# Development of STEAM Media to Improve Critical Thinking Skills and Science Literacy: A Research and Development Study in SD Negeri Laweyan Surakarta, Indonesia

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## Abstract

The research aims of this study are to develop the media STEAM-based learning (Science, Technology, Engineering, Arts, Mathematics) in grade 1 thematic learning to improve critical thinking skills and the culture of scientific literacy in grade 1 students in public elementary school in Laweyan, Surakarta. 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. This type of research is research and development (Research and Development) with ADDIE design (Analysis, Design, Development, Implementation, Evaluation). Based on the results of the study before using STEAM-based colored two-dimensional Figure Mixing media, it is identified know that the average class of students' critical thinking skills of 74.80, and the average science literacy class of 73.61. After using STEAM-based typewriter media it can be seen that the average class of students' critical thinking skills of 86.67 and the average science literacy class of 88.67. The results of this study prove that STEAM-based non-typed media developed can improve students' critical thinking skills so that it has a positive impact on scientific literacy. This study concludes that new learning media developed can increase the activeness of students and ultimately have a positive impact on learning outcomes student.

**Keywords**: *Critical thinking skills, Scientific literacy, STEAM media*

## INTRODUCTION

The development of Steam media is crucial to improve critical thinking skills and science literacy because we found ample evidences that the teacher have limited learning media available. Furthermore, in our sample, school in public Elementary school in Laweyan Surakarta, learning media available. Existing learning media have not met the needs of students so that it has an impact on student learning outcomes. The available media is not entirely precise on the learning objectives so that it is necessary to have teacher creativity in creating learning media innovations to provide a conducive classroom atmosphere since its presence would give students a sense of comfort in learning and later would students to receive the knowledge.

Effective learning media can determine learning outcomes, educators are expected to develop learning media as a tool to deliver effective and efficient learning resources so as to foster interest and motivate students and can improve understanding and learning achievements. Learning media as a means of conveying messages from learning media to students serves to present learning objects that make complex problems easy, systematic and simple (Falahudin, 2014; Primasari, Zulfiani, & Herlanti, 2014; Elisanti & Prayitno, 2018). Thus, innovation from learning media would provide more meaningful learning since the teacher could consider the students condition when preparing the media.

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Critical thinking skills are closely related to literacy. Students' critical thinking will also improve the skills of students in literacy. Active thinking skills in solving real-life problems by analyzing, synthesizing, so that they can conclude the results of observations correctly and scientifically (Irawan & Febriyanti, 2016; Lestari, Saepulrohman, & Hamdu, 2016; Elisanti, Sajidan, & Prayitno, 2018). Thus, decision-making based on critical abilities is a form of good scientific literacy on a scientific basis(Geraldine, 2016; Purangol, Mayuri, Supari, & Elisanti, 2019). Scientific literacy as knowledge and natural skills to be able to identify questions, acquire new knowledge, explain scientific phenomena, and draw conclusions based on facts, understand the characteristics of science, aware of how science and technology build the natural, intellectual and cultural environment, and a willingness being involved and care on science-related issues(OECD, 2018)

Science, Technology, Engineering, Arts, Mathematics (STEAM) deals with science, technology, engineering, arts, and mathematics. Science deals with a way of thinking through observing and conducting experiments, technology is a way (a way of doing) through activities using tools, techniques can be interpreted as a way of doing which involves problem-solving, how to use a variety of materials, designs, and creating art, mathematics is related to measuring (a way of measuring) (Imad Uddin, 2017). STEAM is a development of STEM education by adding elements of art (Arts) in learning activities (Aprilia, Ridwan, Hadinugrahaningsih, & Rahmawati, 2018). Based on this background, this study aims to develop the media STEAM-based learning to Improve Critical Thinking Skills and Science Literacy: A Research and Development Study in SD Negeri Laweyan Surakarta, Indonesia

**LITERATURE REVIEW**

STEAM aim is to create stimulate and motivate students concerning higher-order thinking that includes problem-solving, collaborative strategies, independent learning, project-based learning, challenge-based learning, and research. STEM learning does not only mean to strengthen practical education in the STEM field separately so that students can understand and make decisions about natural conditions and their changes as activities of humans in daily life (Aldila, Abdurrahman, & Sesunan, 2017; Permanasari, 2016).

