



Development of Digital Literacy-Based Educational Games in Introduction to Coding for Early Childhood

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ABSTRACT

In recent years, research has shown that coding learning in early childhood can support computational thinking, problem solving and learning engagement, especially through game-based learning and unplugged coding approaches. The presence of digital technology in children's daily lives requires the assistance of parents and teachers so that its use continues to provide optimal benefits. A number of studies show that children need to be equipped with 21st century skills from an early age, such as critical thinking, problem-solving, creativity, collaboration, and the ability to use technology wisely. Initial observations in the B4 group of the Madani Integrated Model State Kindergarten, East Palu District showed a low interest in learning children, which was characterized by a lack of attention to teacher instruction and the lack of knowledge of basic coding concepts. This condition indicates the need for digital integration through interactive and fun learning media so that the learning process becomes more interesting and able to increase children's understanding of coding concepts. This research aims to develop and test the feasibility of digital literacy-based educational game media to introduce basic coding concepts. This research uses a Research and Development (R&D) approach with the ADDIE model. The subjects of the study were 15 children of the B4 group (10 boys and 5 girls). Data collection techniques include observation, interviews, documentation, and validation questionnaires. The results of expert validation showed that media experts (95.3%), and material experts (98.2%) were very qualified. The implementation resulted in cognitive improvement, in the aspects of recognizing colors, shapes, and grouping shapes, there were no children (0%) in the BSB and BB categories, 10 children (66.7%) in the BSH category, and 5 children (33.3%) in the MB category. In the aspect of recognizing colors, shapes, and grouping shapes, children showed high enthusiasm in using educational game media. The development of educational games based on digital literacy has proven to be feasible and effective in introducing coding, improving the cognitive abilities of B4 children, and overcoming the lack of focus on children's learning.

INTRODUCTION

Early childhood education is the first step in learning. In recent years, research has shown that coding learning in early childhood can support computational thinking, problem solving and learning engagement, especially through game-based learning and unplugged coding approaches. The development of digital technology has brought significant changes in various aspects of life, including early childhood education. The presence of digital technology in children's daily lives requires the assistance of parents and teachers so that its use continues to

provide optimal benefits. A number of studies show that children need to be equipped with 21st century skills from an early age, such as critical thinking, problem-solving, creativity, collaboration, and the ability to use technology wisely (Cynthia & Sihotang, 2023). In this context, the introduction of programming is one of the important focuses in early childhood learning (Maharani dkk., 2020).

Children's introduction to digital media from an early age is an important step in supporting the learning process of using technology appropriately. Therefore, parents and teachers need to provide assistance carefully so that children get the optimal benefits of digital media. This assistance can be done through the selection of content that is safe and appropriate for the child's age, limiting the duration of use of digital devices and implementing parental controls on devices to prevent access to inappropriate content (Handayani, 2022).

Learning to code is closely related to *computational thinking* or computational thinking, which is a structured way of thinking in identifying and solving problems in a systematic way of solving problems. In general, learning coding in early childhood aims to foster 21st century skills, such as problem-solving, creativity, and critical thinking, while supporting the strengthening of basic literacy as the foundation of student development (Kurnia dkk., 2026). In the context of Indonesian education, coding integration is also seen as relevant to support the profile of Pancasila students from an early age.

Digital literacy capabilities are an important prerequisite for understanding the negative impact caused by the information explosion in the digital era. Therefore, learning about the use of technology from an early age is very important. Schools, parents, and play facilities must collaborate to help children become more proficient in using technology appropriately (Miranda dkk., 2022). The wrong use of digital technology can damage personal and social life. To support the formation of national character, increasing digital literacy is needed to foster a generation that is critical, insightful, and selective in choosing accurate and useful information (Naufal, 2021).

As attention to digital literacy increases, especially among teachers and parents, technological developments and changes in learning approaches have made a positive contribution to children's education. But on the other hand, these developments also raise new challenges, one of which is the decline in children's ability to maintain focus during the learning process (Jamilah dkk., 2025). In addition, the excessive use of digital media is also one of the factors that make it difficult for children to concentrate.

There is a growing need for coding education in Indonesia. The government emphasized that programming learning at the elementary school level needs to be implemented to prepare students to face the challenges of the digital era (Awaluddin & Hadi, 2025). However, in Indonesia, the implementation of coding learning at the PAUD level is still faced with a number of obstacles, including the limitations of digital devices, low coding competence among teachers and parents, and time constraints on the curriculum structure (Kumala dkk., 2023). This situation shows that there is a gap between the ideal need for early coding learning and the factual conditions in the field (Sayidina dkk., 2024).

Technology is becoming increasingly important in early childhood education. Technology helps children learn and understand what they are learning. Previous studies have underlined the importance of incorporating computer-based learning media, including online

educational games, to foster children's creativity and provide engaging and innovative educational experiences (Nataliani dkk., 2023). In addition, computer education and programming skills have been recognized as effective techniques for fostering creative thinking in children. For example, teaching parents or adults how to code can help them teach their children (Lutfina & Wardhani, 2020).

