

Exploring the Use of Flashcards to Improve Understanding of Flat Shapes in STEAM-Based Mathematics Learning in Elementary Schools

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Abstract: Mathematics learning in elementary schools often faces obstacles in understanding geometric concepts, especially flat shapes, due to limitations in the use of concrete and interactive media. This study aims to explore the use of flashcards in STEAM-based mathematics learning as an effort to improve fourth-grade elementary school students' understanding of the concepts of sides, angles, and straight lines. The method used is a qualitative approach with a case study design, involving 14 fourth-grade students at SDN Lidah Wetan 4 Surabaya. Data were collected through participatory observation, semi-structured interviews, documentation, and field notes, then analyzed using the Miles and Huberman model. The results showed that the combination of flashcards with manipulative activities using toothpicks and plasticine within the STEAM framework was able to increase student engagement, facilitate concrete conceptual understanding, and encourage critical thinking, creativity, collaboration, and mathematical communication skills. These findings confirm that simple media can be innovatively optimized to strengthen mathematics learning in line with the demands of the 21st-century curriculum. This study provides practical contributions for elementary school teachers and opens opportunities for further research on other geometry materials and different grade levels.

Keywords: Mathematics Learning, Flashcards, STEAM, Flat Shapes, Elementary School

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INTRODUCTION

Mathematics education in elementary school plays an important role in building students' conceptual foundations, especially in geometry subjects such as flat shapes (Restiani et al., 2025). However, the reality in the field shows that many elementary school students still have difficulty understanding the concepts of sides, angles, and straight lines. These difficulties often arise because the teaching methods used tend to be passive, with minimal use of concrete or interactive media, and do not involve students in activities that require direct exploration (Arrosyad et al., 2024). This situation results in students merely memorizing formulas without truly understanding the meaning of the geometric concepts they are learning.

One innovative approach that is currently being promoted is STEAM-based learning (Science, Technology, Engineering, Art, Mathematics) (Barkah et al., 2024). This approach emphasizes integrative, creative, and applied learning, so that students not only receive theoretical material, but also explore through practical application. STEAM encourages active student engagement by combining aspects of science, technology, engineering, art, and mathematics in a series of learning activities (Mu'minah, 2020). Thus, it is hoped that students will not only understand concepts abstractly, but also be able to apply them in real situations through problem solving, critical thinking, and group work.

In the context of learning flat shapes, flashcards are a medium that can support the STEAM approach (Mu'ayyanah et al., 2024). Flashcards have the advantages of clear visualization, simple form, and ease of use in the learning process (Adella & Lestari, 2024). This medium allows students to identify sides, angles, and straight lines directly so that they can distinguish the characteristics of various flat shapes. When combined with manipulative activities, such as making flat shapes using toothpicks and plasticine, the learning process becomes more meaningful. This activity involves engineering aspects in the design process, artistic aspects in the creativity of forming flat shapes, and mathematical aspects in analyzing the properties of the resulting shapes (Mariana & Istiq'faroh, 2024).

A number of previous studies have shown the effectiveness of flashcards in mathematics learning. For example, a study at SDN Pakis 1 Surabaya found that the implementation of flashcards was able to significantly improve student learning outcomes

in flat shapes, from a mastery rate of 54% in the pre-cycle to 88% in the second cycle (Ningsih et al., 2025). Other research conducted by (Sari et al., 2023) and (Nuzula, 2023) related to the development of mathematics flashcards for spatial geometry material also shows that this medium is considered highly valid, practical, and interesting for students. In addition, research (Humairo & Trimurtini, 2025) regarding the development of flat shape scrapbooks, it is clear that concrete visual media are effective in helping students understand basic geometric concepts.

However, these studies still have limitations. First, most studies only emphasize improving learning outcomes in the form of test scores (Wardhana et al., 2020), without further examining students' understanding of specific aspects, such as sides, angles, and straight lines. Second, there is still little research that combines the use of flashcards with fully STEAM-based manipulative activities, such as building flat models using toothpicks and plasticine. Third, existing research is generally conducted in lower grades or on spatial geometry material (Faozan & Kusno, 2024), so that studies on fourth-grade students on flat shapes are still rare. In addition, non-cognitive aspects such as creativity, cooperation, and students' critical thinking and problem-solving skills have not been the main focus of study.

