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Puzzle-based learning media design for early childhood spice introduction to support cultural education

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ABSTRACT

This study aims to design a puzzle-based educational toy for introducing Indonesian spices to early childhood learners as an effort to support cultural education and preserve local knowledge. The study was conducted at Cihaurgeulis Early Childhood Education Center, Bandung, involving children aged 4–6 years and four teachers. A Qualitative and Development Research (Q&D) approach was employed using observations, interviews, thematic analysis, and the ADDIE instructional design model up to the development stage. The analysis revealed that children showed strong interest in puzzle-based learning activities, yet their knowledge of Indonesian spices was limited, with most children recognizing only one or two spice types. Based on these findings, a puzzle-based learning medium was designed, consisting of spice-themed puzzle pieces, flashcards, magnetic learning cards, and authentic spice samples integrated into a contextual learning framework. The design was developed according to the cognitive characteristics of children in the intuitive thinking stage, emphasizing concrete, visual, and hands-on learning experiences. Initial prototype trials and teacher evaluations indicated that the learning media were appropriate for classroom implementation and supported children's engagement in learning activities related to Indonesian spice heritage. The study suggests that culturally integrated puzzle-based learning media can serve as an innovative educational tool for introducing Indonesian spices while supporting contextual and culture-based learning in early childhood education.

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1. Introduction

Referring to Government Regulation of the Republic of Indonesia Number 17 of 2010, Article 1, Paragraph 3, the early age range in Indonesia ranges from 0-6 years. This phase is the first foundation for developing early childhood cognitive, language, physical and motor development, and socio-emotional abilities [1]. This phase is characterized by rapid cognitive and emotional development, during which children learn how to flexibly shift their attention between competing demands and at the same time acquire critical emotion regulation skills [2]. Developmental theories, including Piaget's cognitive development framework, have significantly shaped early childhood education practices [3]. According to Jean Piaget's theory about children's cognitive development, children in the age range of 2-7 years are in the preoperational stage [4]. At this stage, symbolic abilities are developing, and their logic is still dominated by intuition, requiring an appropriate learning approach. These theoretical perspectives highlight the importance of learning media that support concrete and visual experiences. In the preoperational stage (2-7 years), children represent the world through words and images, demonstrating emerging symbolic thinking. At this stage, children's

thinking is unsystematic, inconsistent, and illogical [5]. Piaget divided the preoperational stage into two sub stages: symbolic functions at 2-4 years and intuitive thinking at 4-7 years. In the intuitive thinking sub stage, children begin to seek explanations and curiosity about their surrounding, yet their thinking is still not fully logical or systematic [6]. These cognitive characteristics indicate that children learn more effectively through concrete, hands on, and visually supported learning experiences rather than abstract verbal instruction [7]. For early childhood education, it is recommended to use concrete learning media to shift children's focus and build an understanding of reversibility [8].

Contextual learning is a learning approach that connects the material learned with daily children's real lives to find the meaning of the subject matter for children's lives, including introducing Indonesia's natural wealth. Recent research shows how important it is to integrate cultural heritage into early childhood education to promote cultural identity and cultural continuity [9]. Indonesia has an abundance of natural resources with high cultural value [10]. Historically, Indonesian spices have played a significant role in global trade and remain embedded in culinary traditions and traditional medicine. Nowadays, the knowledge of Indonesian spices is quite weak, especially in young children today. Based on the results of preliminary observations at Cihaurgeulis Early Childhood Education Center from 10 spices used as the initial material for observation, 90% of children only know 1-2 types of spices. These findings indicate a limited introduction of local cultural knowledge, particularly spices, in early childhood learning environments. A decrease in knowledge of spices in Indonesia is caused by various factors, including the rise of instant products, including instant spice powder, which decreases the purchase of the original form of spices. Educational toys are one of the tools that teachers can use to implement a contextual learning model. Using concrete learning media in the way of educational toys such as puzzle blocks can encourage children to actively explore and discover concepts because their thinking is tied to real objects [11]. Puzzles improve children's visual comprehension, problem-solving, and fine motor skills, emphasizing puzzles as an optimal educational method for cognitive development [12]. Therefore, designing a puzzle based educational toys may provide a concrete and engaging approach to introduce Indonesian spices while aligning with the cognitive characteristics of children in the intuitive thinking stage.