Through technology, children can learn to code in an interactive and fun way. Based on observations made by researchers at the Madani Integrated Model State Kindergarten in East Palu, the researcher found several problems, the researcher found that the application of digital media in the introduction of coding learning is still not optimally applied, and most children are still not interested in participating in learning. This is characterized by the attitude of children who do not follow the teacher's instructions and lack focus during learning activities. This condition will certainly have an impact on the teaching and learning process that is less than optimal, as well as the classroom atmosphere becomes less conducive and the learning goals are not achieved as expected. Based on these problems, the solution offered by the researcher is "Development of Digital Literacy-Based Educational Games in Introduction to Coding for Children in the B4 Group of the State Kindergarten Model Integrated Madani East Palu District".

The introduction of coding in early childhood is generally carried out through an approach that is in line with the characteristics of children's cognitive and psychosocial development, such as unplugged coding and the use of simple block-based applications. This approach allows children to gain an initial understanding of the basic concepts of programming through structured play activities, manipulation of concrete objects, and interaction with digital media that are visual and interactive. Through this process, children can gradually develop their *computational thinking*, such as pattern recognition, sequencing, and simple problem-solving, in a contextual and meaningful way according to the stage of development (Talitha dkk., 2025). However, this approach still has limitations in linking coding activities to the broader context of digital literacy, such as understanding the wise and interactive use of technology.

Other research findings reveal that the use of educational games can increase children's motivation and learning engagement because they are able to create fun and interactive learning experiences (Zeng dkk., 2020). Although some studies have shown that the use of educational games in the learning process has been proven to increase children's motivation and learning engagement. However, most of the research still focuses on the use of games as a general educational entertainment medium, not specifically integrating digital literacy and coding concepts in a single learning unit in early childhood. In addition, previous research has tended to focus on the aspect of the effectiveness of media use, not many have studied media development systematically using the ADDIE model which is equipped with expert validation and trials in early childhood in the context of digital literacy-based coding learning. Previous research has shown that educational games and coding learning separately can improve children's cognitive abilities. However, there are still limitations in the integration of digital literacy and coding in one learning medium that is in accordance with the characteristics of early childhood. Therefore, this research presents a novelty in the form of the development of digital literacy-based educational games that integrate the concept of coding through a systematic approach to play with the ADDIE model.

Based on the problems and gaps in the research, the solution offered by the researcher is "Development of Digital Literacy-Based Educational Games in Introduction to Coding for Children in the B4 Group of the State Kindergarten Model Integrated Madani East Palu District". This research presents *novelty* in the form of the development of digital literacy-based educational games that integrate coding concepts through a systematic approach to playing with the ADDIE model. The operational objectives of this study are: (1) analyzing the need for the development of digital literacy-based educational game media for coding introduction in B4 group children; (2) designing and developing digital literacy-based educational game media that is valid according to material experts and media experts; (3) implement the media in B4 group children; and (4) evaluate the feasibility and effectiveness of media in improving the ability to recognize colors, shapes, and classify shapes as basic coding concepts.

METHODS

This research uses *the Research and Development (R&D)* method, with the ADDIE development model covering the stages of analysis, design, development, implementation, and evaluation. The ADDIE model was chosen because it provides systematic work that allows the development of learning media products as well as testing their effectiveness in stages. The product developed is in the form of an educational game based on digital literacy in the introduction of coding for early childhood. The subjects of this study are all children in the B4 group of the Madani Integrated Model State Kindergarten, East Palu District. With a total of 15 subjects, consisting of 10 boys and 5 girls, with an age range of 5-6 years. This research was carried out in the odd semester of the 2025-2026 school year, to be precise in November-December 2025. The sampling technique used was *total sampling* because the population was relatively small and all members of the population were involved as product trial subjects. The research approach used is mixed methods, which combines qualitative and quantitative data descriptively. Qualitative data is used to analyze needs, obtain input from experts, and evaluate the process of using media. Meanwhile, quantitative data is used to measure the level of media feasibility and product use trial results.

The instruments used in this study include observation sheets to record children's ability to recognize colors, recognize shapes, and group shapes during the use of educational games. Observations were carried out on a development assessment scale (Very Well Developed, Developed as Expected, Starting to Develop, Not Developing). Expert validation questionnaires consist of two types: material expert validation questionnaire (covering aspects of subject matter, supporting information, display, and additional materials) and media expert validation questionnaire (covering aspects of cover form, media quality, and media function). Semi-structured interview guidelines are used to extract information from classroom teachers about learning needs, obstacles faced, and responses to the developed media. Documentation in the form of photos of activities, videos of trial implementation, and archives of daily learning implementation plans (RPPH). The validity of the questionnaire instrument was obtained through *expert judgment* by two validators (material experts and media experts) who also assessed the feasibility of the product. The revision of the instrument is carried out based on the validator's suggestions before use.

