Enhancing Early Childhood Computational Thinking Through Level 2 Animal Puzzle Play Activities in 5-6 Year-Old

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ABSTRACT

Computational thinking is inseparable from daily life, including in early childhood. According to Mufidah (2018) [1], computational thinking is a way of formulating problems by dividing them into smaller parts so that they can be easily managed and organized. Seymor Papert (1980) outlined 4 stages of computational thinking: decomposition, pattern recognition, abstraction, and algorithms. Research on computational thinking in early childhood is still rare, but early childhood educators can train it in the classroom.

This type of research is Classroom Action Research (CAR). This aims to determine the improvement of problem-solving abilities through computational thinking through playing level 2 animal puzzle games. The action research was conducted in the second semester of the academic year 2023-2024, comprising 2 cycles at Aulady Islamic Kindergarten BSD, South Tangerang. This action research model utilizes The Kemmis and McTaggart. The researcher involved 11students from Class B Apel (8 girls, 3 boys) as subjects. This study utilized observation sheets. Data collection tools included observation guidelines and documentation. The data obtained from observations and data reflection were analyzed using percentage formulas.

The results of the study indicate that children's computational thinking abilities through playing level 2 animal puzzles significantly improved. In detail,the following points were observed: 1) improvement in children's ability (decomposition) to identify and break down problems increased significantly and
2) improvement in children's ability to recognize patterns increased based on the research findings.

Keywords: early childhood Education, computational thinking, puzzle, early years, classroom action research

1. Introduction

With the rapid advancement of technology and information in today's world, computational thinking skills can now be taught not only in higher education but also to young children. Teachers can stimulate computational thinking starting from early childhood. Teaching computational thinking to young children can be done through activities that teach them to solve everyday problems, such as recognizing patterns and sequencing issues to support computational thinking [2]. Papert, who first introduced computational thinking, defined it as procedural thinking and programming [3].

Table 1: Comparison of Computational Thinking Definitions

Contrasting Definitions of Computational Thinking

Definition	Source
The mental process for abstraction of problems and the creation of automatable solutions.	Yadav et al. (2014)
Computational thinking is the process of recognising aspects of computation in the world that surrounds us, and applying tools and techniques from Computer Science to understand and reason about both natural and artificial systems and processes.	Furber (2012)
Computational thinking is the thought processes used to formulate a problem and express its solution or solutions in terms a computer can apply effectively	Wing (2014)

The process of training computational thinking in early childhood can be more specific, such as: assembling puzzles, sequencing number patterns, sorting shapes, finding differences and similarities in a picture, and circling the word that matches the picture [4]. Furthermore, Wing [5] defines computational thinking as one of the most important problem-solving skills that everyone can learn, not just computer scientists. There is much research on the benefits of puzzle-based learning. Puzzles help children develop problem-solving skills and independent learning. According to Badger et al. (2012), children engaged in puzzle activities take personal responsibility, adopt new and creative approaches, make choices, develop modeling skills, build perseverance, practice case recognition, and reduce problem situations to exercises. Additionally, in assembling puzzles, students use

and apply various strategies that cross different disciplines in an entertaining and engaging way [6].

The four stages of computational thinking are: Decomposition is the process of breaking down a large, complex problem into smaller, more manageable sub-problems. In this study, children practice by assembling 8-10 piece puzzles, organizing puzzles from simple to complex shapes, and completing the entire puzzle. By sorting puzzle pieces from simple to complex and organizing them according to shape/pattern similarities, students can identify and effectively focus on assembling the puzzle, which is part of the pattern recognition stage. Abstracting a problem means that at this stage, children can focus when assembling the puzzle and are not distracted by other children's conversations while doing so, thereby providing useful solutions. Creating an algorithm requires children to collaborate in groups when assembling puzzles and to do so step-by-step and effectively. With an algorithm, children learn and understand how to solve a problem clearly and rationally.

Computational thinking is not solely about digitalization; rather, it is more accurately the skill of solving problems in everyday life. The International Society for Technology in Education (ISTE) defines it as “a problem-solving methodology that can be automated and transferred and applied across various subjects” [7].

Some may wonder how algorithms can be taught to young children in school. However, rest assured that every step taken by these children is highly suitable for active learning and thinking in Class B. When they play, children use creative ideas to explore and are not afraid to take risks. We can even turn these children into inventors and problem solvers within the school learning environment.

