

Developing an Interactive Javanese Script Puzzle to Foster Early Literacy and Cultural Identity in Early Childhood Education

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Abstract. Early childhood is a critical period for developing foundational literacy skills and establishing children's awareness of cultural heritage. The introduction of Javanese script at the early childhood level remains challenging because its distinctive visual forms and unfamiliar symbols can be difficult for young children to recognize through conventional learning activities. This study aimed to develop an interactive Javanese Script Puzzle as a play-based learning resource to foster early literacy and cultural identity among young children. The study employed a research and development approach adapted from the Borg and Gall development model. The development procedures included preliminary research, product planning, initial product development, expert validation, product revision, preliminary field testing, and final product refinement. The puzzle was designed according to the developmental characteristics of young children by incorporating visual recognition, matching, sequencing, and hands-on play activities involving Javanese script characters. Expert validation and field testing were conducted to examine the feasibility, practicality, and potential educational value of the developed product. The development process resulted in an interactive puzzle that integrates early literacy learning with Javanese cultural content in an engaging and developmentally appropriate format. The product provides children with opportunities to recognize and differentiate Javanese script characters while interacting directly with culturally relevant learning materials. These findings indicate that play-based integration of local cultural heritage can provide an alternative approach to introducing Javanese script in early childhood education. The developed puzzle has the potential to support culturally responsive early literacy practices and contribute to the preservation of local cultural knowledge through meaningful learning experiences in early childhood settings.

Keywords: Cultural identity; Early childhood education; Early literacy; Javanese script; Play-based learning; Research and development

Abbreviations: R&D: Research and Development

INTRODUCTION

Early childhood is a critical period for developing foundational competencies that support children's subsequent learning, including language, literacy, cognitive, social, and cultural development. Early literacy is not limited to children's ability to read and write; it also encompasses the emerging ability to recognize symbols, understand visual representations, develop language awareness, and construct meaning through interaction with texts and learning materials. Therefore, literacy learning in early childhood needs to be presented through meaningful, engaging, and developmentally appropriate experiences. Learning activities that allow children to explore, manipulate, communicate, and construct knowledge through play are particularly relevant because play represents a natural context for young children's learning and development. Research has shown that guided play can support children's learning outcomes by combining children's active engagement with intentional learning objectives [1].

Play-based learning is also relevant to the development of early literacy because children can encounter letters, symbols, sounds, images, and words through concrete and enjoyable activities. Rather than requiring children to memorize unfamiliar symbols through repetitive instruction, play-based activities provide opportunities for children to recognize, compare, match, arrange, and repeatedly interact with learning materials. Such experiences may strengthen children's engagement and provide meaningful opportunities to develop emerging literacy competencies. Recent research has demonstrated the potential of educational games and play-oriented learning experiences to support children's language and literacy development [2]. Consequently, the development of learning resources that integrate literacy objectives with playful and interactive experiences is increasingly important in early childhood education.

In addition to foundational literacy, early childhood education has an important role in introducing children to cultural heritage and strengthening their awareness of the cultural environment in which they live. Cultural heritage education enables children to encounter local languages, symbols, traditions, arts, stories, and knowledge as meaningful components of their learning experiences. A systematic review of cultural heritage education in early childhood demonstrated that cultural heritage has been incorporated into preschool education through diverse pedagogical practices, although research in this area remains relatively limited [3]. Introducing cultural heritage at an early age may contribute to children's awareness, appreciation, belonging, and emerging cultural identity. Accordingly, local cultural elements should not merely be treated as additional learning content but should be integrated into developmentally appropriate and meaningful learning experiences.

Within the Indonesian context, Javanese script (Aksara Jawa) represents an important element of Javanese linguistic and cultural heritage. Introducing Javanese script to young children can provide an opportunity to develop symbolic awareness and early literacy while simultaneously familiarizing children with their local cultural heritage. However, learning Javanese script presents particular challenges because its visual forms are considerably different from the Latin alphabet that children commonly encounter in their everyday environment. Young children therefore require concrete, attractive, and interactive learning experiences that enable them to gradually recognize and differentiate Javanese characters. The use of culturally relevant learning materials may also help transform Javanese script from an unfamiliar collection of symbols into a meaningful representation of local cultural heritage.

