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Enhancing Critical Thinking in Early Childhood through STEAM-Oriented Busy Board Media: A Development Study

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Media Busy Board, STEAM Learning, Critical-Thinking Skill, Early Childhood

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Abstract

This study explores the development and effectiveness of STEAM-based busy board media in enhancing critical thinking skills among children aged 5-6 years. Using the ADDIE model, we created a dual-sided active board integrating science, technology, engineering, arts, and mathematics elements. This research examines the effectiveness of STEAM-based busy board media in improving critical thinking skills in 5-6-year-old children. The study utilized the ADDIE model to create a dual-sided board incorporating science, technology, engineering, arts, and mathematics elements. Conducted in Sidodadi Village kindergartens, the methodology included expert validations, trials, and pretest-posttest evaluations. The initial analysis highlighted the absence of specific media to foster critical thinking in this age group. The busy board was deemed feasible, appropriate, and safe by experts. Significant enhancements in children's critical thinking were observed, with post-test results indicating considerable progress. Statistical analysis using SPSS 22 confirmed the busy board's positive impact, emphasizing STEAM's role in early childhood education. The box panel received high effectiveness ratings in expert assessments (85.3%, 76.1%, 87.1%, and 67.7%). The hypothesis test significantly affected critical call thinking development (0.000 < 0.05). Both expert and user evaluations attested to its effectiveness, with trials showing notable improvements in early childhood critical thinking. However, the study was limited by its geographical focus and lacked long-term impact assessments. These results support the inclusion of sensory tools in early education and call for further investigation into their more comprehensive and action-oriented long-term benefits.

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Introduction

Early childhood is a pivotal period for providing the proper stimulation to foster all aspects of a child's development. According to Indonesia's Law No. 20 of 2003 on the National Education System, Early Childhood Education (ECE) aims to nurture quality human resources. This is achieved by stimulating children to grow and develop optimally for their age while also imparting early knowledge, skills, and abilities to prepare them for future education and challenges (Gunawan, 2019)

In the context of the 21st century's challenges, ECE curricula are increasingly focused on equipping children with problem-solving abilities, critical thinking skills, knowledge of information technology, and communication skills (Husain & Kaharu, 2020; Island et al., 2021). The rapid pace of globalization necessitates that human resources adapt and learn a variety of skills to more easily navigate daily challenges, including critical thinking (Choiriyah, 2022; Kiriktaş & Şahin, 2021; Rahmasari et al., 2021)

Experts generally agree that critical thinking involves the capacity to analyze, assess, evaluate, and solve problems through rational logic (Amalia & Wuryandani, 2020). However, for young children in the concrete preoperational stage, critical thinking means processing

thoughts based on experienced scientific processes instead of accepting or rejecting others' opinions and ideas (Christy, 2015). Synthesizing indicators of critical thinking and scientific methods reveal signs of critical thinking in children, including observing, analyzing, forming hypotheses, drawing conclusions based on facts, and communicating with others (Santín & Torruella, 2017). However, it has been noted that over the past two decades, 70% of high school students possess only minimal competencies in literacy, numeracy, and critical thinking skills (Fitri, 2021). This issue is partly attributed to the uneven distribution of educational facilities and resources, including learning media.

In Early Childhood Education, media is a pivotal tool in lesson planning, functioning as intermediaries in various forms such as humans, objects, or materials. This approach facilitates the acquisition of insights and information (Kristanto, 2016; Zaman et al., 2010). It is posited by Newby, Stepich, Lehman, and Russel that media act as messengers, aiding in communication and enhancing learning outcomes (Kristanto, 2016).

A critical component of this educational stage is the integration of STEAM (Science et al.) activities, which are instrumental in cultivating critical thinking skills in young children. This methodology enables children to delve into multiple disciplines under a unified theme. For instance, when exploring the theme of animals, children can learn about the science of animal growth, leverage technology in food processing, design animal enclosures through engineering concepts, express themselves in animal-themed art, and develop mathematical skills like measurement and pattern recognition (Gunawan, 2019; Hadinugrahaningsih et al., 2017; Hasbi, 2021). Additionally, the emphasis on play-based activities in STEAM learning fosters essential 21st-century skills such as technological proficiency, critical thinking, and innovationing good character (Nurdiana et al., al 2020). Furthermore, a conducive and safe learning environment supports children's exploration and comfort during STEAM (Wahyuningsih et al., 2019).