Innovative learning media can attract students' enthusiasm for learning and thinking skills of students which will ultimately produce the literacy skills of students. Good student literacy skills will provide an improvement in student learning outcomes to create a conducive learning climate. Based on the problems that have been described, it is deemed important to develop STEAM-based learning media. Srimati, et al said that with STEM is expected to produce quality resources that are ready to face the challenges of the global era so as to answer the needs of natural resources that have capabilities in the fields of science, technology, engineering, and mathematics (Srimati, Rochintaniawati, Widodo, Purwianingsih, & Riandi, 2018).

Suciati, et al (2019) found that teacher interventions on learning media can overcome low understanding of concepts and can motivate students if the media used appeals to them (Suciati, Kartowagiran, Munadi, & Sugiman, 2019). STEM research has also been conducted by Nurjaman, Hamdu, and Elan which revealed that traditional STEM-based outdoor learning is in line with the 2013 curriculum (Nurjaman, Hamdu, & Elan, 2018). Thus, the used of media that determines students' learning achievements, the application of STEM or STEAM is a scientific approach, integrative thematic, and of course in line with 21st century learning. Suciati and Suciati et al., (2019) The research uses a single-case research design. STEAM contextual learning media. The Subject is a student 6th grader of one of the primary schools. The research result shows that the

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coastal contextual learning media in the form of shells was effective to improve the understanding of concept in number counting operation for the research subject. It can be seen from the improvement of the correct answers on the test of understanding concept given. The STEAM-based learning innovation research method of Colored Two-Dimensional Figure Mixing refers to the research and development design (Research and Development) can be student center learning, was effective to improve the understanding of concept so that as could succeed in improving student's science literature and critical thinking through the designed media.

## RESEARCH METHOD

The STEAM-based learning innovation research method of the Colored Two-Dimensional Figure Mixing refers to the research and development design (Research and Development) by taking the ADDIE development design (Analysis, Design, Development, Implementation, Evaluation). ADDIE design used using the model put forward by Mulyatiningsih(2012), the design stages of ADDIE development are as follows:

**Table 1.** The design stages of ADDIE development

| Stage | Activity |
|---|---|
| Analysis | Analysis of the needs of teachers and students for the development of learning innovation media and selecting priority scales for problems to be resolved immediately. |
| Design | Determine the learning approach to be applied, design innovation media, design assessment instruments. |
| Development | Developing innovation media following the selected learning approach. |
| Implementation | Testing out innovation media, carrying out learning assessments, distributing response questionnaires. |
| Evaluation | Perform data analysis and make revisions or improvements to the applied innovation media |

The subjects of this study were 25 students of grade 1 in Public Elementary School in Laweyan, Surakarta, Indonesia. The percentage population of research this is 100%.

The research instruments were a media validation sheet, a teacher response questionnaire, a student observation sheet, and a student learning result sheet. The type was descriptive qualitative data and quantitative descriptive. Data analysis techniques from the results of this study were descriptive analysis techniques, descriptive quantitative, and quantitative analysis. The quantitative descriptive analysis technique was used to analyze the implementation of the Colored Two-Dimensional Figure Mixing STEAM-Based. The results of students' observations were analyzed using the following formula.

$$Score = \frac{Total\ of\ Score}{Maximum\ Score} x100\%$$

$$Maximum\ Score = Total\ of\ indicator$$

The observation category refers to Arikunto (Arikunto, 2013) and converted as in table 2.

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**Table 2.** The Score Category

| Score (%) | Category |
|---|---|
| 86-100 | Very Good |
| 76-85 | Good |
| 60-75 | Less |
| 55-59 | Fair |

The subjects of this study were 25 students of grade 1 in Public Elementary School in Laweyan Surakarta, Indonesia. The percentage population of research this is 100%. The instrument questionnaire of collecting data used measure indicator critical thinking skill and science literacy skill the item instrument has a scoring interval 0-100 corresponding to respective criteria.