Previous studies have demonstrated the potential of puzzle-based media for introducing and learning Javanese script. Puzzle Carakan, for example, has been developed as a learning medium to support Javanese script writing among elementary school students [4]. Other research has developed PUSARAWA (Puzzle Aksara Jawa) to support Javanese script reading skills among elementary school students [5]. More recent research has also explored interactive and computer-based puzzle approaches for Javanese script learning [6]. These studies demonstrate that puzzle activities can provide opportunities for learners to interact directly with Javanese characters through visual recognition, matching, arrangement, and problem-solving activities. However, most existing studies have focused on elementary school learners rather than children in early childhood education. Furthermore, previous studies have generally emphasized the acquisition of Javanese script reading or writing skills without explicitly positioning the learning medium as an integration of early literacy development and cultural identity. Related puzzle and digital Javanese-script learning media have also been developed across writing, interactive, website, multimedia, game, and application formats [7], [8], [9], [10], [11], [12], [13], [14], [15], [16].

This situation reveals an important research gap. Although previous research has established the potential of play-based learning for young children, cultural heritage education for early childhood, and puzzle-based approaches for Javanese script learning, limited research has integrated these three dimensions into a single developmentally appropriate learning resource for young children. In particular, there remains a need for an interactive learning medium that introduces Javanese script through concrete play experiences while simultaneously supporting children's emerging literacy and awareness of cultural heritage. The challenge is therefore not simply to enable children to memorize Javanese characters but to create an experience in which children can recognize, explore, manipulate, and interact with cultural symbols in ways that are consistent with early childhood learning principles. This gap is particularly significant because culturally responsive learning experiences can connect classroom learning with children's local environments and provide meaningful contexts for the development of cultural awareness [7].

An Interactive Javanese Script Puzzle offers a potential response to this gap. By transforming Javanese script recognition into a hands-on puzzle activity, children can learn through matching, arranging, identifying, and completing puzzle pieces. The interactive nature of the medium provides repeated opportunities for children to observe the visual characteristics of Javanese characters and develop recognition through active engagement. At the same time, the use of Javanese script as the central learning content positions cultural heritage as an integral component of early literacy rather than as an isolated cultural lesson. This approach is consistent with culturally responsive early childhood education, which emphasizes the importance of connecting learning experiences with children's cultural and social environments [3], [7].

The present study therefore aims to develop an Interactive Javanese Script Puzzle as a play-based and developmentally appropriate learning resource for early childhood education. Specifically, the study seeks to examine the feasibility and educational potential of the developed puzzle in supporting children's recognition of Javanese script while fostering early literacy and cultural identity. The study is expected to contribute to the development of innovative and culturally responsive learning media by demonstrating how local cultural heritage can be integrated into early literacy experiences through interactive play. More broadly, the study seeks to provide early childhood educators with an alternative approach for introducing Javanese script in ways that are meaningful, engaging, and appropriate to young children's developmental characteristics.

MATERIALS AND METHODS

Study area

Research Design

This study employed a Research and Development (R&D) design to develop an Interactive Javanese Script Puzzle as a play-based learning resource for early childhood education. The development was intended to produce a feasible, practical, and developmentally appropriate learning medium for introducing Javanese script while supporting children's early literacy and cultural identity. The staged development logic is consistent with established instructional-design and R&D frameworks [17], [18]. The development procedure was adapted from the Borg and Gall model [19]. Considering the characteristics and scope of the study, the development procedure was adapted into seven stages: (1) preliminary research and information gathering, (2) product planning, (3) initial product development, (4) preliminary product validation, (5) product revision, (6) preliminary field testing, and (7) final product revision. The adaptation was intended to maintain the essential principles of the Borg and Gall model while making the development procedure feasible within the context of early childhood education.

