. Along with language acquisition, children recognize number words and are enabled to count step by step. At the end of kindergarten and before attending formal school, they can already use numbers and numbers to solve the first-count problem [4]. The concept of quantification, calculation, and symbolic representation is an important component of the amount of mind that develops during preschool and kindergarten and can be targeted in game-based curricula [5].

Children initially develop an understanding of numbers and quantities separately. A growing understanding of the relationship between numbers and quantities is considered an important step in the development of mathematical competence [6]. According to the Krajewski model, children gain this profound understanding through three levels of development. Level 1 consists of basic numerical competencies, such as obtaining number words, word order numbers, and numbers without semantic meaning. In addition, children can see differences in numbers and sizes but at this level are considered isolated from numbers. Level 2, which is divided into two sublevels (2a and 2b), is marked by the acquisition of basic comprehension. An understanding of the relationship between numbers and numbers is obtained in about 3 years. First, children develop a vague representation of number words that have quantitative meanings, which is indicated by the fact that they connect several number words with one and the same quantity expression (level 2a). For example, children at this level connect both words number one and three with little quantity expressions, while they connect the words numbers eight and twenty with many quantity expressions [4]. Furthermore, the children realize that the number words represent the exact quantity and that the order of the word numbers represents the exact ascending number (level 2b). Now the children understand that the sum of three words is related to the exact quantity of the three elements or objects, while the number of four words is correlated with exactly four elements or objects. In addition to the exact quantity representation, children at level 2 become aware of the relationship between quantities. Thus, children are able to ignore the spatial level between objects when comparing two rows that contain the same number of objects but differ in their spatial levels. At the age of about 6 years, children reach level 3, which is marked by the acquisition of a deepened understanding of the number. At this level, they realize that the relationship between quantities can be accurately explained by numbers. Only now children are able to express the difference between quantity, as well as between sums, with numbers [7], [8], [4].

The competence of children's mathematics differs greatly in kindergarten due to differences in the learning environment [9]. To improve opportunities for all children, kindergartens need to nurture mathematics deliberately and meet their diverse educational needs [10]. In this regard, the German and Swiss educational research groups implemented several conventional games and developed themselves in kindergartens to support the acquisition of mathematical competence in children aged 4-6 years [6]. It should be acknowledged that role play, or pretend play, takes a lot of time for children to set the playing frame, to engage with the game and develop it [11]. As for board and card games, several studies found them to be effective in the acquisition of mathematical competence [12], [13], [14], [15].

The rest of this paper is organized as follow: Section II describes the literature review. Section III describes the material and proposed methodology. Section IV presents the obtained results and following by discussion. Finally, Section V concludes this work.

II. LITERATURE REVIEW

Empirical investigations of these measurements show that a play-based approach supports the acquisition of mathematical competence in terms of the underlying development model [12] and results in improved learning

comparable to standard training programs [16]. A game must appear convincing and real, with play can motivate children's learning, because play is a child's world. There are three social motivations governing player engagement with games: representational motivation (to engage with location, character and narration); ludic motivation (to engage with rule-based challenges); and communal motivation (to engage with other players as an intrinsic part of the game, or as part of the culture around the game) [17]. A play based approach is more effective than training. Overall higher learning outcomes for playing with card and board games rather than training [18]. Thus learning through games can develop mathematical competence proven effective. However, in this research will modify the game of counting in the form of 3 dimensions that have the length, width and height as the playground trajectory.

The most important component of understanding is quantitative knowledge and quantity [19]. Instructions include student time and opportunity to manipulate quantity, create mental images of quantity, and manage quantities using mathematical symbols [20]. When teachers encourage the opportunity to use two-dimensional and three-dimensional objects to discuss and build real-world patterns, students can do mathematize and make connections between mathematical languages, symbols, numbers, and shapes [20]. Mathematical images, or visual models, support mathematical learning and form effective action plans to support Mathematics learning in meeting the objectives of the Early Childhood mathematics process, these goals include: representing, solving problems, reasoning, connecting, and communicating. These objectives are expanded to eight standards in the Core State General Standard, which are known to provide a summary of effective mathematical teaching / learning in action [20], [21]. Based on the theory, games that have 2 or 3 dimensions can help children in the learning process, especially mathematics, because children see concrete objects in real.

