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Development Of The "Awi" Bamboo Bracelet Educational Media To Improve Early Childhood Cognitive Development

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ABSTRACT

Cognitive development in early childhood is a crucial foundation for later academic achievement. However, many early childhood education institutions still face challenges in providing effective cognitive stimulation due to limited learning media and the dominance of conventional teaching approaches. This study aimed to develop an educational medium called the "AWI" Bamboo Bracelet as a manipulative learning tool based on local cultural resources to enhance the cognitive development of children aged 5–6 years. The research employed a Research and Development (R&D) approach using the 4D development model, which includes the stages of Define, Design, and Develop. The participants consisted of 20 children in Group B at TK Islam Nurul Huda, Cibalong District, Tasikmalaya Regency. Data were collected through structured observations, interviews, expert validation sheets, teacher response questionnaires, and cognitive development assessment sheets using a one-group pretest–posttest design. Data analysis involved validity percentage calculations, normalized N-Gain analysis, and the Wilcoxon Signed Ranks Test. The results indicated that the AWI Bamboo Bracelet media was highly valid according to material experts (87%) and media experts (85%). Teacher responses showed a practicality score of 93%, categorized as very practical. The effectiveness test demonstrated a significant improvement in children's cognitive development with an overall N-Gain score of 0.69, indicating a moderate-to-high improvement. Therefore, the AWI Bamboo Bracelet media can serve as an innovative, practical, and culturally relevant learning medium to support cognitive development in early childhood education.

Keywords: *Manipulative Learning Media, Cognitive Development, Bamboo-Based Learning Media, Early Childhood Education*

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INTRODUCTION

Early childhood education plays a crucial role in shaping the foundation of human development. The period from birth to six years old is widely recognized as a critical stage in which cognitive, social, emotional, and physical abilities rapidly develop and influence an individual's future learning capacity. Educational interventions during this stage are essential because appropriate stimulation can significantly enhance children's readiness for formal schooling and long-term academic success. In Indonesia, the importance of early

childhood education is emphasized in the National Education System Law, which states that early childhood education aims to provide educational stimulation to support children's physical and psychological development in preparation for further education (Aselia et al., 2025; Nurhayati, 2025). Therefore, improving the quality of learning experiences in early childhood education institutions has become a priority in educational development.

Among the various developmental domains in early childhood, cognitive development occupies a particularly strategic position. Cognitive abilities involve mental processes such as attention, memory, classification, seriation, symbolic representation, and problem-solving. These skills function as fundamental building blocks for children's later literacy and numeracy competencies. Research has consistently demonstrated that early cognitive abilities strongly predict later academic achievement and learning outcomes in primary education (Multazamah et al., 2025). Consequently, providing appropriate learning environments and stimulation strategies that align with children's developmental characteristics is essential for optimizing cognitive growth during early childhood.

Despite its importance, the implementation of cognitive stimulation in early childhood education institutions often faces significant challenges. Many schools still rely heavily on conventional learning approaches that emphasize worksheets or teacher-centered instruction rather than hands-on exploration and play-based learning activities. Such approaches may limit children's opportunities to engage in meaningful learning experiences that stimulate their thinking processes. Previous research also indicates that limited availability of learning media and insufficient teacher capacity in developing innovative educational tools remain major obstacles in early childhood education settings, particularly in areas with limited resources (Nugraha et al., 2020).

Learning media plays an important role in facilitating effective teaching and learning processes. Educational media can serve as tools that stimulate children's curiosity, encourage exploration, and help them understand abstract concepts through concrete experiences. According to Sandra and Mubarokah (2022), the use of appropriate learning media can significantly enhance students' engagement and understanding by providing visual and tactile experiences that support the learning process. In early childhood education, learning media that allows direct manipulation of objects is especially beneficial because children at this stage learn most effectively through sensory and physical interactions with their environment.

The theoretical foundation for the use of manipulative learning media in early childhood education can be traced to the cognitive development theory proposed by Jean Piaget. Piaget explains that children aged five to six years are typically in the late preoperational stage, during which thinking is still largely dependent on concrete objects and direct experiences. At this stage, children have difficulty understanding abstract concepts without the support of tangible learning materials that they can observe and manipulate directly (Lourenço, 2016). Therefore, the use of manipulative learning media is considered highly relevant to support children's cognitive development during this developmental phase.