Instrument validity test was conducted using Pearson's Product Moment correlational test with the following terms: if r statistic > r table, the item is considered as valid, and if r statistic < r table, the item is considered as invalid and is removed. The instrument of validity test obtained the lowest score of 0.335 and highest one of 0.665 > f table, with 25 students as respondents with r value = 0.380 (r product moment value), meaning that the instrument of indicator critical thinking skill and science literacy skill item was valid. Meanwhile, the reliability test obtained Cronbach Alpha 0.912 > 0.380, meaning that each of items is reliable, implemented in the experiment classes

**FINDINGS AND DISCUSSION**
**Colored Two-Dimensional Figure Mixing Media**

Colored Two-Dimensional Figure Mixing Media is a learning innovation media of the creativity of thematic class teachers. In its implementation, The Colored Two-Dimensional Figure Mixing Media can be used in all themes in Grade 1 in Elementary school. The elements that are handled in this material are the content of the lessons that exist in each theme of Civics, Indonesian, Mathematics, and Arts and Crafts. In conclusion, Colored Two-Dimensional Figure Mixing Media can be implemented in all themes in thematic classes. Media products can be seen in Figure 1, Figure 2, and Figure 3.
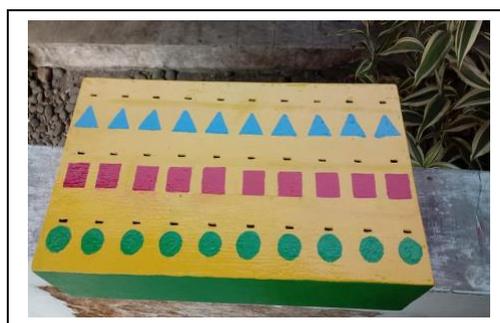


**Figure 1.**
A Colored Two-Dimensional Figure Mixing Block

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**Figure 2.**
The STEAM-Based on Colored Two-Dimensional Figure Mixing Media

The STEAM-Based on Colored Two-Dimensional Figure Mixing Media aims to provide learning convenience to students in learning the subject matter that exists in each theme. The STEAM-Based on Colored Two-Dimensional Figure Mixing Media aims to make students easily recognize knowledge about science, technology, engineering, art, and mathematics. In its Implementation, STEAM-Based Colored Two-Dimensional Figure Mixing Media can be used in all themes in the classroom. In learning activities, the things that the brain manipulates using the STEAM-Based Colored Two-Dimensional Figure Mixing Media are the content of the lessons that exist in each theme. The following is a visualization of design as components of the relationship between STEAM and the STEAM-Based on Colored Two-Dimensional Figure Mixing Media in learning in thematic classes.
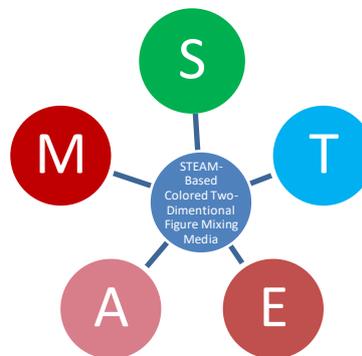


**Figure 3.**
The design as components of the relationship of STEAM with Colored Two-Dimensional Figure Mixing Media

*Science*, the element of science that connects to the Colored Two-Dimensional Figure Mixing Media is the content of science lessons that the brain manipulates using the Colored Two-Dimensional Figure Mixing Media. Students easily capture the scientific knowledge that is in each subject matter.

*Technology*, the technological elements that connect with the Colored Two-Dimensional Figure Mixing Media are the uniqueness of the Colored Two-Dimensional Figure Mixing Media as an innovation in learning media made by the teacher that is adapted to the conditions of the students.

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*Engineering*, the technical elements that connect the Colored Two-Dimensional Figure Mixing Media are the learning strategies or models used in learning when implementing the Colored Two-Dimensional Figure Mixing Media can provide a conducive classroom atmosphere.

*Art*, the art elements that connect the Colored Two-Dimensional Figure Mixing Media is students recognizing the game when using the Colored Two-Dimensional Figure Mixing Media to attract student's activity.

