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Increasing the Learning Result of Early Mathematics Odd and Even Numbers through Montessori "Cards and Counters" Activity: A Quasi-experimental Study

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Abstract

Purpose – This study aims to obtain information about the effect of using the Montessori cards and counters' mathematics activity on learning the result of odd and even numbers of 1 to 10 to the kindergarten students at the age of 4 to 5 years.
Design/methods/approach – Quantitative research with a quasi-experimental model of non-equivalent control group design was carried out by applying conventional methods (lectures and giving questions by worksheets) to the control group and applying the Montessori learning model through the use of Cards and Counters apparatus in the experimental group with 30 samples of students, divided into two classes (control class and experiment class) at Kalyca Azzahra School, West Java, Indonesia.
Findings – The result showed that students who used the Montessori Mathematics cards and counters achieved higher mathematics odd and even numbers are learning results than those who were not taught with the Montessori approach.
Research implications/limitations – This research design used pre-test and post-test. Thus, the treatment results can be more accurate because they can be compared before and after treatment.
Practical implications – The use of the Montessori apparatus becomes necessary in introducing early mathematics to children and attracting children's attention to learn and facilitate teachers in teaching mathematics. Displaying the concrete objects as a medium will help teachers in teaching early mathematics to children. The cards and counters allow children to verify their understanding of the concept by matching the qualitative, concrete, quantitative, or abstract before slowly removing the concrete altogether.
Originality/value – This research contributes to understanding learning strategies used in Early Mathematics, Odd and Even Numbers. The Montessori apparatus becomes more natural to understand it by the child's cognitive development effortlessly.

Keywords Early mathematics, Montessori, Cards and counters, Learning result

Paper type Research paper

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1. Introduction

All children have access to mathematics before they attend school. The kinds of provided experience may not be regarded as mathematical by people in general. While all adults can identify cooking and meeting a train on time as involving mathematics, in other everyday experiences, mathematics is sometimes not so obvious (Zuilkowski et al., 2020). Teachers need to store examples for young learners' mathematical experiences (Flevares & Schiff, 2013). They can be used to reassure parents who feel under-confident about helping the young learners in the family, and they can also be used to illustrate what we mean by mathematics when we talk to parents. Some examples of the 'mathematical' events that may regularly have been part of children's lives before they came to school include: sorting the groceries, matching the socks, arranging food on plates, or laying the table. Kindergarten educators may emphasize that mathematical activities must be embedded in everyday situations (Anders et al., 2012; Bin Sami Khan & Salman, 2020; Dahiya, 2014). Evidence shows, however, that learning mathematics is vital for children's early years and later success in mathematics and better overall academic outcomes in such areas as literacy, science, and technology (Cross et al., 2009; Duncan et al., 2007; Papadakis et al., 2016; Piasta et al., 2014). One of the central planks of our educational thinking is that equal learning opportunities should be offered to all children (Suningsih, 2020).

Piaget's work, including his idea of 'stages' in development, has had a powerful impact on mathematics education. It suggests that children think differently from adults and that their thinking passes through five main stages, which are equated to the following chronological age bands: sensory-motor period (birth to 2 years), pre-operational thought (2-4 years), intuitive thought (4-7 years), concrete operations (8-11 years), and formal operations (11–14 years). The suggestion is that the infant teacher is concerned with pre-operational thought and intuitive thought (Clemson & Clemson, 2002; Montague-Smith et al., 2018). Math skills taught in early childhood education are designed to provide the children's foundation to succeed in elementary school and beyond (Cerezci, 2019; Lamrani et al., 2018; Pelkowski et al., 2019). Educators should focus lessons in early childhood around the essential skills that build up to advanced mathematics in high school and college (Hardy & Hemmeter, 2018; Reimer, 2020; Schillinger, 2020; Whyte et al., 2018). National Research Council explains that early childhood teachers are often uncomfortable teaching mathematics (Cross et al., 2009). Educators might be worried that mathematics is 'not fun' (Lee & Ginsburg, 2009; Moyer, 2001). Many teachers avoid teaching mathematics and express negative feelings (Benz, 2012; Ernest, 2018; Gresham, 2018). These are possibly shaped by their own, often negative, school experiences (Anders & Rossbach, 2015). Mathematics at school is boring. All we ever do is "sheets." If teachers and children feel this way, that mathematics is boring, limited, and about sums, and that is all, it is not a wonder that they begin to see mathematics as something not very pleasant or meaningful. Ausubel suggests that there are three factors involved in being motivated to undertake a task in mathematics. These are interesting in the task, the effect the task has on our image of ourselves, and whether the task accords us links with other people (Ausubel, 1968). In addition, Bruner defines three modes of thinking, enactive, iconic, and symbolic (Bruner, 1966).