The development procedure to be carried out consists of five stages according to Sidabutar & Reflina (2022), namely *Analyze, Design, Development, Implementation, and*

Evaluation. The following is an image of the implementation of the development model *ADDIE*, as follows:

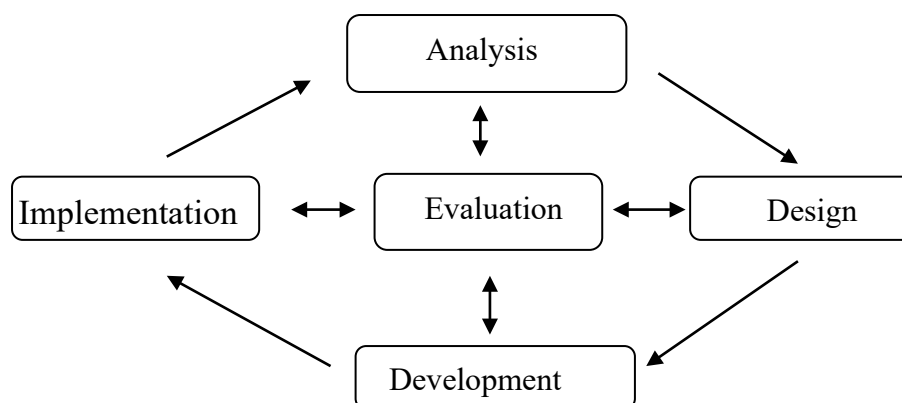


Chart 1. ADDIE Development Model

1. The Analyze stage will be carried out in October 2025 through observation and interviews with teachers in the B4 group. The analysis focused on identifying coding recognition needs, children's characteristics, availability of digital facilities, and learning barriers. The results of the analysis are the basis for product design.
2. Design Stage, After the analysis stage, the next step is to design a learning program. The researcher compiles a *game-flow flowchart*, creates an interface display storyboard, and creates learning materials (color recognition, shapes, and grouping shapes). At this stage, the technical specifications of the media are determined, namely an android-based application developed with Adobe Animate. As well as making a feasibility measurement instrument.
3. Development Stage, After the educational game media is made according to the design, validation is carried out by material experts (Dr. Andi Agusniatih, M.Si.) and media experts (Dr. Besse Nirmala, S.Pd., M.Pd.). The initial stage of validation resulted in suggestions for improvements, namely color replacement to a base color, addition of opening audio, and shape improvement. The media is revised and then re-validated at the final stage until it is declared feasible. After being considered suitable for trial, then the media is tested on users, especially the B4 group of the Madani Integrated Model State Kindergarten, East Palu District.
4. Implementation Stage, Product trials will be held on November 16–December 17, 2025 in group B4. The activity took place in three meetings, 45 minutes each. At each meeting, the children used educational games in turn with the assistance of researchers and teachers. Activities include playing games to recognize colors, recognize shapes, and group shapes through *smart TVs*.
5. Evaluation Stage, Evaluation is carried out formative (at each stage of development) and summative (after implementation). Summative evaluation uses observation data on children's abilities, children's response questionnaires, and expert validation results to determine the final feasibility of media.

The collected data was analyzed descriptively, quantitatively, and qualitatively. Qualitative data came from interview results, observation notes, and validator comments. This

data is analyzed through data reduction, data presentation, and conclusion drawing to revise the product and describe the implementation process. Quantitative data came from expert validation questionnaires and child response questionnaires. This study also involved two expert validators, namely media experts and material experts, the scores of the validators were calculated using a percentage formula with assessments using a rating scale, namely scores of 1 (not feasible), 2 (less feasible), 3 (feasible), 4 (very feasible). The validation data was analyzed by calculating the percentage of the eligibility score using the formula:

$$P = \frac{\sum R}{N} \times 100\%$$

Description:

P =Introduce yourself

Score $\sum R$ =Number of validator scores

N =Maximum total score

Table 1. Media Eligibility Assessment Percentage

AVERAGE SCORE (%)	CATEGORIES
0 - 25	Not Eligible
26 - 50	Less worthy
51 - 75	Worthy
76 - 100	Highly Worth It

The media developed is considered suitable for use in learning If the media has an assessment percentage of 51% to 100% or is considered very appropriate or very good, the media applied to the user is the PAUD child to be researched.

RESULTS

This research produces digital literacy-based educational game media in the introduction of children's coding described according to the stages of the ADDIE (*Analyze, Design, Development, Implementation, Evaluation*) development model. This research is described according to the stages of the ADDIE model, which was chosen for its simplicity and application in the development of research results. The following is an explanation of these stages:

1) Analyze

The results of the needs analysis showed that in the B4 group of the Madani Integrated Model State Kindergarten, the coding learning process was not optimal due to the limitations of digital media. Based on initial observations of 15 children, it was found that most of the children still had difficulty distinguishing shapes and colors and grouping them. Interviews with classroom teachers revealed that schools do not have adequate digital facilities (such as projectors or tablets) so learning tends to be monotonous. In addition, educational games can help children in knowing coding and children can solve problems well, so they will be very interested and actively learn in the classroom or at home.