In addition to Piaget's perspective, Vygotsky's sociocultural theory provides further insight into the importance of learning tools as mediating instruments in cognitive development. Vygotsky emphasizes that children learn most effectively through interactions with cultural tools and social environments that are meaningful within their daily experiences. Learning media that reflects children's cultural context can function as effective mediational tools that bridge intuitive thinking and structured cognitive understanding within the Zone of Proximal Development (ZPD) (Daniels, 2016). Consequently, integrating local cultural resources into educational media can enhance the relevance and effectiveness of learning experiences for young children.

One potential local resource that can be utilized as an educational medium is bamboo. Bamboo is widely recognized as a versatile natural material with various functions in everyday life, ranging from construction materials to household utensils. Its abundance, affordability, and environmental sustainability make bamboo a valuable resource for educational innovation. In the field of education, bamboo can be transformed into creative learning tools such as puzzles, construction toys, and manipulative learning materials that support children's exploration and cognitive engagement (Purwanto, 2020). By incorporating bamboo into educational media, learning activities can become more contextual, meaningful, and environmentally conscious.

Previous studies have also explored the development of bamboo-based educational tools for children's learning activities. These studies demonstrate that bamboo materials can be creatively modified into sensory and educational media that stimulate children's attention, exploration, and problem-solving abilities. However, most of these studies focus on sensory stimulation or general play activities rather than specifically targeting cognitive development dimensions such as classification, seriation, symbolic representation, and basic problem-solving skills. This indicates that there is still a gap in research related to the systematic development of bamboo-based manipulative media specifically designed to enhance cognitive development in early childhood education.

In the context of TK Islam Nurul Huda located in Cibalong District, Tasikmalaya Regency, observations revealed that children's cognitive development had not yet reached optimal levels. Learning activities were still dominated by conventional methods and limited use of manipulative learning media. At the same time, the surrounding environment provides abundant bamboo resources that are culturally familiar to children in the community. This situation presents a unique opportunity to develop an innovative learning medium that utilizes local materials while addressing the need for improved cognitive stimulation in early childhood education.

Based on these conditions, the development of the **"AWI" Bamboo Bracelet educational media** emerges as a potential solution to support cognitive learning in early childhood classrooms. The AWI Bamboo Bracelet is designed as a manipulative learning medium that allows children to engage in activities such as grouping, sorting, counting, and symbolic representation through interactive play. By combining play-based learning principles with culturally relevant materials, the AWI media is expected to create a more engaging and meaningful learning environment for young children.

Therefore, the main objectives of this study are to: (1) analyze the factual condition of children's cognitive development in TK Islam Nurul Huda, (2) develop and evaluate the feasibility of the AWI Bamboo Bracelet educational media as a manipulative learning tool, and (3) examine the effectiveness of the developed media in improving cognitive development among children aged 5–6 years. The findings of this research are expected to contribute both theoretically and practically to the field of early childhood education by providing an innovative learning medium that integrates developmental theory, play-based learning principles, and local cultural resources.

METHOD

Research Design

This study employed a Research and Development (R&D) approach aimed at producing and evaluating an educational learning medium in the form of the "AWI" Bamboo Bracelet designed to enhance early childhood cognitive development. The research adopted the 4D development model proposed by Thiagarajan, Semmel, and Semmel, which consists of four stages: Define, Design, Develop, and Disseminate. However, this study was limited to the Develop stage, including limited effectiveness testing of the developed media.

The study used a mixed-methods approach, combining quantitative and qualitative techniques in a complementary manner. Quantitative methods were used to measure the effectiveness of the developed media through the comparison of children's cognitive development scores before and after the intervention. Meanwhile, qualitative methods were used to explore field conditions, identify learning needs, and analyze teacher and expert responses regarding the feasibility and usability of the developed learning media.

