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Development of Interactive STEAM Storybook to Improve Critical Thinking In 3rd Grade

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Abstract

The research aims of this study are to develop the storybook STEAM-based learning (Science, Technology, Engineering, Arts, Mathematics) for mathematic learning to improve critical thinking skills in grade 3 students in Elementary Public School Bringin 02. This media was developed based on the STEAM approach, so the use of media through the syntax of analyzing, synthesizing, making conclusions, and organizing strategies and tactics. The excellence of this innovative work focuses on improving critical thinking skills and scientific literacy skills. The excellence of this innovative work focuses on improving critical thinking skills. The type of research is Research and Development (R&D) using the Borg and Gall development model. The STEAM Activity: The Three Sides of My Family learning media is deemed suitable by three experts, including a children's literature expert with a 91% rating in the excellent category, a media expert with a 96% rating in the excellent category, and a content expert with an 82% rating in the excellent category. The STEAM Activity book is considered practical by students at Public School Bringin 02, receiving a 100% rating in the excellent category. Using an independent samples t-test, the effectiveness is found to be significant at 0.013, indicating that the STEAM Activity book is effectively used to enhance students' critical thinking skills.

INTRODUCTION

In Indonesia, the Kurikulum Merdeka is the curriculum used today. The independent curriculum focuses on character development and 21st century skills (Pendidikan et al., n.d.). Elementary school students are encouraged to develop critical thinking skills as one of the 21st century skills emphasized in the learning process (Chumdari, 2021). The Kurikulum Merdeka encourages students to think critically by providing them with opportunities to explore concepts and ideas in-depth (Anggraena, 2022). According to Ennis, as cited in Marini & Wihardjo (2020), critical thinking encompasses several categories: elementary clarification (analyzing), basic support (synthesizing), inference (making conclusions), advance clarification, and organizing strategies and tactics. One way to promote critical thinking skills in elementary school students is through the use of STEAM (Science, Technology, Engineering, Arts, and Mathematics).

STEAM media refers to various resources, including books, activities, and educational materials, that incorporate elements of Science, Technology, Engineering, Arts, and Mathematics to promote learning and critical thinking skills in children. STEAM media can include STEAM storybooks, hands-on activities, and educational resources that encourage children to explore and experiment with STEAM concepts (Twiningsih & Elisanti, 2021). Wahyuseptiana et al., 2022 state that implementation of the STEAM approach can contribute to developing critical thinking skills in children and certainly provides opportunities for students to be able to think critically so that later students can decide on a choice of problems that occur in the surrounding environment. Making STEAM-based interactive books provides experiences to students regarding: 1). Science: learning about science focuses on oneself, natural phenomena, and the surrounding environment. Students are able to explore and observe the surrounding environment to train students in improving their thinking skills. 2). Technology: human innovation used to

modify nature to meet human needs and desires in improving the quality of life. Students can use simple technology in solving the problems found. 3). Engineering: Knowledge to operate or design a problem. The use of scientific principles and mathematical reasoning in optimizing technology to meet needs based on predetermined criteria and limits. 4). Art: Student creativity in solving problems and producing works. 5). Mathematics: Knowledge of patterns and relationships to solve a problem. Usually math is related to numbers, shapes, and patterns.