*Mathematics*, the mathematical elements that connect the Colored Two-Dimensional Figure Mixing Media include, using Colored Two-Dimensional Figure Mixing Media, students gain experience learning to recognize simple flat geometry, for instance, squares, triangles, circles, and numeracy skills to recognize numbers.

Colored Two-Dimensional Figure Mixing Media is a tool in learning activities to activate student activity, in this study to improve scientific literacy and ultimately have an impact on students' critical thinking skills as well. Science literacy is introduced to students by using STEAM-based Colored Two-Dimensional Figure Mixing Media. Science literacy is developed in thematic learning activities by linking the theme of a clean, healthy, and the great environment. The use of STEAM-based Colored Two-Dimensional Figure Mixing Media on the theme of a clean, healthy, and the great environment is oriented towards improving students' critical thinking skills. -another theme. The relationship between the STEAM-based Colored Two-Dimensional Figure Mixing Media with critical thinking skills and scientific literacy is visualized in the following figure.
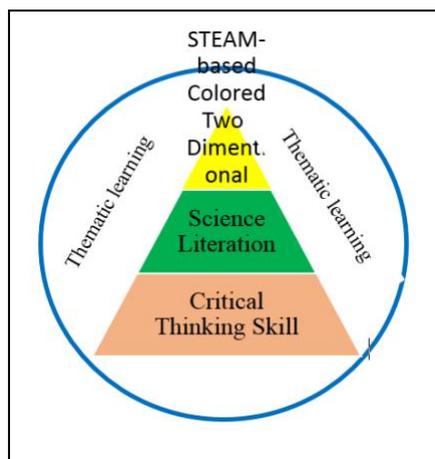


**Figure 4.**
The relationship between the STEAM-based Colored Two-Dimensional Figure Mixing Media, science literation, and critical thinking skill

**Practical Implementation of STEAM-Based Colored Two-Dimensional Figure Mixing Media in Learning**

The use of STEAM-based Colored Two-Dimensional Figure Mixing Media in thematic learning was applied by the teacher through talking stick games. The stages of the STEAM-based Colored Two-Dimensional Figure Mixing implementation in thematic learning activities follow the following stages:

In the analysis stage, the teacher gives an introduction about the STEAM-based Colored Two-Dimensional Figure Mixing Media to the students and the benefits of media in learning. The teacher introduced and motivated how to demonstrate the STEAM-based Colored Two-Dimensional Figure Mixing Media and how to operate it.

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In the synthesizing stage, is the core of implementing STEAM-based Colored Two-Dimensional Figure Mixing Media in integrating with thematic learning and building students' critical thinking skills. Students under the guidance of the teacher tried to use the related media through talking stick games. Students were asked to come forward to mention the type of flat stick labeled with the keywords the theme of a clean, healthy, and great environment then matched it up in a flat shape which was attached to the colorless box. After that, the students took another flat shape stick which was different from other students through talking stick games. Then this game was carried out until the existing flat-shape sticks were embedded in the flat shape that matches the type found in the non-colored block.

In the conclusion stage, students were assigned to retell orally the types of flat shapes that have been studied and relate them to scientific literacy with the theme of a clean and beautiful environment.