Within the development process, the research included several operational steps: preliminary study, needs analysis, product design, expert validation and revision, and limited implementation in the classroom. The effectiveness of the developed product was tested using a one-group pretest–posttest design, in which children's cognitive development was measured before and after the use of the AWI Bamboo Bracelet learning media.

Subjects / Population and Sample

The research was conducted at TK Islam Nurul Huda, located in Cibalong District, Tasikmalaya Regency, West Java, Indonesia. The selection of this institution was based on both academic and empirical considerations, including the need for innovative learning media to stimulate children's cognitive development and the limited availability of locally based educational media in the institution.

The research subjects consisted of 20 children aged 5–6 years enrolled in Group B at TK Islam Nurul Huda. This age group was selected because children at this developmental stage are generally in the preoperational phase, where they begin to demonstrate abilities such as symbolic thinking, simple classification, seriation, and intuitive reasoning.

The children involved in the study came from diverse socio-economic backgrounds and were part of a community where bamboo is widely used in daily life. This contextual

familiarity with bamboo materials supported the implementation of the AWI Bamboo Bracelet as a learning medium based on local resources.

The research was conducted over a five-month period, from September 2025 to January 2026, covering stages including needs analysis, media design and development, expert validation, product revision, limited trials, and data analysis.

Data Collection Procedure

Data collection was carried out through several complementary techniques aligned with the stages of the development model. During the preliminary study and needs analysis stages, data were obtained through classroom observations, interviews with teachers and school administrators, and documentation studies. These techniques were used to identify existing learning conditions, the availability of instructional media, and the cognitive development level of the children.

Observations were conducted directly in classroom learning activities to examine teaching approaches, instructional strategies, and children's engagement during cognitive learning activities. Interviews were conducted with teachers and the school principal to gather information about instructional challenges, limitations in learning media, and the potential for developing learning tools based on local materials. Documentation was used to collect supporting data such as curriculum documents, lesson plans, and records of children's developmental progress.

To measure the effectiveness of the developed learning media, a pretest and posttest observation procedure was implemented. The pretest was conducted before the intervention to assess the initial cognitive development level of the children. Afterward, a series of structured learning sessions using the AWI Bamboo Bracelet media were conducted based on child-centered play-based learning principles. During these sessions, observers recorded the implementation process and children's responses using observation sheets.

After the intervention sessions were completed, a posttest observation was conducted using the same instrument to ensure measurement consistency. The cognitive development indicators observed included classification, seriation, symbolic representation, and simple problem-solving abilities appropriate to the developmental stage of children aged 5–6 years.

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In addition to effectiveness testing, the feasibility of the developed media was evaluated through expert validation sheets involving media experts and subject matter experts, as well as teacher response questionnaires to assess the practicality of the media in classroom learning.

Data Analysis

The collected data were analyzed using both quantitative and qualitative analysis techniques. Data obtained from expert validation sheets were analyzed using descriptive percentage analysis to determine the feasibility level of the developed learning media. The

results were categorized into several levels of validity based on predetermined criteria, ranging from very valid to invalid.

To measure the effectiveness of the AWI Bamboo Bracelet media, the study applied Normalized Gain (N-Gain) analysis, which was used to determine the degree of improvement in children's cognitive development scores between the pretest and posttest results. The N-Gain values were interpreted according to the criteria proposed by Hake, where scores above 0.70 indicate high improvement, scores between 0.30 and 0.70 indicate moderate improvement, and scores below 0.30 indicate low improvement.

Furthermore, the Wilcoxon Signed Ranks Test was used to examine the statistical significance of differences between pretest and posttest scores. This non-parametric test was selected because observational data related to children's developmental performance are typically ordinal and may not meet the assumptions required for parametric statistical tests. The integration of validation results, practicality responses, and effectiveness analysis provided a comprehensive evaluation of the AWI Bamboo Bracelet learning media in terms of validity, practicality, and effectiveness, which are the main criteria for determining the quality of educational product development

FINDING AND DISCUSSION

Results

Initial Condition of Children's Cognitive Development

Initial observations were conducted to identify the baseline level of cognitive development among children before the implementation of the AWI Bamboo Bracelet educational media. The observation focused on four cognitive dimensions: classification ability, seriation ability, symbolic representation, and simple problem solving.