The game of the race track is a mathematical game of displacement and counting. The game aims to train moving from one room to the next by using a counter, training the counting and practicing the summing skills [22]. The game of the race track is expected to improve the numerical knowledge of children. This is because the linear arrangement of numbers on the track board corresponds to the desired mental representation of the linear numerical quantities. Several studies may show that children aged 4 to 5 years who play a linear board game show a greater increase in mathematical competence than children in the comparison group [14], [23], [24]. Because of this, it can be assumed that well-structured and mental material and actual activity with such material can lead to effective learning. In this connection, [25] developed a cognitive alignment framework approach.

Several empirical studies have shown that boards are effective in improving children's numeracy development [26]. Numeric plays not only immerse children in numerical environments but also give them multimodal cues (e.g., visual-spatial, kinaesthetic, temporal, and verbal-auditory) to understand the meaning of numbers and numerical relationships [14]. For example, in a linear number board game, the greater the number denoted, the farther the distance from the start, and the more separate steps and the longer time it takes to move the token there [6]. Laski and Siegler 2014 designed the linear number board game Race to Space to improve the skills of counting 6-year-olds and numerical depictions. The Race to Space game moves from left to right in every row. The arrangement of these numbers visualizes the basic structure 10 of the number system [25].

Laski and Siegler [27] can show that American children who take part in four sessions and play Race to Space according to the count-on rules show a greater increase in mathematical competence than children who play by count-of-1 rules. Thus, the second type of simple educational game has proven to be effective in fostering mathematical competence in children. However, this approach lacks the explicit theoretical background of the development of mathematical competence established in the Krajewski, *et al.* development model of the standard training program Mengen, Zahlen, Zahlen (MZZ; quantity, calculation, number) [27]. This program consists of 24 half-hour sessions and can be delivered in group settings by a kindergarten teacher within a period of 10 weeks Following three levels of the development model, the exercises provided train the mathematical competences outlined systematically with game material and demonstrative.6 Therefore, this study aims to determine the effectivity game of the race track based on evaluation of linear board game from previous research which involves several modifications according to the approach of cognitive alignment framework.

III. MATERIAL & METHODOLOGY

Based on the problems studied, this research type is quantitative method with experimental type. This is a kindergarten in Solok district, West Sumatera Indonesia, with a total of 15 children per class. The sampling technique conducted in the research is cluster sampling techniques (area), which is the technique used to determine the sample when the object to be studied or data source is very wide.

The research instrument used in this research is the test. The test is said to be valid if the test can measure what it wants to measure. This instrument uses a format checklist for its assessment. With the criteria of assessment that is Growing Very Good is given a score of 4 (BSB), Growing As Hope be given a score of 3 (BSH), Start Developed given score 2 (MB), Not Developed given score 1 (BB). The test that researchers use in the form of tests of action. Action tests are tests that demand answers from learners in the form of behaviors, actions or deeds. "So children do according to the command or question given

Validity is a measuring tool that measures objects that should be measured by certain criteria. One technique used to determine the validity of a test is the correlation of product moment with rough numbers or formulas. Test reliability is a measure of the accuracy of a test when it is tied to the same object. To determine the reliability of the test used alpha formula. The data analysis technique used in this study is to compare the difference of two average values, so that it is done by t test (t-test). But before that, first test the normality and homogeneity test.

To analyze the difference, normality test is required. "Normality test is used to determine whether the data to be processed comes from normal distributed data. Normality test

is done before processing the data with correlation technique product moment, regression, *t*-test, and Anova and so on. The technique that is often used for data normality test is test Lilliefors". Before the data is processed, in order to know a normal distributed data or not then tested Lilliefors first. One technique often used to test the homogeneity of population variance is to use the test Bartlett.

If it is known that a data is normally distributed and is homogeneous, then data analysis is done according to the analysis technique that has been done. That is by looking for comparison by using *t*-test. Test the data that has been obtained with the formula t-test.

Based on the above concept, the group that will be made in this research is group B1 and B2. Where group B1 is used as experiment class and B2 group become control class with consideration of number of children of both same group that is each of 15, same child age, same child ability level, same learning facility, recommendation from principal of kindergarten.

IV. Results and Discussion

This section presents the results obtained and following by discussion.

A. Result

Based on the results of research in kindergarten that is the ability of counting children in the experimental class by using the game of race track and control class by using the snake ladder game, the result is that the ability of counting children in the experimental class (group B1) is higher than at the control class (group B2) with the average value in the experimental class is 86 and in the control class the average score is 66.