Enactive means learning through action, whereas iconic representation depends upon images to detect patterns or pathways (Clemson & Clemson, 2002). Symbolic representation means using symbols through which hypotheses can be explored and manipulated (Ingold, 1994). These modes have clear connections with Piaget's stages of development, although Bruner's modes are not so clearly age-related – we make use of all of them to a greater or lesser degree in response to new learning, but there is the suggestion that young children incline towards the Enactive mode (Clemson & Clemson, 2002). In Mathematics, teachers use this idea by letting children count on their fingers, laying out all the objects to count them, putting a hat on each of three teddies before attempting to say how many hats the teddies wear, and so on. The Enactive mode is likely the pre-eminent model for young children (Horowitz, 1972). Thus, teachers must arrange practical learning situations for young children and make them active.

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Meanwhile, children's 'picture Math' recording may be seen as fitting the iconic mode. An iconic representation is used when a child is presented with a picture of three butterflies and asked to draw a flower for each. It is the case that there is now a widespread appreciation of the value of iconic representation in mathematics schemes, and these are nowadays characterized by excellent illustrations and strong images, including, sometimes, the use of cartoon characters to support the mathematical storyline. Symbolic representation includes letters, numerals, and signs like '=' or '+' in mathematics. Whatever the symbol, it is capable of theoretical and abstract manipulation. It is the case that expectations and pressures on teachers lead them to move to symbolic representation in Mathematics as rapidly as possible (Wong & Dillon, 2019). However, given how Bruner suggests how we all learn, it is likely that a rapid move to written symbolism is likely to be counter-productive for most children. It is not to say that children should not use symbols, for they will already, on entering school, be using symbolism when they speak. We need to allow children to use all modes of representation, depending on which they find appropriate.

Based on this problem, children must be assisted with various fun ways, and appropriate methods and strategies to easily understand mathematics lessons and feel comfortable learning mathematics (Surya & Syahputra, 2017). Early childhood mathematics concepts begin with matching, classifying, or placing objects according to specific shapes or categories, comparisons, and equations (Hassan et al., 2018). Kindergarten children at the age of 4 to 6 years are in the pre-operational stage in cognitive development, and they are generally introduced to the following mathematics: number, conservation, seriation, classification, distance, time and speed, pattern, measurement (Piaget & Inhelder, 2010). Meanwhile, mathematics concepts for children at the age of 3 to 6 years are as follows: the concept of numbers, the concept of pattern, the concept of relationship, The concept of measurement, the concepts of data collection, organization, and display (Lestari & Yudhanegara, 2016). Three-to-four-year-old children need guidance to notice quantitative relationships in daily life and to begin representing 'information about pattern, shapes, space and number' (McCray & Chen, 2012). Innovative approaches to early mathematics should be developmentally adequate, effective, and compatible with kindergarten pedagogy (Bertolino & Filippa, 2021; Macià-Gual & Domingo-Peñafiel, 2021; Vogt et al., 2018). In Montessori, before beginning mathematics work, the children must do two things, explore and accept the notion of idealized things with isolated qualities, and gain practice in the requisite intellectual skills (Courtier et al., 2021; Denervaud et al., 2019; Pironi & Gallerani, 2021; Ponticorvo et al., 2020; Rosati, 2021). Montessori mathematics model of cards and counters is one of the best learning approaches to teaching odd and even numbers from 1 to 10 for early childhood.