The practical implementation of STEAM learning involves meticulous planning, including the development of daily learning programs, the preparation of materials and media, and the design of strategies and techniques for the learning process. A critical factor in the success of STEAM learning is the careful selection and preparation of media, which aids in integrating scientific thinking, technology use, and problem-solving techniques for meaningful learning experiences (Hasanah et al., 2021; Ng et al., 2022).

A preliminary study conducted by researchers in all kindergartens in Sidodadi Village concluded that STEAM content had been implemented. However, media use is still not optimal, impacting the success of STEAM learning. Moreover, in the latest curriculum, namely, the independent curriculum, which is starting to be slowly implemented in every early childhood education institution, STEAM is one of the elements of maximized achievement. From the facts of findings in the field and the synthesis of theories and previous research studies, researchers provide ideas to develop one of the media containing STEAM material. They are assumed to be able to develop critical thinking skills by the demands of 21st-century potencies, namely critical thinking adapted to the age of 5–6 years, namely busy board media.

This aligns with previous research findings: busy board educational game tools train fine motor skills and cause pleasure when playing them (Yuliasari et al., 2020). After testing the effectiveness of their use in optimizing motor skills and sensory coordination, it was concluded that busy boards have a significant effect (Anugrah et al., 2021). Another finding in the field is that active board media not only affects one aspect of development but holistically has an impact on helping the development of other aspects of child development (Dimas & Akmal, 2022).

Despite the recognized importance and implementation of STEAM content in early education, gaps remain in the optimal use of media to support these learning objectives. Preliminary studies in Sidodadi Village kindergartens reveal that while STEAM content is incorporated, the media used is not yet fully effective, impacting the overall success of STEAM learning. This gap presents an opportunity for innovation in learning media, particularly in the

context of the evolving independent curriculum, which emphasizes STEAM as a critical component of early education.

This study aims to develop and evaluate the effectiveness of Busy Board media in STEAM learning environments for enhancing critical thinking skills in children aged 5-6 years. Busy Boards, traditionally used for sensory development in younger children, are reimagined here as multifaceted STEAM learning tools. This innovative approach, incorporating science, technology, engineering, art, and mathematics elements, is designed to engage children in a hands-on, exploratory learning process. By evaluating the impact of Busy Boards on critical thinking skills, this research seeks to contribute significantly to the field of early childhood education, offering insights and practical solutions for educators and policymakers in preparing children for the challenges of the 21st century.

Method

In this research, we aim to review relevant literature regarding the importance of agriculture-based learning programs in early childhood to increase young children's knowledge and interest in agriculture. The method used in this study was a scoping review using the Preferred Reporting Items for Systematic Reviews and Meta-Analyses Extension for Scoping Reviews (PRISMAScR) checklist (Tricco et al., 2018). This design uses several questions prepared using 5 of the six stages developed by Arksey and O'Malley (Arksey & O'Malley, 2005). The five stages are identifying the research question, identifying relevant studies, study selection, data extraction, and collating, summarising, and reporting the results (Levac et al., 2010). The ADDIE development model was explicitly used in this study. In English terms, the stages of the ADDIE model include analysis, design, development, implementation, and evaluation (Hidayat & Nizar, 2021). The steps of the ADDIE model development model for developing busy board media include analyzing problems and needs, designing media, developing them, implementing them, and then evaluating the application of active board media to develop critical thinking skills (Figure 1). The product produced in this development research in activity board met is tested for feasibility and effectiveness in developing the necessary thinking skills of children aged 5–6 years.

The population of this study is equivalent to kindergartens in Sidodadi Village. Using purposive sampling techniques (Cohrssen et al., 2021) or based on specific criteria, including the equivalent kindergarten starting to use an independent curriculum, having carried out the STEAM learning model, and having qualified facilities for implementing STEAM learning, this data was collected during the needs analysis and interview process. Then, six kindergartens were selected, which were sampled with a total of 145 children. Data collection techniques use observation and documentation. To test the feasibility of the busy board media product developed, a validation questionnaire was created aimed at expert judgment or media material experts and material experts as well as users, in this case, early childhood education teachers.