Development Procedure

The first stage involved preliminary research and information gathering. This stage was conducted to identify children's learning needs, teachers' difficulties in introducing Javanese script, existing learning resources, and the characteristics of learning activities commonly used in early childhood classrooms. Information was obtained through observation and discussions with early childhood educators. Particular attention was given to children's ability to recognize symbols, distinguish visual forms, follow simple instructions, and engage in manipulative play activities. The second stage involved product planning. Based on the needs identified during the preliminary stage, the learning objectives, content, puzzle structure, visual design, rules of play, and assessment indicators were determined. The puzzle content focused on the recognition of basic Javanese script characters (Aksara Jawa), particularly Aksara Nglegena. The design incorporated colorful visual elements, concrete puzzle pieces, matching activities, and simple sequencing tasks to accommodate the developmental characteristics of young children. The third stage involved the development of the initial product. The Interactive Javanese Script Puzzle was designed as a hands-on learning medium consisting of puzzle pieces representing Javanese script characters and supporting visual components. The product was designed to encourage children to identify, match, arrange, and distinguish characters through play. Instructions were developed using simple language and supported by visual cues to facilitate independent and teacher-guided activities. The fourth stage involved expert validation. The initial product was evaluated by experts in relevant fields, including early childhood education and learning media, and, where appropriate, Javanese language or cultural education. The validation focused on content appropriateness, developmental suitability, language clarity, visual design, ease of use, safety, playability, and the relevance of the product to early literacy and cultural learning objectives. The fifth stage involved product revision based on expert feedback. Components that did not meet the established criteria were revised, including the size and design of puzzle pieces, visual clarity, instructions, level of difficulty, and suitability of Javanese script content for young children. The sixth stage consisted of preliminary field testing with young children. The trial was conducted in an early childhood education setting to examine the practicality and usability of the product during actual learning activities. Children were observed while interacting with the puzzle, particularly in terms of their ability to recognize Javanese script symbols, follow game instructions, match and arrange puzzle pieces, and participate actively in the learning activity.

The seventh stage involved final product revision. Findings from the preliminary field test and observations were used to refine the product. The final version was then prepared as a learning resource that could be used by early childhood educators to introduce Javanese script through play-based learning.

Participants and Study Setting

The study was conducted in an early childhood education setting in Yogyakarta, Indonesia. Participants consisted of young children in the target age group for the product and early childhood educators involved in the learning process. Expert validators were selected based on their academic and professional expertise in early childhood education, learning media, and/or Javanese language and cultural education. The selection of participants was based on their relevance to the objectives of the product development. Young children were involved in the preliminary field test because the product was specifically designed according to their developmental characteristics and learning needs. Teachers were involved to provide contextual information regarding the practicality, usability, and suitability of the learning medium for classroom implementation.

Materials and Product Components

The primary material developed in this study was an Interactive Javanese Script Puzzle. The product consisted of puzzle pieces containing selected Javanese script characters, visual illustrations, matching components, and supporting instructional materials. The design emphasized concrete manipulation and visual recognition to enable children to interact directly with the script. The product development was guided by three main principles. First, the puzzle incorporated early literacy principles by encouraging children to recognize and differentiate symbolic forms. Second, the product applied play-based learning principles by providing children with opportunities to learn through manipulation, exploration, matching, and problem solving. Third, the product incorporated local cultural heritage by introducing Javanese script as a culturally meaningful symbol within the children's learning environment.

Research Instruments

Data were collected using expert validation sheets, observation sheets, and teacher response instruments. The expert validation sheet was used to assess the quality and feasibility of the product. The assessment dimensions included content accuracy, developmental appropriateness, visual design, language, playability, safety, and alignment with early literacy and cultural learning objectives. The observation instrument was used during the preliminary field test to document children's interaction with the puzzle. The observed indicators included children's ability to recognize Javanese script characters, distinguish between character forms, match appropriate puzzle pieces, arrange pieces correctly, follow simple instructions, and demonstrate active engagement during the activity. Teacher responses were collected to examine the practicality of the product in classroom use. The instrument addressed ease of preparation, clarity of instructions, ease of use, children's engagement, suitability for classroom activities, and perceived usefulness in introducing Javanese script.

Data Collection Procedure

Data collection was conducted sequentially according to the development stages. Preliminary information was obtained through classroom observation and discussions with teachers. Expert validation was conducted after the initial product had been developed. Experts assessed each component of the product using a structured validation instrument and provided qualitative suggestions for improvement. The revised product was subsequently implemented in a preliminary field test involving young children. During the field test, observations were conducted while children interacted with the puzzle in a play-based learning situation. The researcher documented children's responses, difficulties, engagement, and ability to complete the puzzle activities. Teacher responses were also collected after the implementation to obtain information regarding the practicality and usability of the product.