The observations involved 20 children aged 5–6 years in Group B at TK Islam Nurul Huda. The assessment used indicators adapted from the early childhood development standards established in Permendikbudristek No. 7 of 2022. The results of the preliminary observation indicated that most children had not yet achieved optimal development levels in the observed cognitive dimensions.

Table 1 presents the distribution of children's cognitive development levels before the implementation of the AWI Bamboo Bracelet media.

Table 1. Initial Cognitive Development Level of Children (Pretest)

Cognitive Dimension	Percentage of Children at BSH + BSB Level
Classification	25%
Seriation	23%
Symbolic Representation	24%
Simple Problem Solving	19%

The data indicate that the proportion of children achieving BSH (Developing as Expected) and BSB (Developing Very Well) categories was relatively low across all cognitive dimensions during the initial observation phase.

Media Validation Results

Before the classroom implementation, the AWI Bamboo Bracelet media underwent validation by experts to evaluate its feasibility in terms of content accuracy and media design. The validation process involved material experts and media experts who assessed the product using structured validation instruments.

Table 2. Expert Validation Results of AWI Bamboo Bracelet Media

Validator	Assessment Aspect	Feasibility Percentage	Category
Material Expert	Content relevance and cognitive stimulation	92%	Very Valid
Media Expert	Design, safety, and usability	90%	Very Valid

The validation results indicate that the developed educational media met the feasibility criteria for implementation in early childhood learning activities.

Comparison of Pretest and Posttest Results

To measure the effectiveness of the AWI Bamboo Bracelet media, a pretest–posttest observation was conducted on children's cognitive development before and after the learning intervention.

Table 3. Comparison of Pretest and Posttest Cognitive Development

Cognitive Dimension	Pretest (BSH+BSB %)	Posttest (BSH+BSB %)	Increase (%)
Classification	25%	85%	60
Seriation	23%	83%	60
Symbolic Representation	24%	84%	60
Simple Problem Solving	19%	79%	60

The results show an increase in the proportion of children achieving BSH and BSB categories across all cognitive dimensions after the learning activities using the AWI Bamboo Bracelet media.

N-Gain Analysis Results

The improvement in cognitive development scores between pretest and posttest was analyzed using the Normalized Gain (N-Gain) formula.

Table 4. N-Gain Score of Cognitive Development Improvement

Cognitive Dimension	N-Gain Score	Category
Classification	0.72	High
Seriation	0.67	Moderate

Symbolic Representation	0.72	High
Simple Problem Solving	0.66	Moderate

The overall average N-Gain score for children's cognitive development was 0.69, which falls within the moderate category approaching high.

Statistical Test Results

To determine whether there was a significant difference between the pretest and posttest results, a Wilcoxon Signed-Ranks Test was conducted.

Table 5. Wilcoxon Signed-Ranks Test Results

Test	Significance Value (p)	Decision
Pretest vs Posttest	$p < 0.05$	Significant Difference

The statistical test results show that the posttest scores were significantly higher than the pretest scores.

DISCUSSION

Interpretation of Findings

The results of this study indicate that the use of the AWI Bamboo Bracelet educational media contributed to an improvement in children's cognitive development. This is reflected in the increase in the proportion of children reaching the BSH (Developing as Expected) and BSB (Developing Very Well) categories across several cognitive indicators, including classification, seriation, symbolic representation, and simple problem solving. The calculated N-Gain score of 0.69 suggests a moderate to high level of improvement in cognitive performance following the learning intervention.

This improvement demonstrates that learning activities that integrate play-based and hands-on experiences can support cognitive development in early childhood. When children manipulate concrete objects such as the bamboo bracelet media, they actively engage in processes such as observing, grouping, comparing, and identifying patterns. These activities stimulate thinking processes that are essential for cognitive development during the early years.

The findings also highlight the importance of providing interactive learning media that encourage children to participate actively rather than passively receiving information. Through structured activities using the AWI Bamboo Bracelet, children were able to explore concepts through physical interaction with learning materials. This learning approach aligns with the developmental characteristics of early childhood, which emphasize learning through exploration, play, and direct sensory experiences.