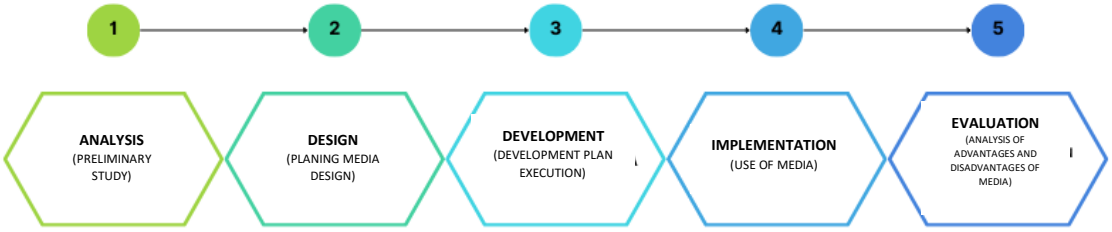

Figure 1. Stages of ADDIE Model Research

Material and media validation data collection using validation sheet guidelines intended for media and material experts. The criteria for experts are those who are fully dedicated practitioners or lecturers who have done much scientific work in the field of early childhood

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education. The data collected based on the total validation score is then calculated by a formula (Figure 2) to infer the eligibility category from each validator score result.

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

Figure 2. Validation Formula

Note:
P: Percent score
∑ : Amount
N: Maximum number of scores

The calculation results of expert validators, media, and users are divided into categories to assess the feasibility of the product developed, in this case, busy board media for STEAM learning, as illustrated in Table 1.

Table 1. Validation Results Category

Percentage Results	Category
81 - 100%	Very decent
61 – 80%	Eligible
41 – 60%	Decent enough
21 – 40%	Not feasible
1-20%	Not very feasible

Data collection on media validation, material validation, and users is carried out at the development stage. Details after the design stage that has been realized, assessed, and tested to users before the implementation stage directly to kindergartens. The validation grid intended for media experts, material experts, and users (teachers) to assess the resulting product, namely the STEAM learning busy board media, is presented in Tables 3., 4., and 5.

Table 3. Material Validator Grid

Indicator	**Item**	**Number Item**
Science	4 Item	1,2,3,4
Technology	3 Item	5,6,7
Engineering	2 Item	8,9
Art	4 Item	10,11,12,13
Mathematics	2 Item	14,15

Table 4. Media Validator Grid

Indicator	**Item**	**Number Item**
Visual Media	6 Item	1,2,3,4,5,6
Media Component	4 Item	7,8,9,10
Media Guide	4 Item	11,12,13,14

Table 5. User Questionnaire Grid

Indicator	**Item**	**Number Item**
Visual Media	1 Item	5
Materi Component	2 Item	2,3
Media Guide	1 Item	4
Children's Response	1 Item	6
Media Practicality and Effectiveness	1 Item	1

Furthermore, after the feasibility test, data collection by observation was done with children aged 5–6 years to determine the effect of busy board media on STEAM learning and critical thinking skills. Meanwhile, to test the influence of active board media to assess the necessary thinking skills of children aged 5–6 years, the data were tested with normality tests and hypothesis tests using SPSS 22 software. There are two hypotheses in this study, namely H0:

there is no influence of busy board media on the ability of children to think critically aged 5–6 years, and Ha: the impact of active board media on early childhood critical thinking skills.

Result

The results and discussion in this development research are described in 5 stages, namely: (1) the analysis stage, (2) design, (3) development, (4) implementation, and (5) evaluation.

3.1. Needs Analysis Stage

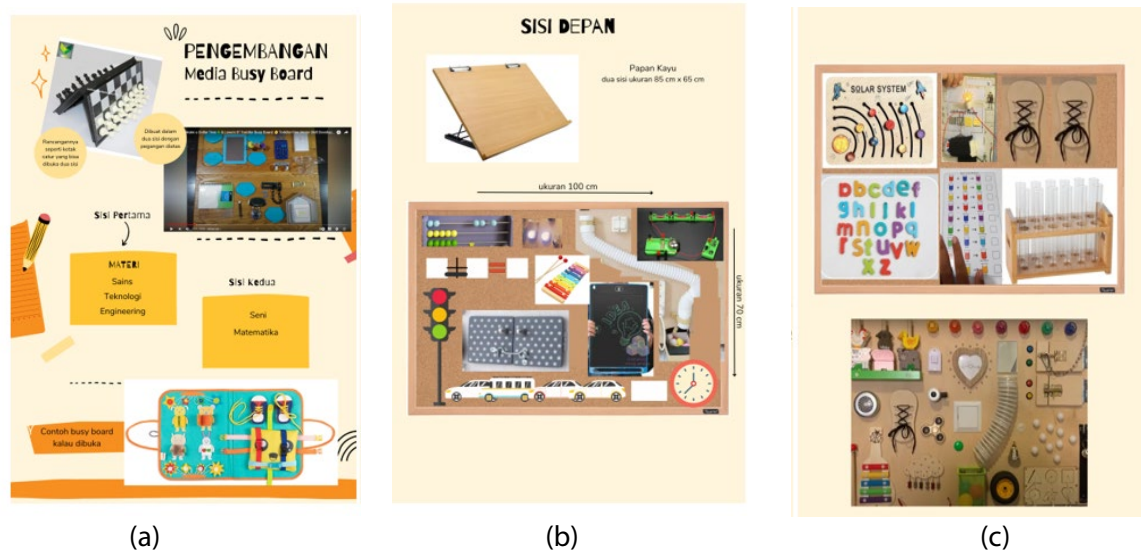
The preliminary phase of the research involved comprehensive exploratory studies through interviews, observations, and a thorough review of existing literature. This initial stage focused on identifying pertinent research related to the interplay of critical thinking variables, STEAM (Science et al.) education, and the utilization of busy board media. This was achieved by sourcing information from diverse scholarly materials, including books, journal articles, and conference proceedings. Natalina M. (2018) posits that critical thinking skills can be effectively nurtured. This is accomplished by encouraging children to question and actively listen to their perspectives and training them to articulate and justify their reasoning, enabling them to discover and analyze viable solutions to straightforward problems.