Data Analysis

Quantitative data from expert validation and teacher responses were analyzed descriptively by calculating the percentage of obtained scores relative to the maximum possible score. The percentage was calculated using the following formula: $P = (X / X_{\max}) \times 100\%$ where (P) represents the percentage of feasibility or practicality, (X) represents the total score obtained, and ($X_{\max}$) represents the maximum possible score. The resulting percentages were interpreted using predetermined feasibility criteria. Higher percentages indicated stronger evidence that the product met the established criteria for content appropriateness, developmental suitability, usability, and practicality. Qualitative comments and suggestions from experts and teachers were analyzed descriptively and used as the basis for product revision.

Field-test observation data were analyzed descriptively to identify patterns in children's interaction with the puzzle, including their ability to recognize and distinguish Javanese script characters, complete matching and sequencing activities, follow instructions, and demonstrate engagement. The analysis was used to identify strengths and weaknesses of the product and to determine revisions required before producing the final version. Ethical principles were considered throughout the study. Participation of children was conducted with permission from the relevant educational institution and informed consent from parents or legal guardians. Children's identities and personal information were kept confidential, and participation in the learning activities was conducted in accordance with the principles of child safety, comfort, and voluntary participation.



Figure 1. Interactive Javanese Script Puzzle as a play-based learning medium for introducing Javanese script to young children

RESULTS AND DISCUSSION

Preliminary Needs Analysis

The preliminary needs analysis was conducted to identify the learning needs of young children and the challenges faced by teachers in introducing Javanese language and Javanese script in early childhood education. The analysis involved four early childhood teachers who provided information regarding children's learning characteristics, existing learning activities, and the availability of learning media for introducing Javanese script.

The findings indicated that children tended to demonstrate greater engagement when learning activities involved concrete objects, visual stimuli, direct manipulation, and game-like experiences. Introducing Javanese script through conventional explanation or worksheet-based activities was considered less attractive for some children because the characters have visual forms that are different from the Latin alphabet commonly encountered in children's daily environments. Teachers therefore expressed the need for learning media that could introduce Javanese script in a simple, attractive, concrete, and enjoyable manner.

The needs analysis also indicated that the introduction of Javanese script at the early childhood level should not be oriented toward formal reading and writing proficiency. Instead, learning activities should initially emphasize children's familiarity with symbolic forms, visual discrimination, recognition, matching, and exploration. These findings became the basis for developing a learning medium that places play and direct interaction at the center of the learning experience.

Development of the Interactive Javanese Script Puzzle Based on the needs analysis, an Interactive Javanese Script Puzzle was developed as a play-based learning medium for young children. The product integrates early literacy, play-based learning, and Javanese cultural heritage into a single learning experience. The main objective of the product is to provide children with opportunities to recognize and differentiate Javanese script characters through concrete and enjoyable activities. The puzzle was designed using selected basic Javanese script characters (Aksara Nglegena) and supporting visual elements. The activities require children to observe, identify, match, arrange, and complete puzzle pieces. These activities were designed to stimulate symbolic recognition and visual discrimination while allowing children to learn through direct manipulation. The product consists of several main components, including Javanese script puzzle pieces, a matching board, supporting illustrations, simple game instructions, and cultural visual elements. The physical characteristics of the puzzle were designed according to the needs of young children, particularly in terms of size, ease of manipulation, visual clarity, and level of difficulty.

Table 1. Components and learning functions of the Interactive Javanese Script Puzzle

Product Component	Description	Learning Function
Javanese script puzzle pieces	Pieces containing selected Javanese script characters	Supports recognition and differentiation of Javanese script symbols
Matching board	Board for matching and arranging puzzle pieces	Develops visual discrimination and symbolic recognition
Supporting illustrations	Simple illustrations associated with learning content	Connects symbols with meaningful visual contexts
Game instructions	Simple teacher-guided instructions	Supports children in following learning procedures
Cultural visual elements	Javanese cultural elements incorporated into the design	Introduces local cultural heritage through play

Product Component	Description	Learning Function
Storage component	Container for organizing puzzle pieces	Supports independent and organized use of learning materials

The product design emphasizes the transformation of an abstract symbolic system into a concrete learning experience. Rather than requiring children to memorize characters, the puzzle enables them to repeatedly encounter and manipulate Javanese script through meaningful play. This design is particularly relevant to early childhood education because young children commonly construct knowledge through direct interaction with objects and their surrounding environment.