Based on this background and research gap, this study is important to conduct. The urgency of this study lies in the need to improve the quality of mathematics learning through an approach that is in line with the demands of the 21st century curriculum. The current curriculum emphasizes the importance of critical thinking, problem solving, creativity, collaboration, and communication skills (Chusna et al., 2024). The use of flashcards combined with activities involving the creation of flat shapes using toothpicks and plasticine within the STEAM framework can be an innovative alternative that addresses these needs. In addition, this study also provides practical contributions for elementary school teachers, as flashcards are inexpensive, simple, and easily adaptable in various learning contexts (Utami & Utomo, 2024).

The theoretical framework underlying this study includes Piaget and Vygotsky's constructivist theory, which emphasizes that students construct understanding through direct interaction with concrete objects (Yolanda et al., 2024), STEAM theory, which integrates various fields of science into learning (Fadhilah, 2022), as well as visual learning theory, which explains that image representations can strengthen the

understanding of abstract concepts ([Wahidin, 2025](#)). In this context, the use of flashcards combined with manipulative activities is in line with the principles of this theory, as it facilitates students in connecting abstract concepts of flat shapes with concrete experiences.

Based on the above description, this study aims to explore and gain a deeper understanding of how the use of flashcards in STEAM-based learning approaches can help fourth-grade elementary school students build their understanding of flat shapes. This study intends to examine the phenomenon of student engagement when identifying sides, angles, and straight lines through manipulative activities using toothpicks and plasticine combined with flashcards. The objective of this study is to produce a comprehensive understanding of the students' learning experiences, including how creativity, cooperation, critical thinking, and problem-solving skills emerge in the innovative mathematics learning process ([Zuhriyah, 2022](#)).

METHODS

This study uses a qualitative approach with a case study design. This approach was chosen because the study focuses on gaining an in-depth understanding of the phenomenon of using flashcards in STEAM-based mathematics learning among fourth-grade elementary school students. A case study was considered appropriate because the study was conducted in a specific class with a unique context, namely the fourth grade at SDN Lidah Wetan 4 Surabaya, allowing the researcher to comprehensively explore the students' learning experiences during the activities.

In qualitative research, researchers play a key role. Researchers are present in the classroom not only as observers, but also as learning facilitators. The researcher directly delivered the flat shape material using interactive PowerPoint media, distributed Student Worksheets (LKPD), assisted students in activities to make flat shapes using toothpicks and plasticine, and guided the group presentation and reflection process. The presence of the researcher provided an opportunity to record classroom dynamics, student responses, individual and group involvement, and the forms of cooperation that emerged during the learning activities.

This study was conducted at SDN Lidah Wetan 4 Surabaya, located at Jl. Raya Lidah Wetan No.07, Lidah Wetan, Lakarsantri District, Surabaya, East Java 60213. This

location was chosen because it was relevant to the focus of the study, particularly on flat shapes, which is in line with the fourth grade elementary school curriculum. The research subjects were all 14 fourth-grade students at SDN Lidah Wetan 4 Surabaya, consisting of 6 male students and 8 female students. In addition to the students, the research informants also included the fourth-grade homeroom teacher, Mr. Pulungan Sulaiman, S.Pd., who provided additional information about the students' characteristics, classroom conditions, and learning habits. The homeroom teacher acted as a partner in learning reflection and helped verify the data obtained by the researcher.