Field studies were conducted across six kindergartens in Sidodadi Village, with each institution nominating a representative teacher to serve as a respondent. The primary focus of these observations and interviews centered on various aspects of kindergarten activities, challenges encountered during the educational process, the implementation of STEAM learning in early childhood education, and strategies employed by educators to enhance critical thinking skills in children aged 5–6 years. The observations revealed that while all six kindergartens adhere to the K–13 curriculum, they have incorporated STEAM education elements and developed independent curricular foundations. It was noted that most kindergartens rely on teacher-created educational media. However, in the context of STEAM education, the media utilized were not fully integrated.

An analysis was conducted on 145 children aged 5–6 years, spanning various grades across the six kindergartens, to assess their preferences in learning media. The outcomes of this analysis are critical in shaping the development of media that stimulate critical thinking in early childhood. It was discovered that none of the kindergartens had previously employed specialized media to foster necessary thinking skills specifically. Instead, the stimulation of these skills was somewhat incidental, integrated into the general teaching and learning process. This approach was primarily due to inadequate resources and guidance for the teachers in this area. Consequently, the development of busy board media emerges as a potential solution to address these field-level challenges.

3.2. Design

Based on the needs analysis in the preliminary study, start designing the developed product. First, plan STEAM learning from materials and activities in busy board media. Second, creating active board media is practical, safe for children, and easy for teachers. Third, design a dynamic board display that is attractive to children. Engaging media for children significantly influences the success of early childhood education's teaching and learning process (Itsna et al., 2022). The busy board media design plan is attached in Figure 3.



(a) (b) (c)

Figure 3. Busy board media design (a) Busy board material design, busy board layout, and media opening and closing mechanism; (b) Details of busy board media design containing science, technology, engineering, art, and mathematics materials; (c) Examples of busy board media relevant to busy boards in STEAM learning

The busy media board is planned to have two sides. The first side is filled with science, technology, and engineering materials. At the same time, the other side contains art and mathematics materials. Busy board media is made with plywood board material of 100 cm x 70 cm; plan to open and close by rotating 180 degrees. This medium has two sides so that more than one child can play it, while the selection can be opened and closed so that the game material in the busy board medium is safer when moving places and carrying everywhere. This design stage also plans a guide in the form of a media booklet so that users can obtain information on the use of the developed busy board media equipped with instruments to measure critical thinking in children aged 5–6 years.

3.3. Development

This development stage is the realization stage of busy board media containing STEAM to develop the critical thinking skills of children aged 5–6 years. The media busy board is assessed by expert judgment, material experts, and media experts to test the product's suitability. The material expert in assessing busy board media is Dr.Ahmad Syukri, M.Pd. He is the secretary of the UINSU PIAUD Study Program, and Prof. Dr. Anita Yus, M.Pd., is a professor in early childhood education. Meanwhile, the expert judgment to assess the product's suitability is Eva Eriani, M.Pd and Khotimatul Majidah, M.Pd.