2. Method

The method used in this research is a qualitative descriptive development research (Q&D). Q&D in this research using mixed methods of thematic analysis for needs data and ADDIE for the design stage. The purpose of this method is to describe and analyze the design of educational game tools in the form of puzzles to preserve spices in Indonesia for early childhood.

2.1. Data Collection Techniques

1) Literature Study

This stage was conducted during the analysis stage to examine theoretical and empirical studies related to educational toys, puzzle based learning, cultural literacy, and early childhood education. The sources included peer reviewed journal articles, research reports, and relevant academic publications. This literature study aims to provide a theoretical basis for the development of puzzle based learning media and to identify existing research gaps, particularly in relation to spice heritage education for early childhood.

2) Observation

Observing learning activities with 20 children age 4-6 years at Cihaurgeulis Early Childhood Education Center to understand the condition of children when learning and playing. Classroom observation were conducted in several thematic learning sessions related to nature, culture, and daily life topics at Cihaurgeulis Early Childhood Education Center. The non-consecutive observation schedule was adjusted to align with relevant thematic lessons in the curriculum. Each session lasted approximately 30-60 minutes. During the initial observation stage, an informal identification activity using flash cards was conducted to assess children's prior knowledge of Indonesian spices. The flash cards displayed images of selected

spices, and children were asked to mention the spice name. This activity aimed to provide preliminary insight into the children's level of familiarity with spice-related content. Structured observation sheets were used to record children's engagement responses and interaction patterns during both regular learning activities and the flash card activity.

3) Interview

Interviews were conducted with four classroom teachers at Cihaurgeulis Early Childhood Education Center to obtain information on the need to design educational game tools like puzzles to introduce Indonesian spices to children.

2.2. Data Analysis Techniques

Based on the research method used, namely qualitative methods, the data analysis technique used is the thematic data analysis technique. According to Braun & Clarke, thematic analysis is a method for analyzing data to identify patterns or find themes through data that researchers have collected [13]. In this technique, researchers identify ideas or concepts that often appear, group similar parts of the data, and compile main themes to provide a clearer picture of the views or experiences of the people in the data. The stages of thematic analysis are explained in Fig. 1.

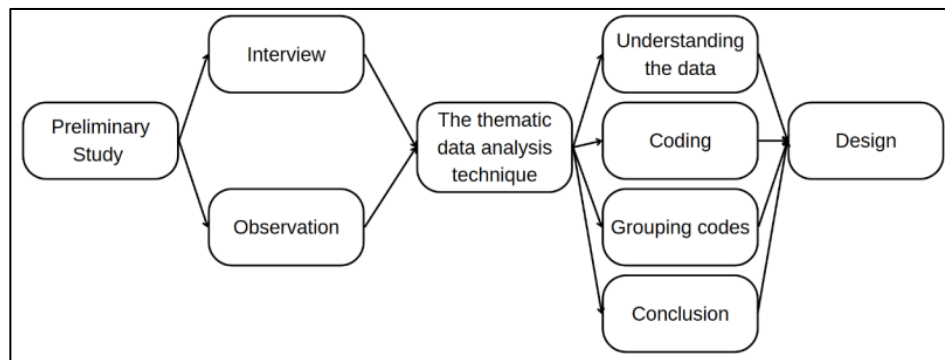


Fig. 1. The Stages of Thematic Analysis

The following details the stages of thematic analysis in Fig.1 in this study:

- Understanding the data: The main purpose at this stage is for researchers to understand the data obtained better. At this stage, researchers can make notes to help them identify things that can be coded later [14]. In this study, researchers listened back and read the results of interviews conducted with teachers at the Cihaurgeulis Early Childhood Education Center.
- Coding: Researchers find interesting or important parts as codes after understanding the data. These codes are words or phrases that represent certain ideas in the data. Based on the results of understanding the interview data in the previous stage, researchers marked several phrases that represented the idea of designing educational toys as puzzles to preserve Indonesian spices for early childhood.
- Grouping codes: In this stage, group codes that have similarities or are related are used as themes or main ideas. In this research, the main idea is to design a puzzle board to introduce spices to early childhood.
- Conclusion: contains conclusions from the results of data analysis at the previous stage; namely, researchers will design a puzzle board to introduce spices to early childhood.