From the description above, it is very clear that the use of the game of the race track is effective against the ability to count children. This can be seen from the acquisition of numeracy ability of children of experimental class there is greater influence than control class that use game of snake ladder.

B. Statement of Results

Table I. Summary of Results Counting Capabilities Children in the Classroom Experiment and Class Control

Variable	Study Method	
	Experiment	Control
N	15	15
Highest Value	95	75
Lowest Value	75	60
Total value of	1 290	990
Average	86	66
SD	6.63	5.22
SD2	44	27.3

Based on the Table I above, the experimental class with the number of children 15 received the highest score of 95 and the lowest score of 75. From the value of this experimental class children obtained the total value of 1290, with an average value of 86, the standard deviation 6, 63 and the value of the variance is 44.

While the control class with the number of children 15 people obtained the highest score of 75 and the lowest score 60. From the value of this control class obtained the total number of 990, with an average value of 66, standard deviation of 5.22 and the value of variance 27.3 (attachment 26). Based on the description in Table I, it can be seen that the results of the development of children's creativity in the experimental class is higher than the control class. For more details can be seen in Figure 1following:

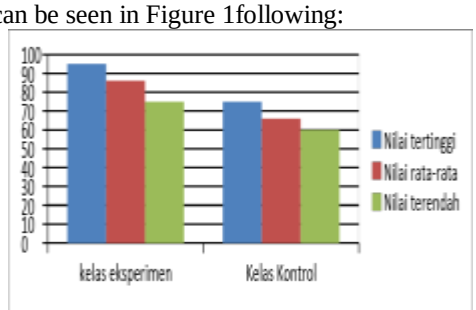

Fig 1. Data Comparison of Results Post-Test Ability of Counting Children in Experiment Class and Control Class

C. Discussion

To draw conclusions from the results of the study, hypothesis testing using t test. Before conducting t test, normality test and homogeneity test on the result of the research are done.

Based on the result of the children's research that is the numeracy ability of the children in the experimental class and control class, it is found that the ability of counting children in the experimental class (group B1) is higher than the control class (group B2).

The results of the experimental class normality test showed *L*-calculated obtained is 0.1422 and control class obtained *L*-count of 0.1996. Meanwhile, the price of *L* with *N* = 15 with the level of α= 0.05 (5%) is 0.220Thus, the *L*-count for the two classes is less than the *L*-table. So the child data comes from the Normally distributed population. This is explained in [28]: The normality test is used to determine whether the data to be processed comes from normal distributed data. Normality test done before processing the data with product moment correlation technique, regression, t-test, and Anova and so on. A commonly used technique for data normality testing is the Lilliefors test. If F (Zi) - S (Zi) is smaller than the table, the data is normally distributed.

For homogeneity test, from the data of the two classes obtained χ^2 calculated a number of 2.546 and for Chi squares (2-1) then obtained χ^2 table of 3,841for significant level α 0,05 (5%). Based on these results can be seen that χ^2 count < χ^2 table (2.546 <3.841). So it can be concluded that the child data comes from the homogeneous group at a real level of 0.05. In accordance with the opinion of Hidayat, *et al.* in [28] : If the calculation results from xx2 counts smaller than xx2 tables means that the data comes from a homogeneous group.

In the hypothesis test, obtained t a number of 8.833 and for *t*-table for α significance level of 0.05 (5%) with *df* of 38 is 2.048.By comparing *t*- count and *t*-table , it can be seen that *t*-

count >*t*-table i.e. 8.833> 2.048. Then it can be said Ha can be accepted and H_0 rejected which means there is influence in the use of the game trajectory of the counting ability of children in kindergarten Annisa in Solok, West Sumatera Indonesia. So it can be concluded that there is a significant difference between the results of numeracy ability of the experimental class and control class.

Based on the results, that the ability to count children obtained the average number of experimental group is 86 the average number of control groups is 66. Based on the results of data analysis has been done that *t*-count of 8.833 compared with α 0.05 (*t*-table = 2.048) for degrees of freedom *dk* (*N*1-1) + (*N*2-1) = 28. Thus *t*-count > *t*-table i.e. 8.833> 2.048 can be said that hypothesis Ha can be accepted or H_0 rejected. Thus, it can be concluded that there is a significant difference between the counting of children in the experimental group using a race track game with a control group that uses a snake ladder game. In the game of the race track, counting learning is more emphasized to counting through to know the symbol of numbers, counting or calling the sequence of numbers, as well as to count or recognize the concept of numbers and count the number.