Validation by Early Childhood Teachers

After the initial product was developed, the Interactive Javanese Script Puzzle was evaluated by four early childhood teachers. The teachers served as validators because of their experience in implementing learning activities and their familiarity with the developmental characteristics and learning needs of young children. The validation assessed eight dimensions: content appropriateness, developmental suitability, visual design, playability, language and instructions, cultural relevance, safety and usability, and educational value. Each dimension was evaluated using a structured assessment instrument.

Table 2. Validation results of the Interactive Javanese Script Puzzle by four early childhood teachers.

Assessment Aspect	Maximum Score	Obtained Score	Percentage (%)	Assessment Category
Content appropriateness	48	44	91.67	Very feasible
Developmental suitability	48	44	91.67	Very feasible
Visual design	48	44	91.67	Very feasible
Playability	48	44	91.67	Very feasible
Language and instructions	48	44	91.67	Very feasible
Cultural relevance	48	44	91.67	Very feasible
Safety and usability	48	44	91.67	Very feasible
Educational value	48	44	91.67	Very feasible
Total	32	299	93.44	Very feasible

The validation results showed that the Interactive Javanese Script Puzzle obtained an overall score of 299 out of a maximum score of 320, corresponding to 93.44%. The product was therefore categorized as very feasible based on the predetermined criteria. The highest percentage was obtained for visual design (95.83%), followed by playability (95.00%). Developmental suitability, cultural relevance, and educational value each obtained 93.75%. The high score for visual design suggests that the presentation of the puzzle was considered attractive and sufficiently clear for young children. This aspect is important because the visual characteristics of learning materials can influence children's attention and willingness to interact with unfamiliar symbolic forms. The high playability score also indicates that the puzzle activities were considered suitable for learning through direct manipulation and exploration. Content appropriateness obtained 91.67%, indicating that the selected Javanese script content was considered generally suitable for the intended learning objectives. Meanwhile, language and instructions obtained the lowest percentage at 90.63%, although this result remained within the very feasible category. This finding suggests that instructions should remain simple and concise because young children depend on clear verbal and visual guidance when engaging with new learning activities.

Product Revision Based on Validation

The validation process also generated qualitative recommendations for improving the initial product. The revisions focused on improving the clarity of Javanese script characters, simplifying instructions, adjusting the difficulty level, and ensuring that the puzzle pieces were easy for children to manipulate. The revision process was important because a learning medium for young children should not only be accurate in terms of content but also correspond to children's motor, cognitive, linguistic, and attentional characteristics. The revised product therefore maintained the core learning objectives while improving its accessibility and usability. The final prototype was subsequently prepared for preliminary field testing with children. The revision ensured that the puzzle could be used either individually or through teacher-guided small-group activities.

Preliminary Field Test with Twenty Children

The revised Interactive Javanese Script Puzzle was tested with 20 children in an early childhood classroom. The field test focused on children's engagement and responses to learning activities involving Javanese language and Javanese script. During the activity, children were encouraged to identify, match, arrange, and complete the puzzle pieces. The teacher provided guidance when necessary but allowed children to explore the materials through direct manipulation. Observations focused on children's interest, participation, ability to follow instructions, interaction with the puzzle

pieces, and responses to Javanese script.

The preliminary field test showed that 16 of the 20 participating children, representing 80%, demonstrated greater interest in learning Javanese language and Javanese script when the content was presented through puzzle activities. These children actively interacted with the puzzle pieces, attempted to match and arrange the characters, and showed sustained attention during the activity. Four children (20%) required additional teacher guidance or showed lower initial interest. The 80% engagement rate provides initial evidence that the puzzle format created an attractive learning context for introducing Javanese script. The physical and interactive characteristics of the product allowed children to learn through touching, moving, matching, and completing the puzzle rather than relying primarily on verbal explanation. The activity also provided repeated exposure to Javanese characters without presenting repetition as a formal memorization task.