2.3. Design Method

The design method used in this research is the ADDIE method. The ADDIE method is a synonym for Analyze, Design, Develop, Implement, and Evaluate. The use of the ADDIE model design method is considered effective because this method can be used for various learning models, media, and teaching materials due to the systematic nature of ADDIE [15]. As can be seen in Fig.2.

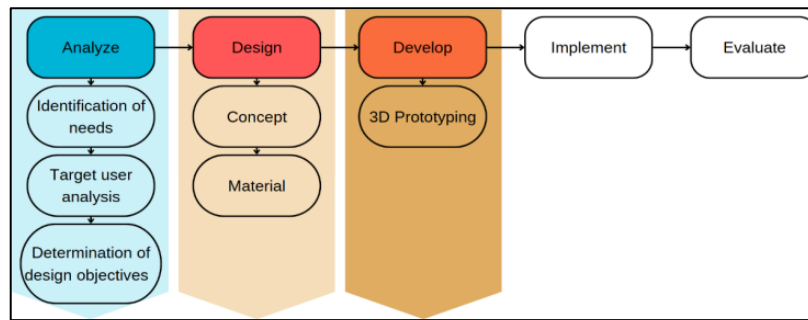


Fig. 2. Stages of ADDIE

This research includes research and product development of educational game tools, and the ADDIE design method implemented in this article will be discussed only until the development stage. The following is a brief explanation of the ADDIE stages.

- **Analyze:** At this stage, the researcher analyses the urgency of developing educational toys for preserving spices. The steps at this stage include identifying needs, analyzing target users, and determining design objectives. The analysis stage was conducted through classroom observation and semi-structured interviews with teachers. Observation was carried out to identify the level of children's engagement with the available learning media and their initial understanding of the types of Indonesian spices. Interviews were conducted to explore teachers' needs for learning media based on local culture. The data from the observations and interviews were then analyzed to identify the main themes that formed the basis for the design of the media.
- **Design:** This stage includes a design plan for the puzzle to be made. This design includes concept basics, shapes, colors, visual styles that integrate spices, and game flow charts.
- **Develop:** At this stage, the designed product is realized as a real product.

3. Results and Discussion

Cihaurgeulis Early Childhood Education Center, located in the Cibeunying Kaler sub-district, Bandung City, West Java Province, uses an independent curriculum. This independent curriculum is a learning method where children can express and explore their ideas and imagination in discussion and work. The learning presentation for early childhood should prioritize the process packaged in play and game activities [16]. Based on the implemented curriculum, Cihaurgeulis Early Childhood Education Center has a learning schedule that can support contextual learning, including learning about Indonesian culture and cooking classes. Contextual teaching and learning is a way to teach content through relevant materials that keep students engaged in learning [17]. Contextual learning is a learning approach that links the material learned with children's real-life experiences, both in the family, school, community, and citizen environment, to find the meaning of the subject matter for children's lives [18]. The learning schedule at Cihaurgeulis Early Childhood Education Center, which is contextual learning, includes cooking classes and an introduction to Indonesian culture. In the cooking class, children will learn materials by introducing raw materials to the dishes that will be made, and the teacher will provide a theme at each meeting as a reference for the class to be held. The types of dishes introduced in this cooking class are quite diverse, ranging from snacks to heavy meals, but traditional types of cuisine or foods that contain spices are still not introduced to children.

Along with the times, nowadays many things are made fast and instant. Many ready-made seasonings and chemical drugs are slowly shifting the role of spices in everyday life [19]. For example, the rise of fast food such as burgers, fried chicken, and other types of food has made many young people not recognize the typical Indonesian spices in food [13]. Based on the results of observations made on November 1, 2024, the children of Cihaurgeulis Early Childhood Education Center were very enthusiastic when learning to use educational toys and also about the cooking class. Children are very interested in learning the ingredients used in a dish. The results of the data analysis are shown in Table 1. Based on the data analysis above,

several important findings related to the design of educational toys for preserving Indonesian spices were found. Initial observations at the Cihaurgeulis Early Childhood Education Center show that the school does not have an appropriate educational toy to support learning about the conservation of Indonesia's natural resources, especially spices. The first step in this data analysis is to understand the existing data and identify a need for educational toys to support this learning.