The game of the race track is a 3-dimensional game that can be used as a learning medium for children of the age with their advantages that is close to the child's environment, giving face-to-face possibilities and observing student responses, having variations of interesting and non-boring presentation techniques, has a variety of colors and symbols that make students more interested and can be used repeatedly.

In this game, the child is educated to better observe the numbers, counting the number of objects present in the picture in the game of the race track. Children are also trained to be more independent, brave, and able to finish the game up to the finish line. This is in line with what was expressed game of the race track is a mathematical game about the transfer and counting. The game aims to train moving from one room to the next by using a counter, training the counting and practicing the summing skills. Race track games can be a tool or game that children can learn to count while playing. Children will not feel burdened to learn counting because the game is structured in accordance with the child's character and close to the child's environment that is using game transfer tools such as cars with a variety of colors. Thus the game of the racetrack can be seen to affect the ability to count children.

Learning by using the game of this racetrack, the teacher serves as a facilitator, who is tasked with providing direction and examples to the child. The liveliness of the children in playing drawings and counting the objects that have been provided is more emphasized in this lesson. With this learning, the cognitive abilities of children can be developed especially the ability to count children.

V. CONCLUSION

Based on the results of the analysis of research data that has been stated above, it will be presented some conclusions and suggestions on the results of research. The results of research conducted in Annisa Kindergarten in Solok result of the ability of counting experimental class children (B1) who use the game trajectory of higher races compared with children in control class (B2) who used the landing snake game, ie (86) experimental class and (66) control class. So it can be concluded that the game trajectory of the race effective against the ability to count children.

It is expected that teachers at Annisa Kindergarten in Solok will be able to apply the game of the race track in the next learning. For Head of Annisa Kindergarten in Solok is expected to provide more motivation to support learning in school to develop various aspects of child development, especially the ability of children. For the next researcher so that the results of this study can be a source of literature for other researchers to develop a long research.

REFERENCES

[1] Engel, M., A. Claessens, T. Watts, and G. Farkas., "Mathematics Content Coverage and Student Learning in Kindergarten." *Educational Researcher* 45 (5), 293-300 (2016).

[2] Miller, SP, "*Validated practices for teaching students with diverse needs and abilities (2nd ed.),*" Upper Saddle River, NJ: Pearson (2009).

[3] Gibbs, USA, Hinton, VM, & Flores, MM (2018). A case study using CRA to practice applying skip counting to multiplication. *Preventing School Failure: Alternative Education for Children and Youth*, *62*(1), 49-57.

[4] Schneider, W., K € uspert, P., & Krajewski, K. (2013). Die Entwicklung mathematischer Kompetenzen [Development of mathematical competencies]. Paderborn: Ferdinand Sch € oningh.

[5] Moomaw, S. (2015). Assessing the difficulty level of math board games for young children. *Journal of Research in Childhood Education*, *29*(4), 492-509.

[6] Skillen, J., Berner, VD, & Seitz-Stein, K. (2018). The rule counts! Acquisition of mathematical competencies with a number board game. *The Journal of Educational Research*, *111*(5), 554-563.

[7] Krajewski, K., Nieding, G., & Schneider, W. (2008). Kurz- und langfristige Effekte mathematischer Fr uhf € orderung im Kindergarten durch dasProgramm "Mengen, zâ ahlen, Zahlen" [Short-term and long-term effects of early mathematics education in preschool]. *Zeitschrift f € ur Entwicklungspsychologie und P € adagogische Psychologie*, 40 (3), 135-146.

[8] Krajewski, K. (2013). Mathematische kompetenzen, entwicklungsmodell [Mathematical competencies, development model]. In MA Wirtz (Ed.), Dorsch - Lexikon der Psychologie [Dorsch - psychological dictionary] (16th ed., P 998). Bern: Verlag Hans Huber.

[9] Sonnenschein, S., and C. Galindo. 2015. "Race / Ethnicity and Early Mathematics Skills: Relations between Home, Classroom, and Mathematics Achievement." *Journal of Educational Research* 108 (4): 261-277.