Table 6. Validation Results from Material Experts and Media Experts

Validator	Score	Percentage	Category
Material Expert 1	64	85,3%	Worthy
Material Expert 2	65	76,1%	Worthy
Media Expert 1	61	87,1%	Sangat Layak
Media Expert 2	59	67,7%	Worthy

Based on the results of calculations by material experts 1 and 2, the scores obtained were 64 and 65, with percentages of 85.3% and 76.1%, resulting in the categories "very feasible" and "decent". Media experts 1 and 2 got scores of 61 and 59, percentages of 87.1% and 67.7%, respectively, resulting in the categories "very feasible" and "decent." Busy board media is

categorized as "very appropriate" and "appropriate" based on the STEAM materials according to the child's needs, age, and culture around the child. This is in line with the theory of the DAP (Developmentally Appropriate Practice) approach, which increases enthusiasm for learning and involves four aspects: knowledge, scientific thinking skills, survival skills, and feelings for young children (Hasibuan et al., 2022).

Busy board media provides a learning experience to explore knowledge based on facts and explore using the five senses as a whole. Some of the STEAM material on busy board media includes children's ability to manipulate various technological components, find problems, and find solutions to these problematic situations, and this is included in the critical thinking indicators of early childhood (Purwaningsih & Wangid, 2021). Apart from material and media expert validation assessments, the busy board media assessment target targets users, practitioners, or teachers. The user assessment results obtained good scores; six representatives from kindergarten as users had percentages of 100%, 91.67%, 91.6%, 83.3%, 91.67%, and 100%.

Six users think 100% busy board media is accessible for teachers. The busy board is made from plywood and light wood and looks familiar to teachers. Furthermore, of the STEAM material on busy board media, 91% thought that the material was suitable for children aged 5–6 years. The same data is generated in easy-to-understand busy board media guide items. The guide booklet developed contains STEAM material, the use of busy board media, critical thinking indicators, and benchmarked evaluations to assess the critical thinking abilities of young children. The final result of the busy board product being developed can be seen in Figure 4.

(a) first side (b) second side

Figure 4. Results of developing busy board media in STEAM learning. (a) the first side of the busy board media for STEAM learning has been created; (b) the second side of the busy board media for STEAM learning has been created.

Instrument validity and reliability tests were carried out before the implementation stage to present a valid and reliable instrument for assessing the critical thinking abilities of young children. The instrument was tested on children aged 5–6 years to assess whether the items and statements used in testing the critical thinking abilities of early childhood children aged 5–6 years using busy board media were appropriate for measuring the variables studied. This analysis uses a two-sided test with a significance level of 0.05, an r-table value of 0.602, and a sample size of 108. The results of the validity test (Table 7) and reliability test (Table 8) are presented below.

Table 7. Validity Test Results of Critical Thinking Ability Instruments Children aged 5–6 years.

Item	Sig.	Label	Criteria
1	0,870	0,602	Valid
2	0,830	0,602	Valid
3	0,866	0,602	Valid
4	0,718	0,602	Valid
5	0,849	0,602	Valid
6	0,742	0,602	Valid
7	0,870	0,602	Valid
8	0,866	0,602	Valid

Based on the presentation in Table 7, Items 1–8 produce signs of 0.870, 0.830, 0.866, 0.718, 0.849, 0.742, 0.870, and 0.866, which means count> r table, so it can be concluded that the instruments from item 1 to item 8 are valid to use. Furthermore, a reliability test was carried out to measure research instrument items more accurately and consistently, which produced the following data (table 8). The reliability test on this research instrument was used to measure the device's accuracy.

Table 8. Reliability Test Calculation Results

Reliability Statistics	
Cronbach's Alpha	N of Items
.918	8

The resulting alpha value is 0.918, which means that the results of Cronbach's alpha reliability test calculation are > 0.7, and it is concluded that the reliability is perfect. The instrument items are consistent (Budiastusi, 2014).