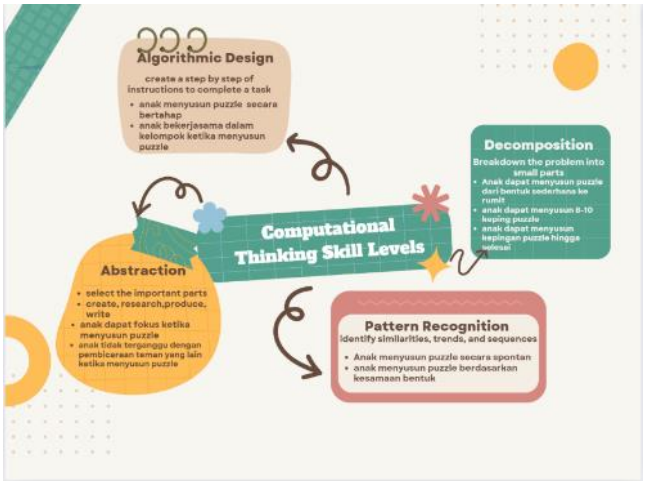
Based on observations on April 29, 2024, during the even semester of the 2023/2024 academic year at Aulady Islamic Kindergarten BSD, involving 11 children in Class B, the findings were as follows: a) some children still struggled with assembling simple puzzles, indicated by the fact that several children required more assistance from the teacher to guide them in assembling puzzle pieces; b) some children were unable to assemble puzzles with up to 10 pieces; c) some children could not follow the rules according to the teacher/researcher's

instructions in assembling puzzles; d) some children could not focus and were easily distracted when assembling their puzzles, resulting in incomplete tasks; e) the teacher used the lecture method with a limited number of puzzle pieces, only 1. Solutions include making learning activities more engaging and allowing children to participate actively in the learning process, especially in mathematics activities and playing with puzzles.

The researcher's goal is to enhance children's computational thinking in problem-solving and enable them to assemble puzzles based on shape similarities. Based on the above problem, the researcher is interested in studying how to improve children's computational thinking in problem-solving and their ability to assemble puzzles according to shape similarities through level 2 animal puzzle games. The researcher conducted a classroom action research with the title "Enhancing Computational Thinking in Early Childhood (Ages 5-6) Through Level 2 Animal Puzzle Games."

2. Framework

Figure 1. Basic strategies for computational thinking (McNicholl, 2018: p.37).



In this classroom action research, the researcher used the above framework in observations conducted on the students with the following stages and indicators:

1. Decomposition, where the child can assemble 8-10 piece puzzles, can arrange puzzles from simple to complex forms, and can complete the puzzles.
2. Pattern recognition, where the child can spontaneously arrange puzzles and can assemble puzzles based on shape similarities.
3. Abstraction, where the child can focus while assembling puzzles and is not

distracted by conversations with other children while working on the puzzle.

4. In the algorithm design stage, the child can collaborate in a group when assembling puzzles (during group puzzle activities) and can arrange puzzles step by step.

3. Method

This research was conducted using Classroom Action Research. Donald Schön (1983) defines Classroom Action Research as systematic but not overly formal research conducted by practitioners to inform their actions [8]. Classroom Action Research is a method to find out what works best in your own classroom so you can improve student learning. We know a lot about good teaching in general (e.g., McKeachie, 1999; Chickering and Gamson, 1987; Weimer, 1996) [9]. Stephen Kemmis and Robin McTaggart, now joined by Rhonda Nixon, describe Action Research Planner as a detailed guide for developing and conducting critical participatory action research projects [10]. In this Classroom Action Research, the observed action is improving Computational Thinking in Early Childhood Children Aged 5-6 Years Through Level 2 Animal Puzzle Activities at Aulady Islamic Kindergarten BSD, in the 2023-2024 Academic Year, involving 11 children (8 female students, 3 male students). The data collection techniques used in this Classroom Action Research are observation and documentation.

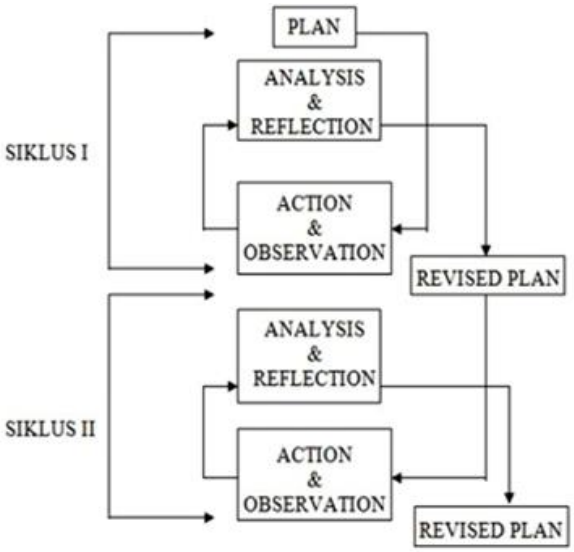


Figure 2. CAR Model Kemmis & Mc Taggart

The data analysis techniques used in this classroom action research employ two approaches: qualitative and quantitative. The qualitative approach is used to analyze the learning process carried out by teachers and students. The analyzed learning process utilizes tools or observation sheets as follows:

Table 2 Observation Form

Child's Name : .....
Time : .....
Date of Observation : .....
Observer : .....