[10] Gasteiger, H., A. Obersteiner, and K. Reiss. 2015. "*Formal and Informal Learning Environments: Using Games to Support Early Numeracy*." In Describing and Studying Domain-Specific Serious Games, edited by J. Torbeyns, E. Lehtinen, and J. Elen, 231-250. Cham: Springer.

[11] Bergen, D. 2015. "Psychological Approaches to the Study of Play." *American Journal of Play* 7 (2): 51-69.

[12] Jörns, C., K. Schuchardt, D. Grube, and C. Mähler. 2014. "Spielorientierte Förderung numerischer Kompetenzen im Vorschulalter und deren Eignung zur Prävention von Rechenschwierigkeiten." Empirische Sonderpädagogik 2014 (3): 243-259.

[13] Kamii, C., and Y. Kato. 2005. "Fostering the Development of Logico-Mathematical Thinking in a Card Game at Ages 5-6." *Early Education and Development* 16 (3): 367-384.

[14] Ramani, GB, and RS Siegler. 2008. "Promoting Broad and Stable Improvements in Low-Income Children's Numerical Knowledge through Playing Number Board Games." *Child Development* 79 (2): 375-394.

[15] Schuler, S. 2013. Mathematische Bildung im Kindergarten in formal offenen Situationen - eine Untersuchung am Beispiel von Spielen zum Erwerb des Zahlbegriffs. Münster: Waxmann.

[16] Hauser, B., Vogt, F., Stebler, R., & Rechsteiner, K. (2014). F € orderung fr € uher mathematischer Kompetenzen. Spielintergriert oder trainingsbasiert [Promoting early mathematical competence playfully or trainingbased]. *Freuhe Bildung*, 3 (3), 139-145.

[17] Burn, A. & Carr, D, "Signs from a Strange Planet: roleplay and social performance in *Anarchy Online*," in *Conference Proceedings, COSIGN 2003, 3rd conference on Computational Semiotics for Games and New Media*, University of Teesside, 14-21 (2003).

[18] Vogt, F., Hauser, B., Stebler, R., Rechsteiner, K., & Urech, C. (2018). Learning through play-pedagogy and learning outcomes in early childhood mathematics. *European Early Childhood Education Research Journal*, 1-15.

[19] Kroesbergen, E., van't Noordende, J., & Kolkman, M. (2014). Training working memory in kindergarten children: Effects on working memory and early numeracy. Child Neuropsychology: A *Journal on Normal and Abnormal Development in Childhood and Adolescence*, 20 (1), 23-37.

[20] Fuson, K., Clements, D., & Sarama, J. (2015). Making early math education work for all children. *Phi Delta Kappan*, 97 (3), 63-68.

[21] Cross, CT, Woods, TA, & Schweingruber, H. (2009). *Mathematics learning in early childhood: Paths toward excellence and equity*. Committee on Early Childhood Mathematics. Center for Education, Division of Behavioral and Social Sciences and Education.

[22] Connolly, Catherine. 2004. *30 Mathematics Game for Kindergarten up to Grade 2 SD*. Bandung: PT Intan Sejati.

[23] Siegler, RS, & Ramani, GB (2009). Playing linear number board gamesbut not circular ones-improves low-income preschoolers' numerical understanding. *Journal of Educational Psychology*, 101 (3), 545-560.

[24] Whyte, JC, & Bull, R. (2008). Number games, magnitude representation, and basic number skills in preschoolers. *Developmental Psychology*, 44, 588-596.

[25] Laski, E., & Siegler, RS (2014). Learning from number board Games: You learn what you encode. *Developmental Psychology*, 50 (3), 853-864.

[26] Cheung, S. K., & McBride, C. (2017). Effectiveness of parent–child number board game playing in promoting Chinese kindergarteners' numeracy skills and mathematics interest. *Early Education and Development*, *28*(5), 572-589.

[27] Krajewski, K., Nieding, G., & Schneider, W. (2007). Mengen, z € ahlen, Zahlen: *Die Welt der Mathematik verstehen* (MZZ) [Quantities, counting, numbers: Discovering the world of mathematics]. Berlin: Cornelsen.

[28] Hidayat, M. F., Syafril, S., & Lindarto, D. (2015). Elevated uric acid level decreases glycated hemoglobin in type 2 diabetes mellitus. *Universa Medicina*, *33*(3), 199-204.