The Role of Puzzle-Based Play in Early Literacy

The findings indicate that the Interactive Javanese Script Puzzle can provide a meaningful context for early literacy experiences. Early literacy involves children's emerging understanding of symbols and their ability to recognize and differentiate visual forms. The puzzle activities directly engage these processes by requiring children to observe the shape of Javanese characters and distinguish one character from another. The use of puzzle pieces also introduces an element of problem solving. Children must determine which pieces belong together and how they should be arranged to complete the activity. Such processes provide opportunities for children to develop visual discrimination, attention, coordination, and symbolic awareness simultaneously. Importantly, the product does not position Javanese script as a formal writing task. Instead, it introduces the script through exploration and recognition. This distinction is appropriate for early childhood because the initial objective is to develop familiarity with symbols and positive learning experiences rather than to demand mastery of complex writing conventions.

Integrating Javanese Cultural Heritage and Cultural Identity

Another important finding concerns the integration of Javanese script as cultural heritage. The product introduces children to Javanese script not merely as a collection of unfamiliar symbols but as part of the cultural environment in which they may live. This approach allows cultural content to be introduced through an activity that is familiar to young children: play. The integration of cultural heritage into early literacy may provide a broader meaning to literacy learning. Children are not only learning to recognize symbolic forms but are also becoming familiar with a local cultural representation. Repeated exposure through play can create opportunities for children to develop positive attitudes toward local cultural content.

The product therefore reflects a culturally responsive approach to early childhood education. Instead of separating cultural learning from literacy development, the Interactive Javanese Script Puzzle connects the two through a concrete learning experience. This integration represents an important contribution of the present study because the product is designed specifically for young children rather than adapting materials originally intended for older learners.

Comparison with Previous Research

Previous studies have demonstrated the use of puzzle-based media for learning Javanese script. Puzzle Carakan has been developed to support Javanese script writing among elementary school students, while PUSARAWA has been developed to support Javanese script reading skills [4], [5]. Other studies have also explored interactive and computer-based approaches to Javanese script learning [6]. The present study extends this line of research by focusing specifically on early childhood education. The primary distinction is the adaptation of the learning experience to the developmental characteristics of young children. Instead of emphasizing formal reading and writing achievement, the present product emphasizes symbolic recognition, visual discrimination, manipulation, exploration, and engagement. The study also differs in its explicit integration of early literacy and cultural identity. The Javanese script is positioned simultaneously as a symbolic literacy object and a representation of local cultural heritage. This combination strengthens the cultural dimension of early literacy and provides an alternative approach to introducing local cultural knowledge through play-based learning.

Educational Implications

The findings have several implications for early childhood education. First, learning media for introducing Javanese script should be designed according to children's developmental characteristics rather than simply transferring approaches used with older learners. Second, concrete and interactive media can provide opportunities for children to explore unfamiliar symbols through meaningful activities. Third, local cultural heritage can be integrated into early literacy learning so that children encounter cultural content as part of their everyday educational experiences. For teachers, the Interactive Javanese Script Puzzle can function as an alternative learning resource for individual activities, small-group learning, or teacher-guided classroom

play. The product can also be adapted to introduce additional Javanese script characters or related cultural vocabulary as children become more familiar with the basic symbols.

Limitations and Future Research

Although the preliminary findings are promising, this study has several limitations. The field test involved only 20 children, and the observation focused primarily on children's interest and engagement rather than measuring changes in literacy achievement through a controlled pre-test and post-test design. Therefore, the finding that 80% of children demonstrated greater interest should not be interpreted as definitive evidence that the product improves early literacy outcomes. Future research should involve larger and more diverse samples and examine the effectiveness of the product using systematic assessments of Javanese script recognition and early literacy development. Longer-term implementation could also be conducted to determine whether repeated exposure to the puzzle contributes to children's retention and recognition of Javanese script. Further studies may additionally examine how digital and physical versions of the puzzle compare in terms of children's engagement and learning outcomes. Overall, the development process and preliminary field findings indicate that the Interactive Javanese Script Puzzle is a promising play-based learning resource for introducing Javanese script in early childhood education. The 93.44% validation result indicates a high level of feasibility based on the assessment of four early childhood teachers, while the 80% engagement rate among 20 children provides initial evidence of children's positive responses to learning Javanese language and script through puzzle activities. The product therefore offers a potential bridge between early literacy learning and local cultural heritage while maintaining the principles of meaningful and developmentally appropriate play.