3.4. Implementation

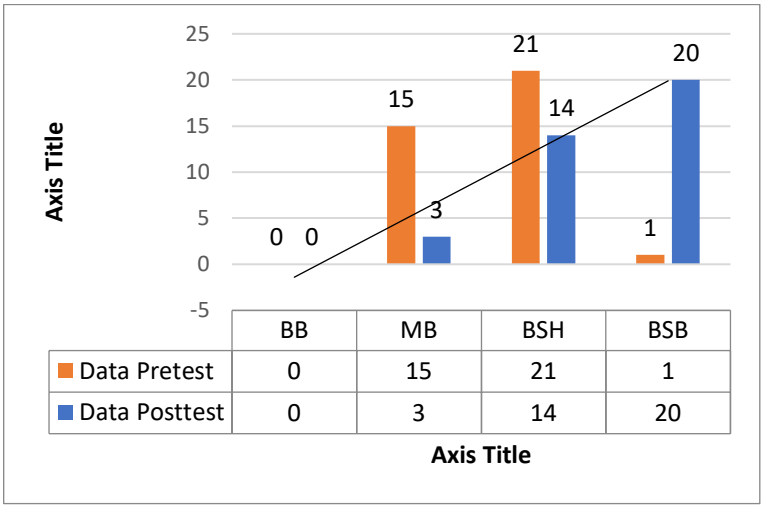
After the media development has been validated, the next stage is implementing STEAM learning with the help of busy board media. This stage is divided into two sessions: small-scale and large-scale. Small-scale trials were conducted in two kindergartens, Al-Hakim and RA Ar-Rahmah, totaling 37 children (Figure 5). Before the trials, teachers, as users and observers, received training and socialization regarding using busy board media, significantly optimizing thinking skills. Critical for children aged 5–6 years. The small-scale trial aims to obtain data about the product's feasibility based on the results of validation calculations by material and media experts. In practice, the specific aim of a small-scale test is to implement busy board media and examine and analyze whether busy board media needs to be corrected or improved before being implemented to a broader scope.

Based on the results of small-scale trial observations (Graph 1) using busy board media in STEAM learning to develop critical thinking skills, there are differences in pretest and posttest scores. Of the 37 children during STEAM learning using audio-visual media such as STEAM learning videos, one child received a score in the "Very Well Developing" category, 21 children in the "Developing According to Expectations" category, and 15 children in the "starting to develop" stage. According to the pretest results, using inappropriate media will hinder children's thinking processes. Even though it is visually attractive, early childhood education's teaching and learning process makes children passive. The lack of teacher involvement during the activity causes the class situation to become passive. Children seeing media only in one direction without any stimulants will hamper their scientific thinking process (Adawiyah et al., 2018). In contrast to the posttest results using busy board media, the "Very Well Developing" data amounted to 20 children. There has been an increase compared to without using busy board media. This is based on the fact that interactive media stimulates children to explore using their five senses. The use of the five senses to find out can be marked by questions that arise when

children play using busy board media. Besides that, busy board media encourages children to interact with other people by asking questions, exchanging opinions, or maintaining their assumptions in a simple context. The facts in the field align with appropriate media indicators, namely, producing a good and beneficial response for children (Zaman et al., 2010).

(a) Implementation of Small-Scale Trials (b) Implementation of Large-Scale Trials

Figure 5. Implementation of Small-Scale Trials



	BB	MB	BSH	BSB
Data Pretest	0	15	21	1
Data Posttest	0	3	14	20

Figure 6. Pretest and Posttest Results of Small-Scale Trials

Before dissemination at the next stage, input from teachers as busy board media users was collected to be improved in the subsequent trial. These improvements include the use of a security device on the media box so that the game material in the media remains on the busy board media box. Another suggestion is the need to prepare backup media for each material because not all media components can last long, considering that the media must be disassembled and assembled, plus the child's reaction to use is appropriate to the child's unique characteristics (Yunita et al., 2019)

Large-scale trials were carried out after improving the media in the limited trial stage, carried out in 4 kindergartens, namely RA An-Nur, TK Bunda Pertiwi, RA Bustanul Ulum, and RA Al-Abbas, with a total of 108 children. In the same scheme as the small-scale trial, the pretest and posttest results of the large-scale trial are depicted in Figure 6. Based on the results of the pretest and posttest calculations, children's critical thinking abilities increase after using busy board media. The data description of children in the "BSB" category on their critical thinking

abilities was 34 higher than the pretest results, namely before using busy board media, and data on children's development in the "Starting to Develop" category of 35 children. Their critical thinking abilities decreased and increased based on the results of the observations of 9 children. Data and facts in the field can be seen when children try to use their five senses to explore STEAM material on busy board media. To meet the need for high curiosity, teachers stimulate children by conducting questions and answers and producing responses in the form of opinions based on facts and data found while playing with busy board media. In line with previous research findings, new and rarely used media makes children ask questions, dare to try to find out and fulfill their curiosity. Moreover, this is supported by environmental settings and facilities that support their ability to think critically, meaning that children do not get information from informants but from interactive media, in this case, busy board media (Cohrssen et al., 2021).