No	Indicators	Assessment Criteria				Teacher/Observer Comments
		4 BSB	3 BSH	2 MB	1 BB	
	Decomposition					
1	Children can assemble a puzzle with up to 8 pieces.					
2	Children can assemble a puzzle with more than 10 pieces.					
3	Children can assemble a puzzle from simple to complex shapes.					
4	Children can complete the entire puzzle.					
	Pattern Recognition					
5	Children assemble the puzzle spontaneously.					

No	Indicators	Assessment Criteria				Teacher/Observer Comments
		4 BSB	3 BSH	2 MB	1 BB	
	Decomposition					
6	Children assemble the puzzle according to shape similarities.					

South Tangerang, …….2024

Note:

BB = Not Yet Developed

MB = Beginning to Develop

BSH = Developing as Expected

BMB = Developing Very Well

Observer

In this case, the data analysis technique conducted by the author through the Classroom Action Research method at Aulady Islamic Kindergarten BSD, the author analyzed the performance of children by observing the components and aspects observed in carrying out level 2 animal puzzle activities. In the first cycle within the specified time through the Weekly Learning Implementation Plan and Daily Learning Implementation Plan.

The author analyzed using a performance assessment instrument consisting of 4 grades:

1. Number (1) / BB (Not Yet Developed), meaning the child still needs guidance or teacher assistance in assembling puzzle pieces up to 5 pieces and cannot be left alone to complete the activity.
2. Number (2) / MB (Beginning to Develop), meaning the child is starting to be independent in assembling 5-10 pieces of puzzle, with minimal teacher assistance.
3. Number (3) / BSH (Developing As Expected), meaning the child is independent in assembling puzzle pieces, starting from easy to difficult, without teacher assistance.

4. Number (4) / BSB (Developing Very Well), meaning the child is independent without teacher assistance in assembling puzzle pieces to completion, and can assemble and complete the puzzle according to the indicators.

Meanwhile, in the quantitative approach, it is used to analyze the learning outcomes evaluated by the teacher. Learning outcomes are calculated using the following formula:

a. Percentage assessment of learning completeness of each child

$$\textbf{Percentage} = \frac{F}{N} \textbf{ x 100\%}$$

F = Frequency of children completing learning

N = number of children

4. Result

Data analysis in the research on improving computational thinking in terms of problem-solving and pattern recognition in early childhood children aged 5-6 years during level 2 animal puzzle activities at Aulady Islamic Kindergarten BSD, can be seen from the recapitulation of data on the improvement of children's computational thinking starting from the initial or pre-cycle data, cycle 1, and cycle 2.

Table 3 Recapitulation of Pre-cycle, Cycle 1, and Cycle 2 Percentages

Indicators	Pre-cycle				Cycle 1				Cycle 2			
	BB	MB	BSH	BSB	BB	MB	BSH	BSB	BB	MB	BSH	BSB
Decomposition		55%	45%			45%	52%	3%		3%	30%	67%
Pattern Recognition		55%	45%			36%	61%	3%		3%	36%	61%

Note:

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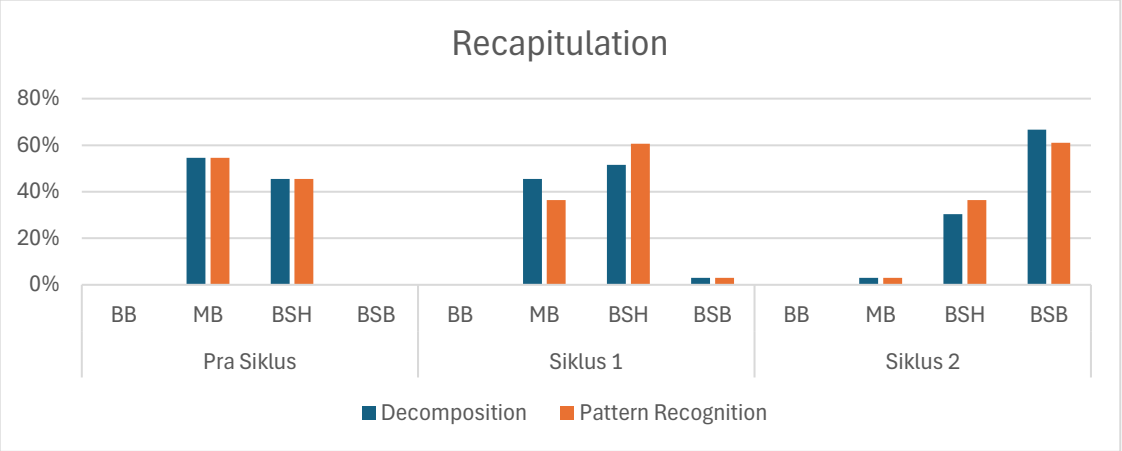
Figure 2 Recapitulation of Pre-cycle, Cycle 1, and Cycle 2.