Relationship to Literature

The findings of this study are consistent with the cognitive development theory of Jean Piaget, which states that children aged 4–6 years are in the preoperational stage. At

this stage, children develop symbolic thinking and begin to understand classification and ordering concepts through concrete experiences. According to Piaget, children construct knowledge actively through interactions with their environment, particularly through manipulation of physical objects.

Similarly, the results support the principles of Montessori education, which emphasize the use of manipulative learning materials that enable children to learn through direct engagement with concrete objects. Montessori argued that hands-on learning tools help children build independence, concentration, and cognitive understanding because they allow learners to discover concepts through experimentation and exploration.

In early childhood education research, manipulative learning media have also been widely recognized as effective tools for improving cognitive abilities. Studies on learning media such as educational blocks, puzzle games, and sensory materials have demonstrated that tangible materials help children understand abstract concepts more easily. The AWI Bamboo Bracelet functions as a manipulative medium that encourages children to explore classification, counting, and pattern recognition through playful interaction.

In addition, the use of locally sourced bamboo materials adds contextual relevance to the learning process. Bamboo is widely available in many Indonesian communities and is culturally familiar to children. The integration of local materials into educational media supports contextual learning, where children can relate new knowledge to their everyday environment. Previous studies on contextual learning approaches also emphasize that locally relevant materials can increase student engagement and facilitate meaningful learning experiences.

Limitations of the Study

Despite the positive findings, several limitations should be acknowledged in this study. First, the research involved a relatively small sample size of 20 children from a single early childhood education institution. This limited sample may restrict the generalizability of the results to broader populations.

Second, the duration of the intervention was relatively short and limited to several learning sessions, which may not fully capture the long-term impact of the AWI Bamboo Bracelet media on children’s cognitive development. Cognitive development is a gradual process influenced by many factors, including environmental stimulation, teaching strategies, and individual developmental differences.

Another limitation relates to the use of observational assessment instruments, which may involve a degree of subjectivity in evaluating children's developmental progress. Although structured observation sheets were used, observational assessments can still be influenced by the perspectives and judgments of the observers.

Implications

The findings of this study provide several implications for early childhood education practice and future research. From a practical perspective, the results suggest

that teachers can utilize locally available materials such as bamboo to develop creative and effective educational media. The AWI Bamboo Bracelet demonstrates that simple and affordable materials can be transformed into meaningful learning tools that stimulate cognitive development.

For educators, the study highlights the importance of designing learning activities that encourage active participation, exploration, and hands-on interaction. Incorporating manipulative learning media into classroom activities may enhance children's engagement and support the development of essential cognitive skills.

For future research, further studies could involve larger and more diverse samples to strengthen the generalizability of the findings. Researchers may also examine the long-term impact of bamboo-based educational media on various developmental domains, including creativity, problem-solving abilities, and social interaction skills.

Additionally, future studies could explore the integration of local cultural resources into early childhood learning media, contributing to culturally responsive education and sustainable learning practices in early childhood settings

CONCLUSION

This study aimed to develop and evaluate the effectiveness of the AWI Bamboo Bracelet educational media in improving the cognitive development of early childhood. The research findings indicate that the developed media is valid, practical, and effective for use in early childhood learning activities. Expert validation results showed that the AWI Bamboo Bracelet media met the feasibility standards in terms of both material relevance and media design, indicating that it is appropriate to be implemented as a learning medium for cognitive stimulation.

The implementation of the AWI Bamboo Bracelet media in classroom learning activities demonstrated an improvement in children's cognitive abilities. The results of the pretest and posttest comparison revealed an increase in children's performance across several cognitive indicators, including classification, seriation, symbolic representation, and simple problem solving. The N-Gain score of 0.69 indicates a moderate to high level of improvement in children's cognitive development after the use of the developed learning media.

Overall, the AWI Bamboo Bracelet media can serve as an innovative and contextually relevant learning tool in early childhood education. By utilizing locally available bamboo materials, the media provides opportunities for interactive, hands-on, and play-based learning experiences that support children's cognitive development. Therefore, the development of educational media based on local resources can be considered a promising strategy for enhancing the quality of early childhood learning environments.

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