2) Design (*Desgin*)

The design stage produces media specifications in the form of flowcharts, storyboards, and learning materials (introduction of 6 colors: red, yellow, blue, green, pink, purple; and 6 shapes: circle, rectangle, rectangle, triangle, triangle, trapezoid). The product is designed in the form of an Android-based application using Adobe Animate, with three main menus: recognize colors, recognize shapes, and group shapes. Educational game media is then assessed by material and media experts, to ensure that the media developed provides maximum benefits for children. The aspects assessed include the effectiveness of improving digital literacy-based educational game development skills in coding introduction for children, the safety of the media used, and the attractiveness of media in attracting children's interest in playing and learning. The evaluation tool used in this study uses an instrument in the form of a questionnaire to measure the validity of digital literacy-based educational game media in the introduction of coding for children.

3) Development

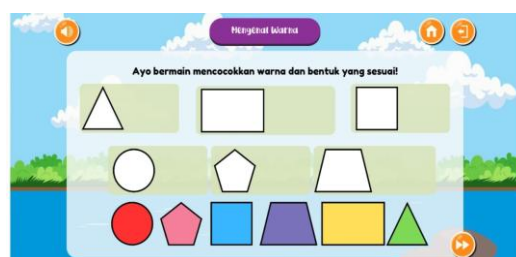
At the development stage of digital literacy-based educational games in the introduction of coding for children were successfully developed in accordance with the design that had been prepared. The following are digital literacy-based educational games in the introduction of coding for children:



(a) Cover



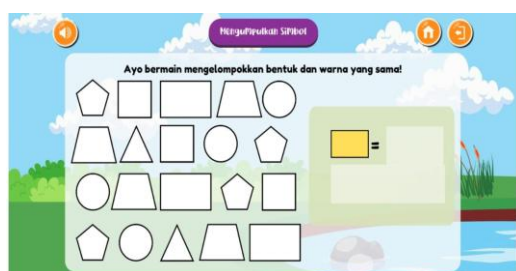
(b) Display



(c) Color game menu



(d) Game menu knows shape



(e) The game menu groups shapes



(f) Appreciation after completing the game

Figure 1. Educational Game Media Trial

Once the game is created, the next step is for experts in the field of materials and media to test its validity to see if digital educational game learning media is a good way to teach children how to code. After the questionnaire has been checked for accuracy, the media that has been created is sent to experts in the field of media and materials for further examination. Experts in the field of media gave a score of 95.3% (very decent), and experts in the field of materials gave a score of 98.2% (very decent). Here are the validation results from experts in the field of media and materials:

INSTRUMEN AHLI MEDIA
TAHAP KEDUA UJI COBA PRODUK AKHIR

"PENGEMBANGAN GAME EDUKATIF BERBASIS LITERASI DIGITAL DALAM PENGENALAN CODING BAGI ANAK DI KELOMPOK B4 TK NEGERI MODEL TERPADU MADANI KECAMATAN PALU TIMUR"

NO	BUTIR PERNYATAAN	PENILAIAN			
		1	2	3	4
A. Aspek Bentuk Cover Media Game Edukatif (Coding)					
1	Cover media Game Edukatif (Coding) sangat menarik				✓
2	Judul cover media Game Edukatif (Coding) mewakili isi game				✓
3	Ketepatan dalam penempatan judul cover media Game Edukatif (Coding)				✓
4	Ketepatan dalam penempatan ukuran tampilan cover media Game Edukatif (Coding)				✓
B. Aspek Kualitas Media Game Edukatif (Coding)					
5	Media Game Edukatif (Coding) yang dibuat tahan lama				✓
6	Game yang dibuat mudah dalam penggunaannya				✓
7	Kesesuaian usia dengan game, Game Edukatif (Coding)				✓
8	Semua fitur dan tombol navigasi berfungsi dengan baik (tidak ada yang bug atau error)			✓	
9	Kualitas audio (suara, musik latar, efek suara) jelas dan sesuai			✓	
10	Kualitas visual (resolusi gambar) tajam dan tidak pecah			✓	
11	Kesesuaian elemen game (tulis, seret, lepat) mudah dilakukakan			✓	
C. Aspek Fungsi Media Game Edukatif (Coding)					

12	Media Game Edukatif (Coding) membuat anak aktif dalam aktivitas memainkan game edukatif				✓
13	Media Game Edukatif (Coding) dapat meningkatkan aspek kognitif anak				✓
14	Media Game Edukatif (Coding) yang dibuat dapat meningkatkan problem solving anak				✓
15	Media Game Edukatif (Coding) yang dibuat dapat menarik minat dan antusias anak				✓
16	Media Game Edukatif (Coding) dapat memberi semangat bagi Anak Usia Dini (AUD)				✓

Catatan Perbaikan:

- 1.
- 2.
- 3.