2. Methods

This research is quasi-experimental and carried out at Kalyca Azzahra School Depok, West Java. The research population is about 30 students at Kindergarten level A aged 4 – 5 years on the subject of Mathematics. This study used two classes, the control group, and the experimental group. The determination of this group is done using a lottery witnessed by the partner teacher, in this case, the class teacher. The sampling technique used in this study is a non-probability sampling design with a convenience sampling type. It was done due to administrative limitations to select the participants randomly. Fifteen students are in the experiment class (Sunflower Class) and 15 in the control class (Jasmine Class). The first group is the experimental group and uses the Montessori mathematics media cards and counter, and the second group is the control group, which does not use the Montessori mathematics media. The study is explained as follows: first, Preliminary stage, activities carried out in this stage include preparations in connection with conducting research: 1) Conduct observations or preliminary studies to see firsthand how students learn, 2) Provide lesson plans that use the Montessori mathematics of cards and counters, 3) Compile material that will be given to students, 4) Determine the experimental class and the control class. Second, Implementation phase, the implementation phase carried out by the teacher: 1) The teacher conducts class preparation, 2) The teacher records the presence of students, 3) The teacher repeats the previous learning material and relates it to the learning material to be taught, 4) The teacher explains the lesson using the cards and counters in teaching odd and even

numbers 1 to 10 in the experimental class, 5) The teacher evaluates student learning outcomes about the ability to know the add and even numbers 1 to 10 from the experimental class and the control class. The next stage is preparing the research report.

In this study, the independent variable is the Montessori mathematics media of cards and counters, causing the emergence or change in the ability of children to order odd and even numbers from 1 to 10. The dependent variable is the ability to order the odd and even numbers distributed by the Montessori mathematics learning media of cards and counters.

The material of the card and counter consists of 10 number cards, 1 to 10, and 55 round red counters. The critical aim of using this apparatus is to reinforce the sequence of one to ten and give another perceptual experience of quantity as a collection of separate objects and introduce the concept of odd and even numbers. The Presentation of Montessori mathematics of cards and counters are as follows: 1) teacher invites children to the shelf and names the exercise "This is cards and counters," then carry them onto the floor mat; 2) teacher lays out the numbers at random on the mat; 3) Counting, one, two, …, and start to place the numbers named in a row from left to right along the far edge of the mat, with a few inches between them. The teacher then puts the correct counters under the numbers. The teacher proceeds in this manner until ten and demonstrates how to place the counters; 4) When the presentation is completed, children can be asked if they can notice any difference in these patterns; 5) Teacher starts to introduce the names 'odd numbers' and 'even numbers' by using a pencil and places it in the middle of the counter, "one" does not have a partner we call "odd numbers" and "two" has a partner we call "even numbers"; 6) When all cards have been introduced, the teacher asks children to show which numbers are odd numbers and/or even numbers.

Figure 1. Odd and Even Numbers

The research design of this study is pre-test (before being given treatment) and post-test (after being given treatment). Thus, the treatment results can be more accurate because they can compare the conditions before and after treatment.

3. Result

The research started with a pre-test in both groups, which was carried out on Saturday, December 21, 2019, considering that the action would be carried out in the second semester of the academic year, which would take place in January 2020. The experimental and control group students worked on the pre-test questions, which amounted to 5 items in 35 minutes according to the length of learning for 1 lesson. The teacher gave directions to students about the steps for working on the questions before students answered the questions. Students were also allowed to ask the

teacher if there were questions that the students did not understand. The teacher who accompanied the students while working on the pre-test, treatment, and post-test questions was the same. The activity of learning in the experimental group used the Montessori Cards and Counters media. The implementation of learning for three meetings was the primary material of knowing numbers 1 to 10, 1 to 10, and even and odd numbers. A partner teacher carried out learning. It was carried out in 3 stages, introduction, core activities, and closing. The closing activity contained affirmation, reflection, and follow-up on students. The students in the control group received the opposite treatment. They did not use Montessori Cards and Counters apparatus and continued to use the conventional systems as before, such as lectures by the class teacher and giving a task through worksheets.

The following is the description of the data distribution. The researcher wanted to show the differences in the experimental and control groups' data for each indicator. The results of the data distribution can be seen from the following tables. From table 1, it is known that the results of counting and ordering even and odd numbers 1 to 10 by children in the experimental class obtained an overall value of 250 with the lowest value 12 and the highest value of 20. Then, there were an average of 16.80 and a variant value of 5,314 with standard deviations of 2,305. Children in the experimental class are categorized as influencing the Montessori Mathematics learning model of cards and counters on the ability to count and order even and odd numbers 1 to 10 in the expected development stage.