Based on the comparison in the figures and tables above, it can be concluded that there has been an improvement in children's computational thinking at Auldy Islamic Kindergarten during the research intervention in the pre-cycle, cycle 1, and cycle 2. In the pre-cycle, the improvement in computational thinking was still relatively low, classified as Beginning to Develop (MB) based on the assessment criteria. After implementing the intervention in cycle 1, children's computational thinking began to improve, progressing from Beginning to Develop (MB) towards Developing as Expected (BSH), but the percentage had not yet reached the standard. Therefore, the researcher continued the intervention to cycle 2, where very satisfactory results were obtained. In cycle 2, children's computational thinking abilities improved, reaching the criteria of Developing as Expected (BSH) to Very Good Development (BSB).

5. Conclusion

The results of the classroom action research show an improvement in children's computational thinking abilities with each action. This can be seen from the pre-cycle results, where children's computational thinking abilities in decomposition and pattern recognition stages generally fell into the categories of Beginning to Develop (BD) at 55% and Developing as Expected (DE) at 45%. No children had reached the category of Very Good Development (VGD) yet. However, after learning through playing Level 2 animal puzzle games, children experienced an improvement in their computational thinking abilities. In cycle 1, children's computational thinking abilities were in the Developing as Expected category at 52% and 61%. And in cycle 2, children's

computational thinking abilities were in the Very Good Development (VGD) category at 67% and 61%. Based on the results of the classroom action research through playing Level 2 Animal Puzzle activities, it can be concluded that children's computational thinking abilities in Class B at Aulady Islamic Kindergarten BSD have improved.

REFERENCES

Badger, M., Sangwin, C, J., Ventura-Medina, E., Thomas, C, R.: 2012, A Guide To Puzzle-Based Learning In Stem Subjects, University of Birmingham.

Chickering, A.W. and Gamson, Z.F. (1987). "Seven principles for good practice in undergraduate education." AAHE Bulletin, 39 (7), 3-7.

Children's knowledge construction of computational thinking in a play-based classroom https://www.tandfonline.com/doi/full/10.1080/03004430.2023.2299405

Computational Thinking and repetition patterns in early childhood education: Longitudinal analysis of representation and justification

Computational thinking in early childhood education: Reviewing the literature and redeveloping the three-dimensional framework https://www.sciencedirect.com/science/article/abs/pii/S1747938X23000131

Computational thinking: early childhood teachers' and prospective teachers' preconceptions and self-efficacy https://www.ncbi.nlm.nih.gov/pmc/articles/PMC9118824/

Enhancing computational thinking in early childhood education through ScratchJr integration https://www.cell.com/heliyon/fulltext/S2405-8440(24)06513-7

Furber S (2012) Shut down or restart? The way forward for computing in UK schools. Technical report, The Royal Society, London.

https://link.springer.com/article/10.1007/s10639-023-12051-6

https://ojs.pnb.ac.id/index.php/matrix/article/view/743/614 CAR Model Kemmis & Mc Taggart

https://teachinglondoncomputing.org/puzzles/ PUZZLES, COMPUTER SCIENCE AND COMPUTATIONAL THINKING

https://www.naeyc.org/resources/pubs/tyc/spring2022/computational-thinking

https://www.sciencedirect.com/science/article/abs/pii/S1747938X23000131

Computational thinking in early childhood education: Reviewing the literature and redeveloping the three-dimensional framework

Kemmis, S., McTaggart, R., & Nixon, R. (2014). The action research planner: Doing critical participatory action research.

McKeachie, W.J. (1999). Teaching tips: Strategies, research and theory for college and university teachers. Boston: Houghton Mifflin.

Mufidah, I. (2018). Menyelesaikan Bebras Task Ditinjau dari Kecerdasan Logis Matematis Siswa. November.

Papert, S. A. (2020). Mindstorms: Children, computers, and powerful ideas. Basic books.

Schön, D. (1983). The Reflective practioner, Basic Books.

Weimer, M. (1996). Improving your classroom teaching. Newbury Park, CA: Sage

Wing, J. (2014). Computational thinking benefits society. 40th Anniversary Blog of Social Issues in Computing, 2014.

Wing, J. M. (2006). Computational thinking. Communications of the ACM, 49(3), 33-35.

Yadav, A., Mayfield, C., Zhou, N., Hambrusch, S., & Korb, J. T. (2014). Computational thinking in elementary and secondary teacher education. ACM Transactions on Computing Education (TOCE), 14(1), 5.