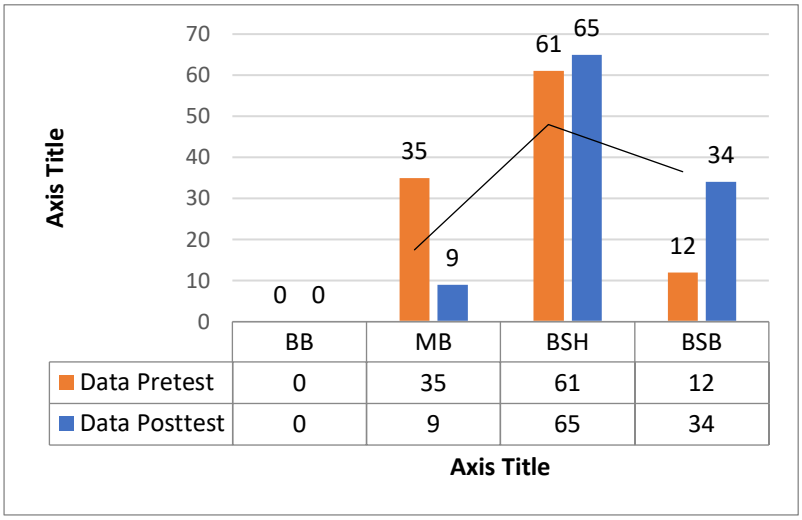


Figure 7. Pretest and Posttest Results of Large-Scale Trials

However, the indicator "defending one's opinion" requires encouragement and teacher assistance. The child's response when he successfully expresses his opinion is then refuted by his friend; the child is not yet able to defend and provide rationalization for the opinion he believes in. Even though the child's egocentric nature biases this (Novitasari et al., 2020), it is pretty representative of the child's openness regarding the point of view of things that the child understands. Then, a large-scale trial tested the effect of busy board media on the critical thinking abilities of young children by fulfilling the data normality test, test, and hypothesis test as described in Table 9 below.

Table 9. Normality Test

	Kolmogorov-Smirnov[a]			Shapiro-Wilk		
	Statistic	df	Sig.	Statistic	df	Sig.
Pretest	.133	108	.000	.959	108	.002
Posttest	.131	108	.000	.907	108	.000
a. Lilliefors Significance Correction						

Sig calculation results in 0.000 < 0.05 in pretest and posttest data, so it can be concluded that the data is not normally distributed. Hypothesis testing of the influence of busy board media on critical thinking skills was carried out using the t-test. The results of the statistical t-test are explained in Table 10. From Table 10, it is found that the t-test got significant results. 0.000 < 0.05, it is concluded that busy board media affects young children's critical thinking skills. The pretest and posttest data from large-scale trials conducted in 4 kindergartens show

an increase in the critical thinking abilities of young children. Apart from that, the resulting mean also experienced an increase in the teaching and learning process in early childhood education.

Table 10. T-Test Results

		Paired Differences			t		
		Mean	Std. Deviation	Std. Error Mean		df	Sig. (2-tailed)
Pair 1	Pretest Kemampuan Berpikir Kritis - Posttest Kemampuan Berpikir Kritis	3.11111	4.93762	.47512	-6.548	107	.000

The critical thinking abilities of young children during large-scale trials receive special attention in terms of analytical skills. The environmental setting is a factor in increasing this ability. This busy board medium is one of the facilities and tools suitable for stimulating analytical skills. The basis of children's analytical abilities is characterized by identifying relationships between one fact and another. STEAM learning material on busy board media includes the integration of five scientific disciplines; teachers give examples, stimulate children to ask questions, and help children to connect deep thinking habits regularly (Purwaningsih & Wangid, 2021). Directly, critical thinking habits also train children to include opinions based on logical and rational reasons. Children's logical and rational reasoning develops through tools, learning experiences, stimulation from teachers and parents, and setting a good learning environment so that children do not easily influence other people's wishes and can choose yes or no, accept or reject, continue or stop (Priyanti & Warmansyah, 2021).

3.5. Evaluation

The evaluation process for using busy board media containing STEAM content is carried out during the teaching and learning process in the form of input and suggestions from the teacher. Evaluation can be seen in the child's response when playing using the developed busy board medium. Direction from the teacher and supervision from adults around the child help optimize young children's critical thinking skills by using engaging media, one of which is the busy board media developed in this research.

Discussion

The development of busy board media in STEAM learning addresses a significant gap in early childhood education, particularly in fostering critical thinking skills in children aged 5-6. The necessity for such innovative educational tools was underscored by the lack of specific media for developing critical thinking skills, as observed in Sidodadi Village kindergartens. The research question probes the impact of busy board media on enhancing these critical thinking skills, a query rooted in the intersection of education, cognitive development, and early childhood learning methodologies.