Based on the preliminary research on Public School Bringin 02, it was found that there was a lack of STEAM-based learning media, especially STEAM interactive storybooks. Interactive storybooks encourage learners to be more active by engaging in activities while reading. This aligns with research explaining that interactive picture storybooks are illustrated books with interactive elements such as games accompanied by questions related to the storyline, encouraging learner involvement (Langi & Setyaningtyas, 2022). Th According to the definition from The New Oxford Dictionary of English mentioned in the study by (Siregar et al., 2020) an interactive book is a learning material that facilitates a two-way flow of information between the reader and the book itself. In this context, "two-way flow" signifies the interactive exchange of information between the book as a learning tool and the reader. There are several types of interactive books available: 1). Interactive books with paper engineering, also known as movable books, incorporate techniques like folding and cutting paper on their pages, creating interactions between readers and the book. Various forms of paper engineering include pop-ups (featuring folded or cut paper sections that can stand or form three-dimensional shapes on the pages), pull tabs (featuring pullable paper elements), lift-the-flap (featuring parts of the page that can be opened to reveal surprises inside), and volvelles (featuring rotating parts on the pages). These elements enhance reader engagement and interaction with the book. 2). Interactive peek-a-boo books are designed to engage readers by requiring them to open the pages to discover surprises hidden inside. 3). Interactive participation books feature explanations or stories accompanied by questions and answers or instructions, encouraging readers to actively engage with the content to test their understanding of the information or story presented in the book. 4). Interactive hidden objects books invite readers to find concealed objects by following the storyline on each page of the book. 5). Interactive play-a-song or play-a-sound books are equipped with buttons when pressed, produce sounds such as songs or noises related to the story within the book. 6). Interactive touch and feel books are designed especially for preschool children, aiming to develop their interest in exploring textures. These books typically feature tactile elements like soft feathers on a bird's picture, encouraging children to touch and explore different textures as part of their learning experience. 7). Interactive mixed books are interactive publications that combine elements from various interactive book types. These books integrate features such as movable parts, peek-a-boo surprises, participation activities, hidden objects, play-a-song or play-a-sound elements, and touch-and-feel textures, offering readers a diverse and engaging interactive experience. Interactive books provide learning through play-based activities. Play is one of the effective methods for learning due to several reasons. Children enjoy playing, and the desire to engage in playful activities comes from within themselves. Learning becomes effective when it is initiated voluntarily and done joyfully without being hindered by fear or pressure (Loarid et al., n.d., 2015).

The data from the Public School Bringin 02 library showed that no STEAM-based interactive storybooks were available. This lack of STEAM media in Public School Bringin 02 may hinder the development of critical thinking skills in elementary school students. STEAM interactive storybooks serve as valuable resources for enhancing critical thinking skills in elementary school students (Twiningsih & Elisanti, 2021). Integrating Science, Technology, Engineering, Arts, and Mathematics, these storybooks engage children in learning and foster the development of critical thinking skills by presenting real-world

scenarios, these books stimulate creative and analytical thinking in children, effectively promoting critical thinking skills. It is important for schools to provide access to STEAM media, including STEAM storybooks, to promote critical thinking skills in elementary school students. Based on the description above, this research focus to develop product interactive storybook STEAM-based that can improve students' critical thinking skills.

METHODS

This research utilizes a research design based on the theory of Borg and Gall. According to Borg and Gall as cited in (Gustiani, 2019), this research follows a modified five-stage procedure based on the ten stages of Borg and Gall: 1) information gathering and research, in this stage, field surveys and data analysis are conducted, 2) planning, in this stage, the researchers compile and design an interactive storybook based on STEAM according to the described theories, 3) developing the preliminary form of the product, the development of a prototype for the interactive STEAM storybook, along with the selection of materials, size, color, and format of the storybook. 4) revising the final product, this stage involves refining the final product based on expert testing; these inputs are combined to revise and create a perfect interactive STEAM storybook product, 5) dissemination and implementation, the interactive STEAM storybook product is ready for implementation.

This research was conducted at Public School Bringin 02, during the month of November 2023. In this study, a questionnaire was used as an instrument to measure attitudes, opinions, and perceptions of individuals or groups regarding social phenomena to collect data (Sugiyono, 2015). The data collection technique involved direct administration of the questionnaire to 10 third-grade students, both before and after the product testing.

The data analysis technique employed in this study is qualitative descriptive, closely aligned with the type of data to be obtained (Sukmadinata, 2007). Qualitative descriptive analysis is utilized for the development of the STEAM Activity: The Three Sides of My Family book, employing non-test techniques such as validation processes through assessment instruments, student response questionnaires, as well as pretests and post-tests. Sukmadinata (2007) states that the validation percentage for each expert is calculated using the formula.

$$PS = \frac{Actual\ Score}{Ideal\ Score} X100\%$$

The developed expert test assessment criteria are presented in the table 1.