Palu, November 2023

Ahli Media

Dr. Besse Nirmala, S.Pd., M.Pd

NIP. 198812202015042003

INSTRUMEN AHLI MATERI
TAHAP KEDUA UJI COBA PRODUK AKHIR

"PENGEMBANGAN GAME EDUKATIF BERBASIS LITERASI DIGITAL DALAM PENGENALAN CODING BAGI ANAK DI KELOMPOK B4 TK NEGERI MODEL TERPADU MADANI KECAMATAN PALU TIMUR"

NO	BUTIR PERNYATAAN	PENILAIAN			
		1	2	3	4
A. Aspek Materi Pokok					
1	Kesesuaian materi pada game edukatif (Coding)				✓
2	Kesesuaian (Kurikulum) materi dengan tujuan pengenalan coding bagi anak usia 5-6 tahun				✓
3	Kesesuaian materi dalam game edukatif (Coding) yang sesuai dengan konsep dasar coding bagi anak usia 5-6 tahun			✓	
4	Ketepatan dalam penggunaan indikator pada game edukatif (Coding)				✓
B. Aspek Informasi Pendukung					
5	Game berupa aplikasi yang digunakan tidak berbahaya				✓
6	Game yang ditampilkan menarik minat anak				✓
7	Game berupa aplikasi berbasis teknologi (Android)				✓
C. Aspek Tampilan					
8	Tampilan game edukatif (Coding) menarik perhatian anak				✓
9	Kesesuaian gambar, warna, simbol, bentuk, dalam game edukatif (Coding)				✓
10	Game edukatif (Coding) dapat dimainkan dengan mudah dan jelas				✓
11	Tiap pilihan level yang berbeda dalam game edukatif (Coding) dapat dipahami anak dengan baik dari game awal hingga game akhir				✓
D. Aspek Materi Tambahan					
12	Pengenalan Coding, serta pengembangan Problem Solving bagi anak				✓

13	Mengembangkan kemampuan mengenal warna dalam game, seperti warna Merah, Kuning, Biru, Hijau, Merah Muda, dan Ungu dalam pengenalan Coding bagi anak				✓
14	Mengembangkan kemampuan mengenal bentuk simbol, seperti simbol Persegi [□], simbol Persegi Panjang [▭], simbol Segi Tiga [△], simbol Lingkaran [○], simbol Bintang [☆], dan simbol Love [♥], pada game edukatif dalam pengenalan Coding bagi anak				✓

Catatan Perbaikan:

- 1.
- 2.
- 3.

Palu, November 2023

Ahli Materi

Dr. Andi Agustinthi, M.Si

NIP. 19690128 200112 2 001

(a) Media Member Evaluation Sheet

(b) Material Expert Assessment Sheet

Figure 2. Media Expert Validation Results and Material Expert Validation Results

At the development stage, the product is validated by media experts and material experts. The validation results are presented in the following Table 2:

Table 2. Validation Test Data

VALIDATOR	INTRODUCE YOURSELF	REMARKS
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Media Member	95,3%	Highly Worth It
Material Expert	98,2%	Highly Worth It

Based on table 2, the validation results show that the media obtained a score of 95.3% from media experts and 98.2% from material experts with the very feasible category. This is evidenced by the results of the assessment of the validation test of the development of digital literacy-based educational games in the introduction of coding for children. The media expert validation test consists of 3 aspects, including aspects of media cover form, media quality aspects, and media function aspects. 1) In the aspect of the form of coding educational game media covers, there are 4 indicators that are assessed, namely: Coding educational game media cover is very attractive, the title of the coding educational game media cover represents the game content, Accuracy in the placement of the coding educational game media cover title, and Accuracy in the placement of the display size of the coding educational game media cover. 2) In the aspect of the quality of coding educational game media, there are 7 indicators that are assessed, namely: Educational game media that is made durable, Games that are made easy to use, Age appropriateness with coding educational games, All button and navigation features work well (nothing bugs and errors), Audio quality (sound, background music, sound effects) is clear and appropriate, Visual quality (image resolution) is sharp and does not break, Match game elements (click, drag, drop) are easy to use. 3) In the aspect of the function of coding educational game media, there are 5 indicators that are assessed, namely: Coding educational game media makes children active in educational game playing activities, Coding educational game media can improve children's cognition, Coding educational game media that is made can improve children's problem solving, Coding educational game media that is made can attract children's interest and enthusiasm, Coding educational game media can encourage early childhood. The results of the validation test of educational game media experts obtained a percentage value of 95.3% with a very feasible category.