Table 1. Thematic Analysis Steps

Thematic Analysis Step	Explanation
Understanding the data	Cihaurgeulis Early Childhood Education Center still lacks suitable educational toys that support learning about conserving Indonesia's natural resources, especially spices.
Coding	The codes representing the design idea are 'Children's interest in educational toys in the form of puzzles,' 'Children's interest in spices in Indonesia,' 'Introduction of spices to children,' 'Visual design in puzzles,' 'Variations in how to play puzzle games.'
Grouping Codes	The codes obtained from the results of the interviews were grouped and became the main idea, namely the design of a puzzle with the theme of Indonesian spices.
Conclusion	Based on the data obtained in the previous stage, the researcher concluded that early childhood children are interested in educational toys in the form of puzzles and are also interested in spices in Indonesia, so the researcher got the main idea, namely, designing a puzzle board to introduce spices to early childhood.

The next stage is the stage of compiling codes; at this stage, the codes are compiled from the results of the interviews that represent design ideas. Some of the codes identified include 'children's interest in educational toys in the form of puzzles,' 'children's interest in spices in Indonesia,' and 'variations in how to play puzzle games.' These codes show children's interest and need for educational toys, which are visually appealing but also educational and interactive. These codes are then grouped and compiled into the main idea: designing a puzzle with the theme of Indonesian spices. This idea reflects the need to design a puzzle that can introduce different types of spices to early childhood in a fun and educational way. This puzzle is designed with interesting visual aspects and various gameplay styles that can motivate children to learn more about Indonesian spices. Based on the data obtained in the previous stage of analysis, it was concluded that children at the Cihaurgeulis Early Childhood Education Center showed a high interest in puzzle-type educational toys and had an interest in knowing more about spices in Indonesia. This provides a strong foundation for researchers to design puzzle boards as an effective and interactive educational medium. The puzzle board is expected to help introduce and preserve knowledge about spices to children from an early age so that they grow up with a better understanding and appreciation of Indonesia's natural wealth. Thus, the design of educational toys as a puzzle aims to educate children about spices and form a generation more aware of the importance of preserving Indonesia's natural resources. This effort is expected to significantly contribute to preserving Indonesia's culture and natural resources. The design method used in this design is the ADDIE method, which will be limited only to the development stage; the details of the use of this method are explained in [Table 2](#).

Table 2. Design Method

Design Methode	Explanation
Analyse	Identification of needs: Based on the results of observations at the Cihaurgeulis Early Childhood Education Center, it was found that children in the school were very interested in the spices that Indonesia has, but 90% of children only knew 1-2 types of spices, and no educational toys could support learning about these spices. Target user analysis: Children at Cihaurgeulis Early Childhood Education Center tend to be interested in contextual learning, where the learning material intersects with things in their environment. They also like to use educational toys, especially puzzles, in their learning process. Determination of design objectives: This design aims to introduce Indonesian spices too early childhood through interactive puzzles as one of the efforts to preserve Indonesian spices.

Design Methode	Explanation
Design	The puzzle concept that will be used in educational toys this time is a puzzle with a 4-piece puzzle type with various ways to play. Four-piece puzzles are more appropriate for children aged 4-6 years. With a simple spice illustration design and bright colors, it can represent spices according to their original state. The materials in this game are also very useful because there is a flashcard for each spice that contains an explanation of the identity and food that uses the spice.
Develop	3D Prototyping

Looking at [Table 2](#), which outlines the stages involved in designing this puzzle, it can be concluded that the design aims to introduce spices to young children in an interactive and fun way. In the process of making this puzzle, many aspects must be considered, especially the shape and material that will be used because the users of this puzzle are in early childhood, so the shape and material must be according to standards so that it is safe when children play using this puzzle. This is presented in [Table 3](#).