Table 1. Validation assesment categories

Interval (%)	Categories
81 – 100	Very high
61 – 80	High
31 – 60	Enough
21 – 40	Low
1-20	Very low

HASIL DAN PEMBAHASAN

The results of the preliminary study conducted through observation and interviews with 3rd-grade teachers at Public School Bringin 02 indicated that there were no STEAM-based interactive storybooks available. The lack of interactive learning media, such as STEAM-based media, in Public School Bringin 02 may hinder the development of critical thinking skills in elementary school students. Considering the needs of Public School Bringin 02, this research is aimed at developing an interactive storybook learning media based on STEAM with the goal of enhancing students' critical thinking skills in learning

mathematical geometry. Kementrian Pendidikan, Kebudayaan, Riset, dan Teknologi explains mathematics as a subject in their book titled "Learning Outcomes Mata Pelajaran Matematika Fase A- Fase F" learning mathematics can enhance students' abilities in logical, analytical, systematic, critical, and creative thinking. These competencies are necessary for learners to have the ability to acquire, manage, and utilize information to survive in constantly changing, uncertain, and competitive situations. The developed product is STEAM Activity with the title "The Three Sides of My Family." This learning media covers the mathematical geometry material for Phase B of the 3rd grade.

The geometry material for Phase B of the 3rd grade focuses on students being able to describe the characteristics of various flat shapes (Teacher's Book Grade 3 Vol. 2 of 2022). The initial part of creating the STEAM Activity includes the title and introduction of characters to help students understand the characters in the story. STEAM Activity introduces various types of triangles with the concept of a family and is designed with colorful images and an interactive storyline that reflects daily life, aiming to assist students in the analysis process.

The STEAM Activity book contains activities that students can engage in, such as experimenting with cheese, chocolate sticks, paper, completing mini-games, and solvisng practice problems. The activities in the STEAM Activity book are tailored to the material requirements and the writing style of children's literature. The language used is adjusted to the level of critical thinking skills of 3rd-grade students. Below is a glimpse of the STEAM Activity learning media.

Figure 1 STEAM Activity book cover - page 12.

After the draft product is developed, the next step is to test the product with media experts, children's literature experts, and media experts. These experts are lecturers in Elementary School Teacher Education, Mathematics Education, at Satya Wacana Christian University Salatiga. According to the content expert's assessment, the STEAM Activity book received a percentage of 82%, indicating that it meets the criteria for very high. This indicates that aspects such as the curriculum, content components, content concepts, and language in the STEAM Activity book received a very high rating and are suitable for further testing. In the assessment by the children's literature expert, the STEAM Activity received a percentage of 91%, meaning it achieved a very high rating based on aspects such as plot, characters, setting, language, and characters used in the STEAM Activity book. The media expert's evaluation showed a percentage of 96%, meaning it meets the very high criteria based on aspects such as the physical condition of the book, presentation, and language suitability.