Table 1. Pre-Test Result of the ability to count and order of odd and even numbers in the Control Class and Experiment Class

		Experiment Class	**Control Class**
N	Valid	15	15
	Missing	0	0
Total		**135**	**145**
Mean		9.29	9.67
Std. Error of Mean		.475	.410
Median		10.00	10.00
Mode		10	10
Std. of Deviation		1.829	1.589
Variance		2.981	2.524
Skew ness		-250	-.352
Std. The error of skewness		.58	.580
Kurtosis		-823	-622
Std. Error of Kurtosis		1.121	1.121
Range		6	5
Minimum		5	7
Maximum		11	12
Percentiles	25	8.00	8.00
	50	10.00	10.00
	75	11.00	11.00

Table 2. Post - Test Result of Experiment Class

N	Valid	15
	Missing	0
Amount		250

Mean	16.80
Std. Error of Mean	.595
Median	17.00
Mode	15
Std. Deviation	2305
Variance	5.314
Range	8
Minimum	12
Maximum	20

Table 3. Frequency Distribution of The Ability to count and order of odd and even numbers in the Experiment Class (Post Test)

Interval	Frequency	Percent	Valid Percent	Frequency Cumulative	Cumulative Percent
12 - 13	1	6.7%	6.7	1	6.7%
14 - 15	4	33,3%	33.3	5	40%
16 - 17	2	13,1%	13.1	7	53,1%
18 - 19	4	33,1%	33.1	13	86.5%
20 - 21	3	13.3%	13.3	15	100%
Total	15	100%	100	15	100%

Table 3 shows that from the frequency distribution table data above, one student received the lowest score with a percentage of 6.7%, and two students with the highest score and a percentage of 33.31%.

Table 4. Post-Test Result of Control Class

N	Valid	15
	Missing	0
	Amount	250
Mean		11.67
The error of Mean Standard		.485
Median		12.00
Mode		10
Deviation Standard		1.875
Variance		3.521
Range		6
Minimum		9
Maximum		15
Sum		173

From Table 4, the results of counting and sorting even and odd numbers 1 to 10 for children in the control class obtained an overall value of 173 with the lowest value of 9 and the highest value of 15. Then, overall have an average value of 11.67 with a standard deviation of 1.875. The results of children in the control class are categorized as beginning to develop.

From the frequency distribution in Table 5, 8 students received the lowest score with 47.7% and the highest score of 1 person with 6.7%.

Table 5. Frequency Distribution of the ability to count and order of odd and even numbers in the Control Class (Post Test)

Interval	Frequency	Percent	Valid Percent	Frequency Cumulative	Cumulative Percent
9 - 10	8	47.7%	47.7%	7	47.7%
11 - 12	5	40%	40 %	13	86.7%
13 - 14	1	6.7%	6.7%	14	93.31%
15 - 16	1	6.7%	6.7%	15	100 %
Total	15	100%	100	15	100%

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After the data met the requirements for normality and homogeneity, hypothesis testing was performed using t-test statistics of data obtained through initial observation and final observation from experimental and control classes. A summary of the t-test results is shown in table 6.

Table 6. T-test Result

Data	Number of Children	t_{count}	t_{table}	Conclusion
The ability to count and order odd and even numbers	15	18,34	2,047	Significant Influence

4. Discussion

This study aims to determine the influence of the Montessori approach through Cards and Counters media on Kindergarten A student's learning result in early Mathematics even and odd numbers 1 to 10. This study was carried out for the cognitive development of Kindergarten A students through mathematics lessons. Quantitative research with a quasi-experimental model of non-equivalent control group design was carried out by applying conventional methods (Lectures and giving questions by worksheets) to the control group and applying the Montessori learning model through the use of Cards and Counters apparatus in the experimental group. This study also shows that the Montessori Cards and Counters approach Influences the early mathematics learning outcomes of even and odd numbers 1 to 10 in Kindergarten A students. Researchers conducted an analysis of the initial ability difference test in the control group and the experimental group. The analysis shows that the control group and the experimental group have the same initial ability. This step ensures that the initial abilities of the two groups are the same even though the sampling technique is not done randomly. The following analysis is to test the significance of the treatment effect. This test aims to determine the influence of the Montessori Cards and Counters approach on the early mathematics learning outcomes of even and odd numbers 1 to 10 in Kindergarten A students. The results of the analysis show that the Montessori Cards and Counters approach influences the results of students' learning outcomes.