Table 3. Design Aspects

Design Aspects	General Concepts	Specific Concepts
User	4-6 years	The user is an early childhood education child with an age range of 4-6 years.
Function	Introducing spices to early childhood	The function of educational toys is to introduce spices to early childhood through puzzle games, The function of educational toys is to introduce spices to early childhood through puzzle games,
Activity	Arrange the spice picture pieces and match them with the names and foods made from those spices.	There is a magnetic whiteboard that serves as a base for children to arrange puzzle pieces. Teachers or parents can play various games on the whiteboard. An example is making a puzzle that matches the name or type of food from the spice puzzle.
Product Operations	Easy to use by children aged 4-6 years and accompanied by teachers or parents.	Puzzles are designed to be easy for children to use under the supervision of teachers or parents.
Ergonomics & Anthropometrics	Designed based on ergonomics and anthropometrics for children aged 4-6 years to make it easier to learn to recognize spices	The size of the puzzle box and puzzle pieces is adjusted to the ergonomics and anthropometrics of children aged 4-6 years.
Appearance	The overall appearance of this game is made simple so that children focus on the main point of the spice picture in the puzzle.	Using simple illustrations and representing the shape of the spices, they are made as similar as possible to the original shape without adding other ornaments.
Material	The material used is safe for children aged 4-6 years.	Using pine wood materials and finishing that is safe for children.

Based on the data in the [Table 3](#), it can be determined that the puzzle to be designed must be suitable and safe for children aged 4-6 years. The puzzle box will be a storage place for puzzles and a means for students to play with puzzles measuring 0.6m x 0.6m, using pine wood materials and finishing that is safe for children. The first part is a lid, a magnetic whiteboard that will be used as a place for children to attach puzzles. The next part is the top-level puzzle box, where there are many columns containing pieces of the puzzle pieces that the children will compile. The puzzle box on the lower level contains a column measuring 0.12m x 0.12m with a lid with a picture of spices. The column contains information about spices. Pinewood was chosen as the main material because of its characteristics of pine wood, which include a clean, smooth, sturdy, durable texture, easy to work/shape, and easy-to-find raw materials available [\[20\]](#), [\[21\]](#). The 3D puzzle box can be seen in [Fig.3](#).



Fig. 3. 3D of Puzzle Box

According to the official website of the Ministry of Tourism and Creative Economy, which was uploaded on August 22, 2021, 7 typical Indonesian spices have very high potential, including pepper, cloves, cinnamon, vanilla, cardamom, *andaliman*, and nutmeg [22]. Meanwhile, according to the book *'Rempah & Herba Kebun-Pekarangan Rumah Masyarakat: Sumber Fitofarmaka dan Wisata Kesehatan-kebugaran'* there are eight typical Indonesian spices that have many benefits, namely nutmeg, cloves, cinnamon, turmeric, ginger, pepper, vanilla, and lemongrass [23]. Based on these two sources, it can be concluded that 11 spices can represent the characteristics of spices in Indonesia; then, additional spices have become icons of typical Indonesian cuisine, namely *kluwek* and star anise. An explanatory table of the 12 spices that will be used in this puzzle can be seen in Table 4.

Table 4. Spices

Spices	Spices Explanation
Pepper	Pepper is spread in several regions of Indonesia, Indonesia's main spice commodity, especially in the Bengkulu, Bangka Belitung, Lampung, West and East Kalimantan, Southeast Sulawesi, and South Sumantan. Pepper is used as a seasoning for cooking, raw materials for the making and medicinal industries, and pepper oil is used as a mixture of drinks that have health benefits [24].
Cloves	Cloves are a spice native to Maluku, but the most clove-producing areas in Indonesia include East Java, Maluku, Sulawesi Island, East Kalimantan, and NTT. Various fields often use cloves from the culinary industry as an ingredient for making acid oils for perfumes [25].
Cinnamon	Cinnamon in Indonesia is a spice that comes from Jambi. Cinnamon is generally used in the coolie part of the stem as an additive to food and drinks [26].
Vanilla	Indonesia is the largest vanilla-producing country in the world after Madagascar. Vanilla cultivation in Indonesia includes East Java, Central Java, Lampung, and NTT. Vanilla is often used as a flavoring and enhancer of the taste and aroma of food.
Cardamom	Cardamom is a typical Indonesian spice, with North Sumatra as the main cardamom-producing region in Indonesia. Cardamom is often used as a flavor for dishes [27].
<i>Andaliman</i>	<i>Andaliman</i> is a unique Indonesian spice. <i>Andaliman</i> is often found in Batak food mixtures [28].
Nutmeg	Nutmeg is believed to have originated from Maluku and Banda islands. Nutmeg has diverse benefits because almost any plant part can be used for various purposes. Nutmeg seeds are one of the most widely used spices for food processing [29].
Turmeric	Turmeric is a spice native to Southeast Asia, and Indonesia is one of the countries that produce the best turmeric. The best turmeric-producing region in Indonesia is the East Java region. Turmeric is often used as an additional spice in Indonesian cuisine because it can neutralize the smell of new [30].
Ginger	Ginger can be grown in various regions of Indonesia. The region with the largest ginger producer in Indonesia is West Java. Ginger is often used as a flavoring for dishes and also as a herbal medicine [31].
Lemongrass	Lemongrass is a spice that grows widely in Indonesia. Lemongrass is often used as an addition to culinary bubbles and herbal medicine.
<i>Kluwek</i>	<i>Kluwek</i> is a typical spice that grows in Indonesia. <i>Kluwek</i> is synonymous with a spice used to make rayon.
Star anise	Star anise grows in tropical areas such as Java, Sumatra, and Kalimantan; like other spices, star anise has various benefits and is often used as an additional spice in cooking and herbal medicine.