Figure 2 STEAM Activity page 29- back cover

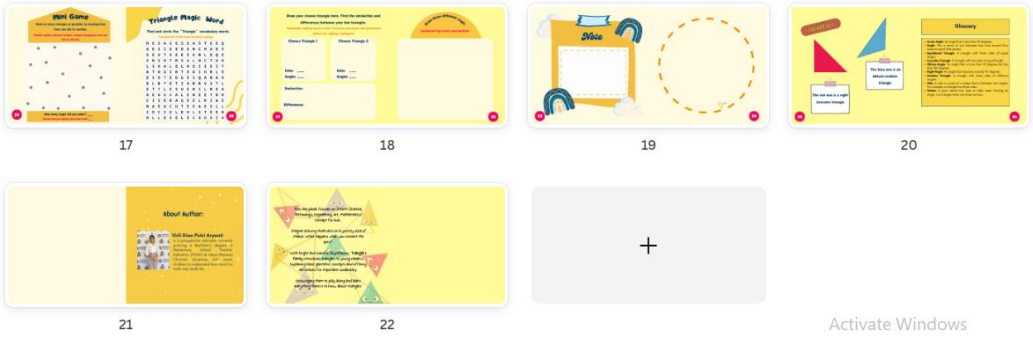

Figure 3 STEAM Activity page 13- page 28

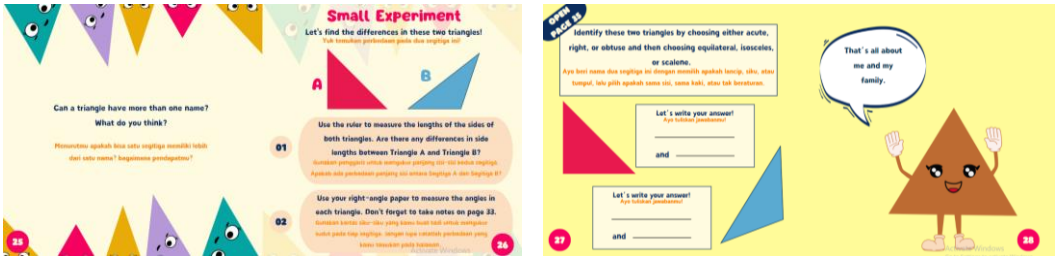

Figure 4 Experiment page and exercise

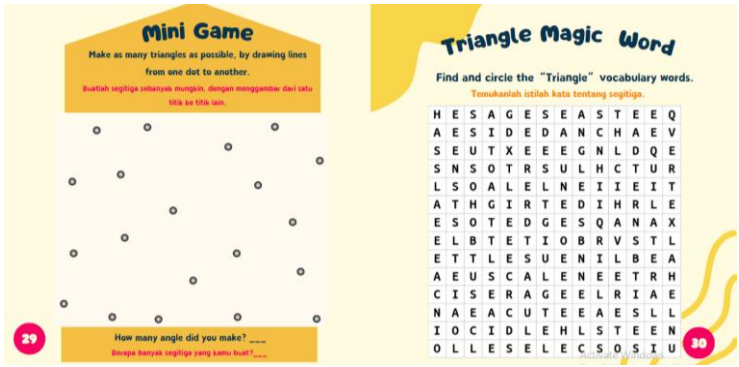

Figure 4 Mini game

After the draft product is developed, the next step is to test the product with content experts, children's literature experts, and media experts. These experts are lecturers in Elementary School Teacher Education, Mathematics Education, at Satya Wacana Christian University Salatiga. According to the content expert's assessment, the STEAM Activity book received a percentage of 82%, indicating that it meets the criteria for very high. This indicates that aspects such as the curriculum, content components, content concepts, and language in the STEAM Activity book received a very high rating and are suitable

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According to Ennis, as cited in Marini & Wihardjo (2020), critical thinking encompasses several categories: elementary clarification (analyzing), basic support (synthesizing), inference (making conclusions), advance clarification, and organizing strategies and tactics. The assessment of critical thinking skills by the children's literature expert, content expert, and media expert yielded a percentage of 89%, indicating a very high rating and suitability for use.

Table 2 Critical Thinking Assesment of Material, Children's Literature, Media Expert.

Aspects	Material			Media			Children's Literature			Average	
	Total score	Ideal Total	Percent (%)	Total score	Ideal Total	Percent (%)	Total score	Ideal Total	Percent (%)	Percent (%)	Criteria
Elementary Clarification	9	12	75%	12	12	100%	11	12	91%	89%	Very High
Basic Support	3	4	75%	4	4	100%	3	4	75%	83%	Very High
Inference	4	4	100%	3	4	75%	4	4	100%	91%	Very High
Advance Clarification	3	4	75%	4	4	100%	4	4	100%	91%	Very High
Strategy and Tactics	6	8	75%	8	8	100%	8	8	100%	91%	Very High
Average										89%	Very High

As indicated in Table 2, the content expert assigned a score of 75% for the aspect of elementary clarification, with a high rating. This indicates that the STEAM Activity book enables students to identify geometry based on specific properties (according to their concepts) and establish criteria for considering possible answers. In the aspect of basic support, it achieved a percentage of 75% with a high rating, demonstrating that STEAM Activity can make students able to consider appropriate solutions. Furthermore, in the aspect of inference, it received a score of 100%, indicating that STEAM Activity can make students able to make and determine considerate results. For the aspect of advance clarification, it obtained a score of 75%, signifying that STEAM Activity can make students able to create a defined form by providing additional explanations. The evaluation of the aspect of strategy and tactics yielded a score of 75%, showing that STEAM Activity can make students able to formulate the application of their logical strategy. Critical thinking involves using logic effectively. It is crucial for students to possess critical thinking skills. These skills encourage students to reflect on issues, analyze problems, and determine the cause and effect of the decisions made (Hayati, 2022).