The study's results reveal a significant enhancement in critical thinking skills among children utilizing the busy board media. Notably, the posttest outcomes showed marked improvements in categories such as "Very Well Developing" and "Developing According to Expectations." These findings are crucial, as they provide empirical support for the busy board's effectiveness. The dual-sided design, incorporating elements of science, technology, engineering, art, and mathematics, proved engaging for the children and effective in stimulating their cognitive abilities. Such results were anticipated but underscored the media's practicality and attractiveness (Anugrah et al., 2021).

Annisa Putri Dimas and Nur Akmal also shared relevant research results in 2022, who studied busy board media and found that active board media increased children's enthusiasm for teaching and learning. The changing variety of materials also attracts children's attention to

learning new things. Busy board media is an alternative creative, innovative, and fun medium to be implemented in early childhood education institutions (Dimas & Akmal, 2022).

Furthermore, the advantage of busy board media is that it provides sensory stimulation. Busy boards provide sensory stimulation through various materials, textures, and elements. It helps children's sensory development, including touch, hearing, and vision. Specifically, the busy board media designed for STEAM learning in this research is affordable and has adequate portability. The busy board medium in STEAM learning is made in a medium size. It can be played by more than two children, made on two sides, to minimize the fighting that often occurs among children due to their egocentric attitudes (Cohrssen et al., 2021). Apart from that, this medium is also easy to move, so that it can be used in various locations at home, school, and traveling.

In several studies, busyboard media only focuses on motor skills. However, the development of busy board media for STEAM learning is designed to stimulate the critical thinking abilities of children aged 5–6 years. Starting from the initial observation process, children are given busy board media. Then, they can see, hear, and feel various stimulations from the media presented. From the observation process, basic concepts and questions about the child's curiosity began to emerge. These questions encourage children to look for existing facts and provide initial hypotheses for their questions. This aligns with the steps in scientific thinking mentioned by various experts in several previous studies (Purwaningsih & Wangid, 2021).

Materials containing science, technology, engineering, art, and mathematics (STEAM) allow children to experiment and make more profound observations. They might try mixing colors to see what happens or assembling wooden blocks to understand how they function. During this process, they may also seek adult guidance (Santín & Torruella, 2017). After the experiment, children try to evaluate the results. They try to understand what happened, identify errors in their thinking, and perhaps seek additional information to understand the phenomenon better. The critical thinking process also involves children's ability to solve their problems. They may try several different approaches to achieve their goals.

The results hold significant educational implications. They suggest that integrating STEAM elements into early childhood education through practical interactive media can substantially improve critical thinking skills. This finding is particularly relevant in modern education, which increasingly emphasizes the importance of STEAM learning. However, while the results are promising, they should be interpreted cautiously. The study's context and the busy board media's specific characteristics might limit the findings' generalizability. Therefore, further research in diverse settings is recommended to validate these results.

The implications of this study are far-reaching for the field of early childhood education. It underscores the potential of well-designed educational tools, like the busy board media, to enhance young children's critical thinking skills. This aligns with the growing recognition of the importance of STEAM education in early learning stages. Educators and curriculum developers can draw from these findings to integrate similar media into educational settings, thereby enriching the learning experience for children. Furthermore, this research contributes to the broader discourse on educational innovation, advocating for a more interactive, multisensory approach to teaching methodologies. These insights can guide future research and practice in developing practical educational tools for young learners.

Conclusion

In this study, we aimed to develop busy board media for STEAM learning to enhance critical thinking skills in children aged 5-6 years, and our findings have been significant. The busy board media feasibility test was assessed by expert judgment, and the results were suitable for use and application for children aged 5–6 years. Based on the results of expert judgment validation of

material and media, namely 85.3%, 76.1%, 87.1%, and 67.7%, Testing the hypothesis of using busy board media resulted in a value of 0.000 < 0.05, indicating that busy board media in STEAM learning affects the critical thinking abilities of children aged 5–6 years. A thorough needs analysis revealed a gap in specialized media for developing these skills, creating a dual-sided busy board incorporating STEAM elements. Expert and user assessments affirmed its feasibility and effectiveness, with trials showing marked improvements in children's critical thinking categories. These findings highlight the potential of well-designed educational tools in early childhood education, particularly in fostering STEAM skills. However, the study's limitations suggest further research, including its limited geographic scope and the absence of long-term impact assessments. Future studies should explore such tools' broader applicability and sustained effects, offering valuable insights for educators and curriculum developers and contributing to the evolution of interactive, multisensory teaching methodologies.

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