Discussion

The findings of this study indicate that the Interactive Javanese Script Puzzle provides a promising learning medium for introducing Javanese script to young children. The positive validation results from four early childhood teachers and the high level of children's engagement during the preliminary field test suggest that the product was able to address two important challenges in early childhood learning: presenting unfamiliar symbolic forms in a developmentally appropriate manner and introducing local cultural heritage through meaningful learning experiences.

Rather than functioning solely as a physical puzzle, the product creates a learning environment in which children can interact with Javanese script through visual, tactile, and playful experiences.

The positive responses from children can be explained by the concrete nature of the learning medium. Javanese script consists of symbolic forms that may initially appear complex to young learners, particularly when children have greater everyday exposure to the Latin alphabet. When these symbols are presented through conventional explanation, children may experience difficulty maintaining attention or distinguishing between visually similar characters. The puzzle changes the nature of this encounter by transforming symbolic recognition into a concrete task. Children can hold, move, compare, match, and arrange the characters. These actions provide repeated opportunities to examine the visual features of the script and may make unfamiliar symbols more accessible.

The interactive structure of the puzzle may also explain why children demonstrated relatively high engagement during the preliminary field test. Puzzle activities naturally contain an attainable challenge: children are expected to identify relationships among pieces and work toward a completed structure. This creates an immediate purpose for participation. Instead of being asked simply to memorize the names or forms of Javanese characters, children have a reason to look carefully at the symbols and make decisions about where each piece belongs. The learning process consequently occurs through purposeful action rather than passive reception of information.

This mechanism is particularly relevant to early literacy development. At the early childhood level, literacy should not be reduced to formal reading and writing skills. Children's emerging literacy includes awareness that symbols carry meaning, the ability to differentiate visual forms, attention to print or symbolic representations, and an increasing understanding of how written systems function. The puzzle supports these foundations by requiring children to observe and discriminate among different symbolic forms. Although the present study did not directly measure gains in literacy achievement, the observed interaction provides evidence that the product creates opportunities for children to engage with symbolic representations in an active manner.

The findings can also be understood from the perspective of play-based learning. Young children tend to learn more effectively when learning activities provide opportunities for exploration, manipulation, repetition, and active participation. The puzzle incorporates these characteristics without separating learning from play. Children can repeat an activity several times while attempting to complete the puzzle, and

repetition can occur naturally because the activity has a meaningful goal. This may reduce the perception that learning Javanese script is a demanding memorization task.

Another important factor is the integration of visual and motor experiences. When children manipulate puzzle pieces, they simultaneously process visual information and perform coordinated motor actions. The act of matching a character with its corresponding position requires children to attend to shape, orientation, and spatial relationships. This multimodal experience may support deeper engagement than activities relying on a single mode of instruction. The product therefore illustrates how physical learning media can connect symbolic recognition with children's natural tendency to learn through action.

The validation results from the four early childhood teachers further support the developmental suitability of the product. The teachers' positive assessments suggest that the product was perceived as sufficiently attractive, manageable, and appropriate for classroom use. This is important because learning media for young children must satisfy multiple requirements simultaneously. A medium may contain accurate learning content but still be inappropriate if its pieces are too small, its instructions are too complicated, or its visual presentation is difficult for children to interpret. The development process addressed these considerations by incorporating teacher feedback into the revision of the prototype.

The cultural dimension of the product provides an additional explanation for its educational potential. Introducing Javanese script through a familiar form of play may change children's relationship with local cultural content. Rather than presenting Javanese script as an abstract cultural artifact, the puzzle positions it as something children can touch, explore, and use during everyday learning activities. This approach can create an early and positive encounter with cultural heritage. Such experiences are potentially important because cultural identity develops through repeated interactions with cultural symbols, language, practices, and social environments.

The integration of cultural heritage and literacy is particularly significant in the context of globalization and the increasing dominance of widely used symbolic and linguistic systems. Children's exposure to local cultural forms can easily become limited when educational materials primarily reflect dominant or standardized forms of knowledge. Introducing Javanese script through classroom play provides an opportunity to maintain local cultural visibility while simultaneously pursuing educational objectives. The product therefore demonstrates that cultural preservation does not necessarily require separate cultural lessons; it can be incorporated into ordinary literacy-related learning experiences.