This study also showed that Montessori learning media becomes necessary to introduce early mathematics to children and attract children's attention to learn and facilitate teachers in teaching mathematics. Displaying the concrete objects as a medium will help teachers in teaching early mathematics to children. One learning media that can introduce numbers, especially even and odd numbers from 1 to 10, is Montessori mathematics "cards and counters." The cards and counters allow children the opportunity to verify their understanding of the concept, by matching the qualitative concept, or the concrete, with the quantitative concept, or the abstract, before slowly removing the concrete all together (Darnis, 2018). The media also concretely teaches a child what number is odd and even, a concept that can otherwise seem very abstract. Learning media manifests the various components in the student environment that can stimulate students to learn (Indriana, 2011). Learning media is a tool that can help the process of teaching and learning and clarify the meaning of the message conveyed to achieve learning goals better (Kustandi et al., 2013). Based on the opinions above, it can be concluded that the learning media are all tools or objects in the form of whatever is used by the teacher in teaching and learning activities with the intention on convey learning information between the teacher and students so that the learning process interactions can take place effectively and efficiently. The Montessori Mathematics activities are organized into the following five groups (Piaget & Inhelder, 2010): Group 1 is an introduction to numbers, and the apparatus are number rods, sandpaper numbers, number tablets, spindle box, cards and counters, memory play; Group 2 is an introduction to the decimal system, and the apparatus is bead materials, number cards, the function of the decimal system, formation of complex numbers, unlimited bead material (addition, subtraction, multiplication, and division), stamps (addition, subtraction, multiplication, and division) and dots; Group 3 is an introduction to tens, teens, and counting; Group 4 is Arithmetic tables, and the apparatus are addition snake game, stripboard and chart, subtraction snake game, stripboard and chart, multiplication tables, multiplication bead boards, and chart, units division board and charts; and Group 5 is an abstraction, and the apparatus are short bead frame, hierarchies, long bead

frame, simple division. The Montessori mathematics cards and counters are in group one, introducing quantity units and illustrating several counting exercises.

The cards and counters learning media in Montessori mathematics bring the abstract to the concrete, allowing a child to feel the units as they count (Adeniyi & Kuku, 2018; Aljabreen, 2020; Kayılı, 2016; Phillips-Silver & Daza, 2018). This material consists of 10 number cards, 1 to 10, and 55 round red counters (Montessori & George, 1964). Each counter is approximately the size of a nickel. This work is typically organized on a floor mat. The aims of this material are (1) to arrange the numerals in their correct order while putting the proper quantity with each other; (2) To give another perceptual experience of quantity as a collection of separate objects; and (3) A minor purpose is to arrange the counters to give a visual impression of odd and even quantities and later to teach the terms "odd" and "even."

5. Conclusion

The result implication of this study is that the use of Montessori mathematics of cards and counters has a positive and significant influence on the ability to count and order the odd and even numbers 1 to 10 of children at Kalyca Azzahra School at the level of Kindergarten A. It can be seen from the results of hypothesis testing obtained $t_{count} > t_{table}$, i.e., 18.34 > 2.0047. The use of Montessori mathematics cards and counters learning media becomes exciting and relevant to the needs of the children. Children readily accept the stimulus given by the teacher, which will affect the ability to count and order the odd and even numbers 1 to 10. The Montessori cards and counters apparatus allow children to verify their understanding of the concept, by matching the qualitative concept, or the concrete, with the quantitative concept, or the abstract, before slowly removing the concrete altogether.

Declarations

Author contribution statement

Syefriani Darnis conceived the presented idea. Jaime Dodd developed the theory of the Montessori approach in early childhood education. All authors discussed the results and contributed to the final manuscript.

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Data availability statement

The datasets generated during and/or analyzed during the current study are available from the corresponding author on reasonable request.

Declaration of interests statement

The authors declare that they have no known competing financial interests or personal relationships that could have influenced the work reported in this paper.

Additional information

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