Furthermore, the material expert validation test consists of 4 aspects including the subject matter aspect, the supporting information aspect, the display aspect, and the additional material aspect. 1) In the aspect of the subject matter, there are 4 indicators that are assessed, namely: Suitability of the material in the coding educational game, Suitability (curriculum) of the material with the purpose of introducing coding for children aged 5-6 years, Accuracy of the material in the coding educational game in accordance with the basic concept of coding for children aged 5-6 years, Accuracy in the use of indicators in the coding educational game. 2) In the aspect of supporting information, there are 3 indicators that are assessed, namely: Games in the form of applications that are used are harmless, Games that are displayed that attract children's interest, Games in the form of technology-based applications (android). 3) In the aspect of display, there are 4 indicators that are assessed, namely: The appearance of educational games attracts children's attention, The suitability of images, colors, shapes, in educational games, educational games can be played easily and clearly, Each choice of different levels in the game can be understood well by children from the beginning to the final level. 4) In the aspect of additional material, there are 3 indicators that are assessed, namely: Educational games can introduce coding and can develop problem solving for children, Develop children's ability to recognize colors in games such as red, yellow, green, blue, pink,

and purple colors in the introduction of basic coding concepts for children, Develop the ability to recognize shapes such as square shapes, rectangles, circles, triangles, triangles, and trapezoidal shapes in educational games in coding introduction for children. The results of the validation test of educational game material experts obtained a percentage value of 98.2% with a very feasible category.

Based on the results of the validation test, media experts and material experts to determine the feasibility of educational game media to obtain results with categories that are very suitable for use. However, validation results have the potential to be biased due to the limited number of validators, so the assessment tends to be subjective depending on the perception of each validator. Therefore, further research is recommended to involve more validators to improve the validity of educational game media outcomes, as well as to use more robust experimental designs to comprehensively test the effectiveness of the media.

4) Implementation

This stage is carried out after validation by validators of material experts and media experts, after the media is developed and improved then tested in the B4 Group of the Madani Model Integrated State Kindergarten, with the participation of all children in the B4 group (15 children), aged 5 and 6 years. The purpose of this trial activity is to find out the extent to which digital literacy-based educational game media affects children's development, especially the ability of children to know *Coding*. The educational game media trial was carried out for three meetings, each meeting was held for 45 minutes.

The first meeting of the activity began with the researcher introducing himself, and greeting the children first, before the researcher introduced the educational game media to the children, the class teacher introduced and explained in advance the educational game media that would be tested to the children in the B4 group. Then the researcher explained the general picture of educational games that will be broadcast through *Smart TVs*. So that children can easily understand the explanations that have been conveyed. How to use educational games is also explained to children, before starting the core learning activities, learning outcomes, and learning objectives are conveyed first to children in the B4 group. After that, the researcher conducted an educational game media experiment for children in the B4 group alternately, each child accessed one of the games at the same level.

In the second meeting, learning began by asking material about digital literacy-based educational games in the introduction of *Coding* that had been delivered in the previous meeting. The researcher continues to provide direction to children in the use of educational games, so that children can easily use educational games through *Smart TVs* so that children can easily use educational games and can understand the basics of coding, recognize colors, recognize shapes, and can group appropriate shapes and colors, in these educational games. Then learning is carried out by playing educational games at the level of the educational game menu (Recognizing colors, Recognizing shapes, Grouping shapes and colors) in turn.

In the third meeting, the researcher asked about the educational game material that had been tested to children in the B4 group, then the researcher gave assignments to the children through LKA about *Coding* to recognize colors and shapes. The researcher observed the development of children in the B4 group through observations and children's responses

obtained directly from the field, in the form of activities using digital literacy-based educational game media in the introduction of coding in children in the B4 group.



(a) Explain how to use educational games



(b) Getting to know the colors



(c) Getting to know the colors



(d) Getting to know the shape



(e) Getting to know the colors



(f) Doing LKA Coding knows shapes and colors

Figure 3. Educational Game Media Trial

The trial was conducted on 15 children in the B4 group (aged 5–6 years) during three meetings (45 minutes/meeting). The data from the observation of children's abilities in three aspects (recognizing colors, recognizing shapes, grouping shapes) are presented in the following table 3:

Table 3. Results of Observation of Children's Abilities

Categories	Getting to know the colors	Getting to know the shape	Grouping shapes
BSB (0%)	0	0	0
BSH (66.7%)	10	10	10
MB (33.3%)	5	5	5

BB (0%)	0	0	0
<i>Remarks: BSB = Very Well Developed, BSH = Developed as Expected, MB = Started to Develop, BB = Not Developed.</i>			

The recapitulation of the results of the observation shows that there is a significant increase in children's cognitive abilities through the use of digital literacy-based educational games in the introduction of coding for children. In this study, 15 children were tested in three aspects: recognizing colors, recognizing shapes, and grouping shapes. Each aspect shows the same pattern of results. No children (0%) were in the BSB and BB categories, 10 children (66.7%) were in the BSH category, and 5 children (33.3%) were in the MB category, as shown in the histogram image below:

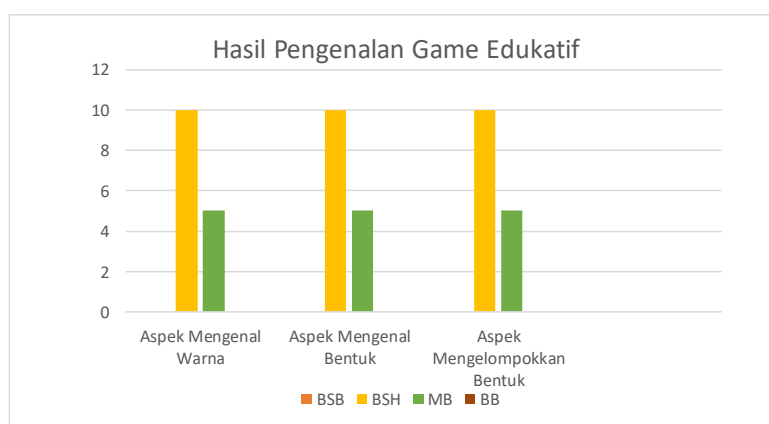


Chart 2. Histogram Results of Educational Game Data

5) Evaluation

The summative evaluation showed that the development goals were achieved, namely that educational game media was effective in improving children's cognitive abilities in recognizing colors, shapes, and grouping shapes. This is evidenced by the absence of children in the BB category (0%) and the majority (66.7%) are in the BSH category. In addition, the positive response from children (100%) indicates that this medium is interesting and motivating for learning. The weakness found is that children still find it difficult to recognize the shape of the trapezoid and the color purple, so it needs further strengthening.

DISCUSSION

The results of this study show that there is an increase in children's ability to recognize colors and shapes, group the same colors and shapes, and understand the concept of coding, after using digital literacy-based educational game media in the introduction of coding for children. Children become more enthusiastic in following the learning process, when they are given concrete learning media. The findings indicate that attractive visual media is able to support children's understanding of the material better.

Educational games developed with an interactive visual approach (bright colors, animations, drag-and-drop activities) are in accordance with these characteristics, so that children can process information more easily. In addition, the improvement in children's

abilities (66.7% achieving BSH) also strengthens Vygotsky's theory of *zone of proximal development* (ZPD), which is with the help of the right media and teacher assistance, children can achieve a higher level of development than independent learning (Mustakimah, 2023). The absence of children in the BB category (0%) shows that this media is able to reach all children with various levels of early ability. However, the absence of children in the BSB category (0%) indicates that this media is not enough to encourage children to reach the highest level, so it is necessary to enrich the material or vary the level of the game.

Research results from Suhendro (2022), entitled "Coding Kids as a Step to Develop Digital Literacy for Early Childhood". The results of the study stated that the development of digital literacy for early childhood can be carried out by implementing coding kids with several stages, namely the preparation stage, the training stage and the evaluation stage. The program provides opportunities and training for children to hone basic technology skills, which are the foundation of digital literacy development. The goal is for them to grow into outstanding individuals who are ready to compete in this technological era.

The results of the study from (Talitha dkk., 2025), entitled "Implementation of Media Coding in Early Childhood Computational Thinking: A Literature Review". The results of this study state that various forms of coding media including unplugged activities, block-based digital applications such as Scratchjr, educational games, and simple robotics have strong effectiveness in improving the computational thinking (CT) skills of children aged 5-6 years.

Research Results from (Bendriyanti dkk., 2025), entitled "Basic Introduction to Coding Training Based on Educational Games for Early Childhood Teachers as an Effort to Foster the Spirit of Early Childhood Leadership in Rejang Lebong Regency". The results of this study stated that this training succeeded in improving the understanding and skills of PAUD teachers in introducing the basics of coding through educational games. In addition, this activity is effective as a strategy to foster the spirit of early childhood leadership through the decision-making process, collaboration, and communication in coding activities.

Research results from Dayurni & Rahmadani (2025), entitled "Development" *Gameboard MIKO (Coding Mission) as a Learning Media Coding Unplugged For Early Childhood 5-6 Years*". The results of the study stated that the MIKO Gameboard is a feasible, practical, and effective learning medium for coding to introduce basic coding concepts to early childhood, especially in the aspects of sequencing, pattern recognition, debugging, and problem solving.

The results of the research from (Darwati dkk., 2025), titled "Critical Thinking Profile in Coding Learning for 6-Year-Old Early Childhood Educational Students". The results show that interactive learning and digital technologies such as programming are very effective in increasing creativity, problem-solving, and analytical skills in childhood. By integrating technology as an important learning medium in today's digital era, this research opens up new horizons for early childhood development.