The concept of puzzles can encourage children's reflection, collaboration, and critical thinking through interaction with concrete materials [32]. In addition to the puzzle box design as the main container, the puzzle design to be prepared must be made as similar as possible to the original shape and made simple so that children focus on the introduction of spices. Puzzle based learning can help motor, intellectual, and social aspects through visual-contextual interaction [33]. Using spice illustrations in puzzles aims to make children more interested in learning. Illustrations can help improve children's thinking and cognitive abilities [34]. Illustration designs that only slap spices without additional ornaments will make children more focused on the shape of the spices so that children can memorize the spices faster. An example of an illustration of spices can be seen in Fig. 4.



Fig. 4. Sample Spice Illustration

The puzzle chosen is a type of 4-piece puzzle. Based on observations, the four-piece puzzle is suitable for children aged 4-6 years if the main purpose of the puzzle is to introduce the images on the puzzle. Children will find it easier to compose and remember the shape of spices. The puzzles are designed to measure 0.1m x 0.1m, with each piece measuring an average of 0.05m x 0.05m according to the grasping ability of children aged 4-6 years. Samples of puzzle can be seen in Fig. 5.

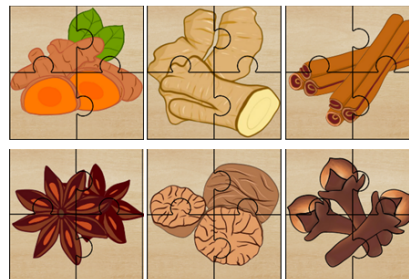


Fig. 5. Samples of Puzzle

The next component is the key to unclosing the columns on the information box. The lock is designed with a female lock in the shape of a basic figure and initials and equipped with a picture of spices. It is applied with the aim of training students' ability to match a shape. The 12 types of spices used are divided into four groups to determine the basic shape of the key so that spices with the same initials will be differentiated in the shape of the data so that students can only use one key to open one column. The basic division of shapes is explained in the following Table 5.

Table 5. Spices Code Key

Basic Shape	Initials	Spices
Circle	K	Cinnamon
	C	Cloves
	P	Nutmeg
	K	Turmeric
Triangle	A	Andaliman
	J	Ginger
	K	Kluwek
Square	B	Star Anise
	V	Vanilla
	K	Cardamom
Pentagonal	S	Lemongrass
	L	Pepper

Based on the code in the Table 5, here is a prototyping in the form of a 3D model of the information box column key. An example of the key can be seen in Fig. 6.



Fig. 6. Samples of Key

After the lid of the column can be opened, there is information about spices. There is a flashcard on the front with a picture of a cracker and information on the spice's origin on the back; then, there is a magnetic card with a picture of food that can be made from the spice. The use of flashcard visual media can improve children's early reading ability [35]. In addition to the two cards, some original spices have been dried to introduce children to the spice's shape, color, and smell. The following is a sample of the flashcard and magnetic card design that will be used; both cards will be 0.1m x 0.1m in size. As can be seen in Fig. 7.