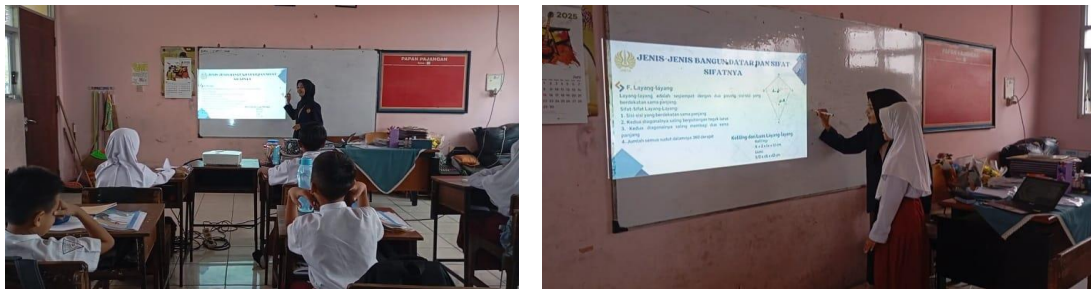
Research data was collected through participatory observation, semi-structured interviews, documentation, and field notes. Observations were conducted directly during the learning process to record students' activities when using flashcards, constructing flat shapes with toothpicks and plasticine, and presenting their work. Interviews were conducted with students and homeroom teachers to explore their experiences and perceptions of using flashcards. Documentation in the form of photos of activities, student work, worksheets, and student reflection sheets were used as authentic evidence of student engagement in learning. In addition, the researcher also compiled field notes as personal reflections and detailed descriptions of the classroom atmosphere.

Data analysis was conducted qualitatively following the Miles and Huberman model, which includes data reduction, data presentation, and conclusion drawing (Qomaruddin & Sa'diyah, 2024). Data obtained through observation, interviews, and documentation were reduced to select information relevant to the research focus, then presented in narrative form, so that researchers could draw conclusions about students' understanding of flat shapes, critical thinking skills, problem solving, creativity, and cooperation in STEAM-based learning.

To ensure data validity, this study used triangulation techniques. Source triangulation was conducted by comparing information from students, teachers, and researcher notes (Susanto & Jailani, 2023), whereas triangulation is done by combining the results of observation, interviews, and documentation (Saadah et al., 2022). The researchers also conducted member checking with homeroom teachers to ensure that the interpretation of the data was consistent with the actual conditions in the field (Adelin et al., 2025).

RESULTS

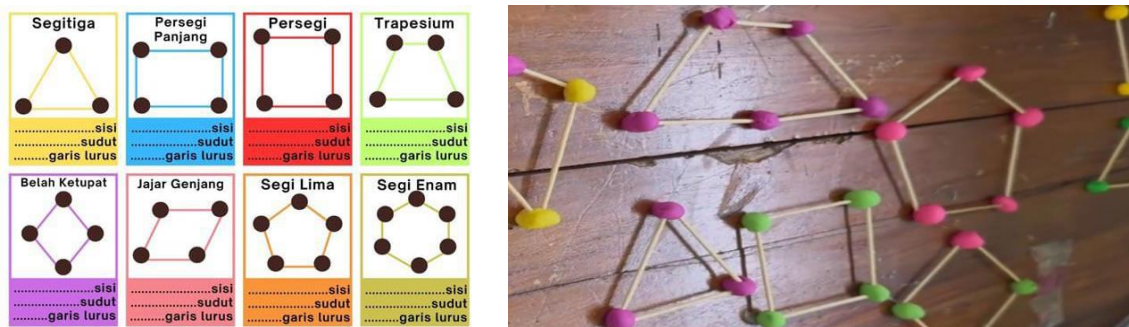
The implementation of STEAM-based mathematics learning using flashcards for flat shapes in grade IV at SDN Lidah Wetan 4 Surabaya showed positive results in terms of students' understanding of the concepts. The activity began with the delivery of material using interactive PowerPoint, followed by the distribution of Student Worksheets (LKPD) containing instructions for group work. Through this activity, students appeared enthusiastic and were able to follow the learning process well.



(a) Implementation of learning activities (b) Students are enthusiastic during activities

Figure 1. Implementation of learning using PowerPoint media

During the core activity stage, students were divided into small groups to work on worksheets containing instructions on how to make flat shapes using toothpicks and plasticine. This activity helped students to concretely understand the concepts of sides, angles, and straight lines (Apsari et al., 2022). Based on observations, most students showed an increase in understanding when manipulating these simple materials to form flat shapes. They were able to identify and name the properties of flat shapes more easily than through verbal explanations alone (Solihin & Rahmawati, 2024).