In addition to the above studies, these findings are also supported by various other relevant studies. First, research from (Berliana dkk., 2024) It shows that educational games are effective in improving the ability to recognize geometric shapes, in line with our findings that educational games improve the ability to recognize shapes in children. Research Research (Zeng dkk., 2020) emphasizing that educational games integrate knowledge with games so that

they motivate learning, which we prove by the 100% positive response from children. Research (Sugiana dkk., 2023) found that teachers' paradigms about coding are still low, so that media like the one we developed can be a practical solution for teachers who do not have coding skills. Research (Huda dkk., 2024) about the analysis of web-based digital literacy educational games show an increase in students' digital literacy, in line with the focus of digital literacy in this study. Overall, the study not only reinforces the previous findings but also complements them with the integration of three components in a single product that was systematically developed using the ADDIE model, accompanied by expert validation and field trials.

In a study conducted by (Fitriyah dkk., 2021), explained that one of the solutions to overcome the decline in student learning motivation is to provide educational games as well as make it an assessment tool in measuring students' abilities. Educational games are one of the learning media that really supports educators in the teaching and learning process. Educational games can be used to teach concepts, including digital literacy in an engaging and relevant way.

Theoretically, this research contributes to the development of early childhood learning theories in the digital era. This theory reinforces constructivism that children build knowledge through active interaction with the environment, where educational games play the role of a stimulating rich learning environment. In addition, this study supports the expansion of *the theory of multiple intelligences* (Gardner) that logical-mathematical and spatial intelligence can be stimulated through game-based coding activities. Practically, the implications of this research are: (1) for teachers, this medium can be an interesting and easy-to-use learning alternative without coding skills; (2) for schools, the results of expert validation (95.3% and 98.2%) show that this media is suitable for adoption in the independent curriculum; (3) for parents, this media can be used as a companion for learning at home while directing the use of gadgets to educational content; (4) for subsequent researchers, these development procedures can be replicated or modified for different contexts.

The advantages of this study not only reinforce previous findings, this study integrates educational games, digital literacy, and coding introduction in one learning platform specifically designed for early childhood. This integration is still rarely done in previous studies that generally only focus on one aspect. Educational game media is developed with an interactive visual approach, (colors, animations, and play activities) that is tailored to the cognitive development of children aged 5-6 years, so that it is more contextual than the abstract coding media. This research not only develops media, but also through systematic stages (analysis, needs, expert validation, and product trials) so that it will produce an academically tested product.

In addition to having advantages, digital literacy-based educational game media in coding introduction also has several disadvantages, First, the limited number of research subjects (only 15 children in the B4 group) can affect the generalization of research results. Second, the number of validators is limited (only 2 people: one media expert and one subject matter expert) so the potential for subjectivity bias is quite high. Third, the research time was relatively short (3 meetings, a total of 135 minutes) so it has not measured the long-term impact of the use of educational games on children's coding skills. These four studies did not use experimental designs (pretest and posttest) so the improvement could not be measured comprehensively.

Fifth, the lack of availability of digital devices such as tablets, computers, smartphones and internet connections. Children in areas with inadequate technological infrastructure are likely to not have equal access to this kind of learning.

Based on some of the opinions above, it can be concluded that digital literacy-based educational games in the introduction of coding for children, are learning media that can support the learning process and relevant learning media in the current digital era, as well as one of modern learning tools using technology to support the teaching and learning process. The existence of educational games, it is hoped that children can understand the learning materials easily and fun. This media not only improves cognitive understanding, but also children's motivation and learning engagement and children can balance between play and learning. Therefore, further research with a wider scope and more in-depth analysis is needed to strengthen these findings. and can balance between playing and learning. Further research is also recommended to test the effectiveness of media on other aspects of computational thinking such as debugging, algorithms, and collaboration, as well as adapt these media into various platforms (offline Android, iOS, web) so that they can be accessed by children in areas with limited digital infrastructure. Thus, digital literacy-based educational games can be one of the concrete solutions in preparing the alpha generation who are intelligent, creative, and technologically literate from an early age.

CONCLUSION

Based on the results of the research that has been conducted, it can be concluded that the development of digital literacy-based educational games in the introduction of coding for children in the B4 group has proven to be effective as an innovative learning medium. This media is able to increase children's focus, enthusiasm, and cognitive ability in recognizing colors, shapes, and grouping shapes appropriately. Thus, all research objectives have been achieved.

The practical implications for early childhood education (PAUD) are that digital literacy-based educational games can be an alternative learning media that is easy to use for teachers without special coding skills, while supporting the strengthening of digital literacy and the introduction of coding concepts from an early age in accordance with the demands of the 21st century. Teachers and schools are advised to integrate similar media in the independent curriculum as part of children's cognitive stimulation and *problem solving*.

Recommendations for further research are: (1) developing educational games for more complex coding competencies (such as *sequencing*, *debugging*, and simple algorithms); (2) apply the media to different age groups (e.g., 3-4 years or 6-8 years) to test the effectiveness across ages; (3) using experimental designs with control groups and long-term (*follow-up*) measurements to test capability retention; (4) involve more subjects from various socio-economic and geographical backgrounds to improve the generalization of results.

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