The media expert assessed the aspect of Elementary Clarification with a score of 100%, indicating a very high rating. This shows that STEAM Activity enables students to analyze flat geometric shapes according to concepts. For the aspect of basic support, it received a percentage of 100% with a very high rating, demonstrating that STEAM Activity can make students capable of considering appropriate solutions. In the aspect of inference, it achieved a score of 75%, suggesting that STEAM Activity can make students able to make and determine considerate results. For the aspect of advance clarification, it obtained a score of 100%, signifying that STEAM Activity can make students capable of creating a defined form by providing additional explanations. The evaluation of the aspect of strategy and tactics yielded a score of 100%, indicating that STEAM Activity can make students capable of formulating the application of their logical strategy.

The children's literature expert evaluated the aspect of Elementary Clarification with a score of 91% and a very high rating. This indicates that STEAM Activity enables students to analyze flat geometric shapes according to concepts. For the aspect of basic support, it received a percentage of 75% with a very high rating, demonstrating that STEAM Activity can make students capable of considering appropriate solutions. In the aspect of inference, it obtained a score of 100%, indicating that STEAM Activity can make students able to make and determine considerate results. For the aspect of advance clarification, it obtained a score of 100%, signifying that STEAM Activity can make students capable of creating a defined form by providing additional explanations. The evaluation of the aspect of strategy and tactics yielded a score of 100%, showing that STEAM Activity can make students capable of formulating the application of their logical strategy.

The assessment of critical thinking conducted by the content expert, media expert, and children's literature expert yielded results that align with the respective aspects. The average critical thinking assessment for the aspect of elementary clarification is 89% with a very high rating, the aspect of basic support is 83% with a very high rating, the aspect of inference is 91% with a very high rating, the aspect of advance clarification is 91% with a very high rating, and the aspect of strategy and tactics is 91% with a very high rating. STEAM Activity obtained a total average of 89%, making it suitable for further testing in mathematics learning as suggested by the provided recommendations.

After being tested by product experts, the STEAM Activity was subjected to a limited trial at Public School Bringin 02. The limited trial was conducted by providing student response questionnaires to assess the practicality of the STEAM Activity book. In terms of the physical condition of the book, children's literature content, and material content, students responded "Yes" with a percentage of 100%. Therefore, the STEAM Activity book is deemed practical for use in 3rd-grade mathematics learning, specifically for geometry material in Phase B.

Table 3 Resutl of Student Respon

Aspect	Total Score	Ideal Score	Percentage (%)	Criteria
Physical condition of the book	2	2	100%	Very High
Content of material	6	3	100%	Very High
Content of children literature	5	5	100%	Very High
Total	10	10	100%	Very High

An experiment was also conducted by providing pretest and post-test questions to assess students' understanding of geometry. On the pretest answer sheets, students had difficulty comprehending and answering the given questions, providing only brief or incorrect responses. After completing the pretest, students were guided to read the STEAM Activity: The Three Sides of My Family book. They engaged in various activities from the book, completed exercise questions, and played mini games that included geometry material. Subsequently, students were given a post-test with the same questions, and they were able to solve the problems more smoothly and correctly.

This experiment aimed to determine the effectiveness through the significant average difference between pretest and post-test scores. This analysis was computed using an independent samples t-test to identify significant differences related to the STEAM Activity book. The STEAM Activity product obtained a t-test value of 0.013 with a significance level of 0.05. From this calculation, it is known that the significant value from the t-test result is greater than 0.05, meaning that the alternative hypothesis (Ha) is accepted,

and the null hypothesis (Ho) is rejected. Thus, the use of the STEAM Activity book is effective in enhancing the critical thinking skills of 3rd-grade Phase B students in geometry material.

Tabel 3. Result of Independent Samples Test

		Levene's Test for Equality of Variances		t-test for Equality of Means		
		F	Sig.	t	df	Sig. (2-tailed)
Hasil Belajar	Equal variances assumed	7.647	.013	-7.649	18	.000
	Equal variances not assumed			-7.649	14.178	.000

KESIMPULAN

Based on the results of this study, it can be concluded that STEAM Activity: The Three Sides of My Family in mathematics learning can enhance critical thinking skills in third-grade students. This teacher learning innovation, structured as a learning medium, ultimately provides optimization and improves student learning outcomes. The positive impact on students' critical thinking skills is evident in the significant learning outcomes with a value of 0.013, which is greater than 0.05. Therefore, the alternative hypothesis (Ha) is accepted, and the null hypothesis (Ho) is rejected.

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