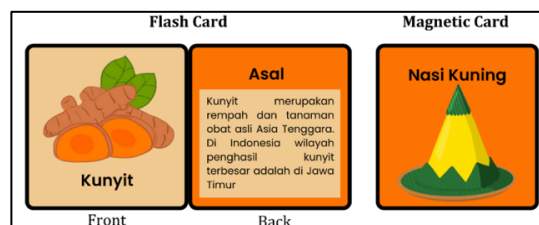


Fig. 7. Sample of the Flashcard and Magnetic Card

This puzzle is designed to be flexible as a learning medium. Teachers can create different games for each game. The magnetic whiteboard behind the puzzle box lid aims to make this game more varied, it can also be a direct learning medium if you want to teach students to write or read and hone children's matching skills in one medium. Here's a suggested flowchart from the researchers, shown in Fig. 8.

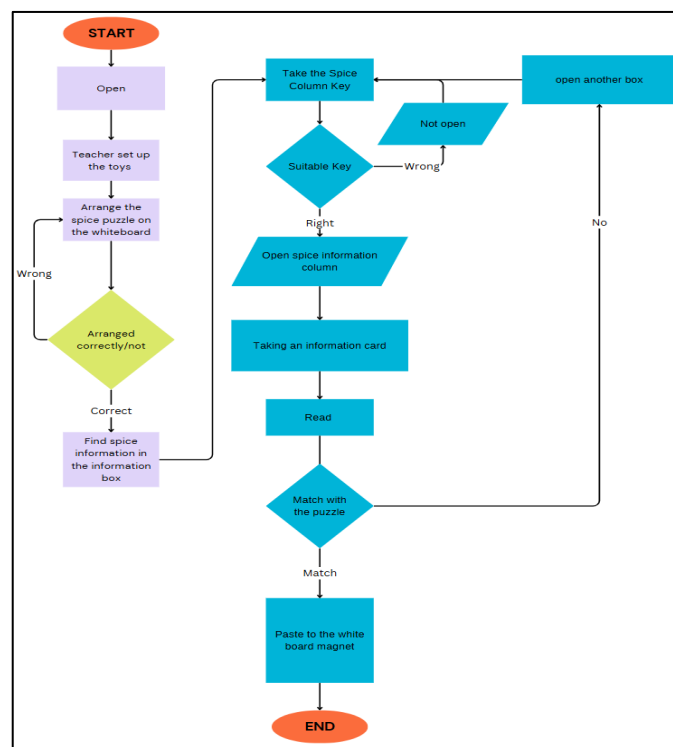


Fig. 8. Flowchart

In developing the product, a trial using a 1:1 prototype was carried out with students directly. In this prototype trial process, teachers carried out the learning process using this puzzle-based educational toy to introduce spices as material in a learning plan about nature, plants, and their benefits. This can be seen in the prototype testing process in Fig. 9.



Fig. 9. Prototype Trial Process

Based on the results of the initial discussion and evaluation conducted by the teachers on this puzzle, it was found that in general, this puzzle can be used as a teaching medium for the learning process. The following are the positive conclusions from the prototype trial: (1) The spice theme content on the puzzle toys developed is in accordance with the curriculum and teaching materials used at Cihaurgeulis Early Childhood Education Center so that through this puzzle children can achieve the learning goals that have been prepared in a more effective and fun way; (2) Puzzle-based learning can provide a concrete and engaging approach to introduce Indonesian spices while aligning with the cognitive characteristics of children in the intuitive thinking stage.

4. Conclusion

This study concludes that the puzzle-based educational toys are suitable for introducing Indonesian spices to children aged 4-6 years in the intuitive thinking stage. The results of the prototype trial process indicate that children showed high engagement, active participation, and improved recognition of various spices through hands-on interaction with the puzzle components. The concrete and visual characteristics of the puzzle align with the cognitive features of preoperational learners, particularly their reliance on symbolic representation and intuitive reasoning. By integrating cultural content into a manipulative learning format, the designed puzzle provides a concrete and engaging approach to support contextual learning while facilitating early exposure to Indonesia's spice heritage. These findings suggest that culturally integrated puzzle media can serve as an effective instructional tool in early childhood education settings.

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Declarations

- | | |
|-------------------------------|---|
| Author contribution | : AR: observation, designing research methods, design methods, conducting interviews, observation, study literature, collecting data, analyzing the data, making design, writing the article; NFB: research idea, advisor |
| Funding statement | : Telkom University funds the research. |
| Conflict of interest | : The authors declare no conflict of interest. |
| Additional information | : No additional information is available for this paper. |

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