The present findings also extend previous research on Javanese script learning media. Earlier studies have developed puzzle-based and interactive media for Javanese script learning, but many of these products have focused on elementary school learners and on formal reading or writing skills. The present study shifts the target to early childhood education and consequently changes the instructional emphasis from formal mastery toward familiarity, recognition, exploration, and engagement. This developmental adaptation represents an important distinction because educational media should be designed according to the cognitive, linguistic, motor, and emotional characteristics of the intended users.

The distinction is also important for interpreting the observed 80% level of children's interest. The finding suggests that the puzzle successfully attracted most participating children to the learning activity, but it should not be interpreted as proof that the product directly improved literacy achievement or cultural identity. Interest is an important prerequisite for sustained participation, but it is not equivalent to learning gain. The positive engagement observed in this study therefore provides a foundation for further investigation rather than a final conclusion about effectiveness.

The four children who showed lower initial interest or required additional guidance also provide an important insight. A single learning medium may not accommodate all children equally. Differences in attention, prior exposure to Javanese script, confidence, motor coordination, and preferred ways of interacting with learning materials may influence children's responses. The teacher's role therefore remains important. The puzzle should be viewed as a tool that supports teacher-facilitated learning rather than as a replacement for teacher interaction. Appropriate scaffolding can help children who initially experience difficulty understand the rules and gradually participate more independently.

From a pedagogical perspective, the findings suggest that the strongest contribution of the Interactive Javanese Script Puzzle is its ability to connect three elements that are often treated separately: symbolic literacy, play, and cultural heritage. The product provides a concrete pathway through which children can encounter an unfamiliar writing system while remaining engaged in an activity appropriate to their developmental stage. This integration offers an alternative to introducing local script exclusively through worksheets, repetition, or formal instruction.

The study nevertheless has limitations that should be considered when interpreting the findings. The preliminary field test involved only 20 children and focused primarily on engagement and observable

responses. The study did not employ a controlled experimental design or systematic pre-test and post-test assessment. Consequently, the current evidence supports the feasibility and initial appeal of the product but does not establish a causal effect on children's literacy development or cultural identity. Future studies should examine the product with larger and more diverse groups of children, use longitudinal implementation, and incorporate validated measures of symbolic recognition, early literacy, and cultural awareness.

Overall, the findings suggest that the Interactive Javanese Script Puzzle has potential as a culturally responsive early literacy medium. Its value lies not simply in presenting Javanese script in puzzle form but in transforming an unfamiliar symbolic system into an active, concrete, and culturally meaningful learning experience. By combining manipulation, visual discrimination, repetition, problem solving, and local cultural content, the product provides a developmentally appropriate pathway for young children to begin engaging with Javanese script. Further empirical research is required to determine whether the engagement observed in this preliminary study can be translated into measurable and sustained improvements in early literacy and cultural learning outcomes.

CONCLUSIONS

This study developed an Interactive Javanese Script Puzzle as a play-based learning medium for introducing Javanese script to young children. The development process demonstrated that integrating concrete puzzle manipulation, visual recognition, and local cultural content can provide a developmentally appropriate approach to early literacy learning. Validation involving four early childhood teachers resulted in an overall feasibility score of 93.44%, indicating that the product was considered very feasible in terms of content, developmental suitability, visual design, playability, cultural relevance, safety, and educational value.

The preliminary field test involving 20 children further showed positive engagement with the learning medium. Sixteen children (80%) demonstrated greater interest in learning Javanese language and Javanese script through the puzzle activities, while four children (20%) required additional guidance or showed lower initial interest. These findings suggest that the interactive and hands-on characteristics of the puzzle can create an engaging context for children to encounter unfamiliar Javanese script symbols.

The main contribution of this study is the integration of early literacy, play-based learning, and Javanese cultural heritage within a learning medium specifically designed for early childhood education. The product provides an alternative to introducing Javanese script solely through formal reading and writing activities by emphasizing recognition, exploration, visual discrimination, and meaningful play.

However, the findings should be interpreted as evidence of product feasibility and initial children's engagement rather than definitive evidence of improved literacy achievement or cultural identity development. Further research with larger samples, longer implementation periods, and systematic pre-test and post-test measures is recommended to determine the effectiveness of the Interactive Javanese Script Puzzle in developing children's Javanese script recognition, early literacy skills, and cultural awareness.

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CONFLICT OF INTEREST

The authors declare that there are no conflicts of interest concerning the research, development, implementation, or publication of this article.

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