In the stage of arranging strategies and tactics, students were asked to draw simple flat shapes of squares, triangles, and circles on their respective book's worksheets. The results of the measurement of critical thinking skills and science literacy skills can be seen in figure 5 below.
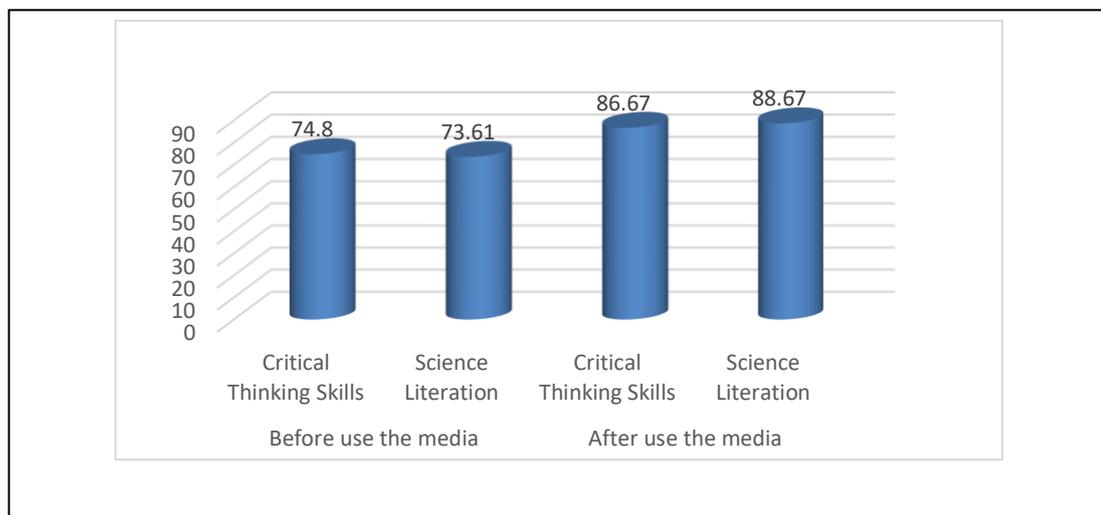


**Figure 5**
Graph of the average score of student's critical thinking skills and student's science literacy in class before and after the learning using STEAM-based Colored Two-Dimensional Figure Mixing Media.

Based on the results of this study research before using STEAM-based Colored Two-Dimensional Figure Mixing Media, it was identified that the average score of student's thinking skills class of 74.80, and the average of the student's science literacy skill class of 73.61. Based on the results of this study research after using STEAM-based Colored Two-Dimensional Figure Mixing Media, it can be identified that the average score of the student's critical thinking skills class of 86.67, and the average of the science literacy class of 88.67. Based on the results of research before and after using the STEAM-based Colored Two-Dimensional Figure Mixing Media, it can be stated that the STEAM-based Colored Two-Dimensional Figure Mixing Media can improve students' critical thinking skills and scientific literacy in learning.

The use of appropriate media can increase student activity in learning activities, including problem-solving activities to stimulate students to think critically (Feuerstein, 1999; Syawaludin,

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Gunarhadi, & Rintayati, 2019; Elisanti, et al., 2020). The implementation of the STEAM-based Colored Two-Dimensional Figure Mixing Media, teachers can build students' abilities in solving problems in the classroom, assist students to become active in stimulating critical thinking skills and students reveal it easier to solve and understand difficult concepts.

The use of STEAM-based Colored Two-Dimensional Figure Mixing Media follows the STEAM learning syntax. The implementation of the STEAM approach in the use of learning media is proven to be able to improve students' ability to solve problems (Kim, Gwon-Suk, & Young, 2012). Increased problem-solving abilities are followed by the development of scientific literacy, by following the STEAM approach, students can find answers to problems scientifically (Land, 2013; Long & Davis, 2017). Using STEM learning models students can see the meaning of the learning material. They can also connect materials with everyday experiences in real life (Pasaribu & Suyanto, 2020).

The student center is a learning process so that it can involve students' active learning in the class. The teacher provides a problem in learning that can create a better learning atmosphere where a problem can stimulate students to get answers to a problem and how to solve problems in various ways. This is in line with Vygotsky's learning theory, which states that social interaction with other relatives triggers the formation of new ideas and enriches the intellectual development of students.

## CONCLUSION

Based on the results of this study, it can be concludes that STEAM-based Colored Two-Dimensional Figure Mixing Media in thematic learning can improve student's critical thinking skills and scientific literacy in the first-grade students is one of teacher learning innovations that is structured as a learning medium that ultimately provides optimization and increases student learning outcomes. STEAM-based Colored Two-Dimensional Figure Mixing Media in its application can be positive for students 'critical thinking skills and scientific literacy, this is indicated by the improvement in students' critical thinking skills which previously had a mean score of 74.80 improved to 86.67. The increase in scientific literacy, which was previously a mean score of 73.61, increased to 88.67.

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