(a) Flashcard (b) Flat structure made from toothpicks and plasticine

Figure 2. Students make flat shapes with toothpicks and plasticine

Flashcards used after flat shape construction activities were also proven to help reinforce students' understanding. Flashcards containing questions about sides, angles,

and straight lines successfully encouraged students to think critically in connecting theory with the flat shapes they made. Students appeared more confident in answering because they had real models that could be used as references. In addition to improving conceptual understanding, this activity also encourages problem solving and critical thinking skills. Students practice finding solutions when the flat shapes they make are not correct, for example in determining the number of angles or sides. Group discussions are quite active, and students demonstrate the ability to listen, express opinions, and work together to complete tasks. This is in line with the characteristics of STEAM-based learning, which integrates creativity, collaboration, and higher-order thinking skills (Rahayu et al., 2025).



(a) Students

(b) Assistance

Figure 3. Assisting students while working on group assignments

After completing the construction and solving the problems on the flashcards, each group presented their project results in front of the class. These presentations provided an opportunity for students to practice their mathematical communication skills and foster a sense of responsibility for the results of their group work (Lubis & Rahayu, 2023). Other students also contributed their responses, creating a participatory learning atmosphere. At the end of the lesson, the reflection sheets distributed to students showed that most students found the lesson more enjoyable and easier to understand through the use of flashcards and activities involving making flat shapes with toothpicks and plasticine (Aprilianti et al., 2025).



Figure 4. Presentation of student group work results

The findings of this study show that STEAM-based learning with the help of flashcards not only improves students' understanding of mathematical concepts, but also fosters 21st-century skills, namely critical thinking, creativity, collaboration, and communication (Fauziah et al., 2025). In other words, integrating flashcards into STEAM-based learning has been proven to enrich students' learning experiences and make the learning process more enjoyable (Gultom & Mudiono, 2024).

DISCUSSION

This study shows that the use of flashcards in STEAM-based mathematics learning is very effective in improving fourth-grade students' understanding of flat shapes at SDN Lidah Wetan 4 Surabaya (Kusumayadi, 2025). Key findings include: students are able to understand sides, angles, and straight lines more concretely through manipulative activities; they actively think critically and solve problems; and they demonstrate creativity and cooperation. Presentations and reflections reinforce understanding and build students' sense of responsibility and self-confidence.

The results of this study are directly related to the research objective, which is to explore how flashcards and flat construction activities (toothpicks and plasticine) help students understand concepts and develop 21st-century skills such as critical thinking, creativity, and cooperation (Hartati et al., 2025). It can be said that this objective was successfully achieved, because students not only memorized the properties of flat shapes, but were also able to identify sides, angles, straight lines, and correct incorrect flat shapes through group discussions and reflection (Qomaria, 2021).

Scientifically, the success of using flashcards and manipulative activities can be explained through the principles of concrete and visual learning (Aswandari et al., 2025). Activities involving the construction of flat shapes using real materials enable students to build stronger mental representations than through lectures or abstract explanations alone (Mulyadi & Fiangga, 2022). Flashcards provide visual reinforcement and questions that encourage critical thinking, as students must connect theory (the concept of flat shapes) with the real objects they create (Zahra & Soebagyo, 2025). This combination facilitates understanding concepts from concrete to abstract. In addition, the STEAM approach also provides space for creativity (through form design), collaboration (group work), and reflection, all of which support deep understanding (Nurfadila et al., 2025).

When compared to previous studies, there are similarities as well as significant differences. One of them is research (Pohan et al., 2025), who use STEM Lidi Flashcards to improve fifth graders' understanding of flat shapes. The study found that the use of these media, combined with a discussion-based approach and cultural contextualization, improved learning completeness, activity, and meaningful conceptual understanding. Similarities with this study include the use of flashcards as concrete visual media and the aspects of increasing student activity and conceptual understanding. The differences lie in the additional use of manipulatives such as toothpicks and plasticine in the fourth grade context, as well as the integration of reflection and group presentations as part of the process. The uniqueness of this study lies in how students build their own flat models, making learning more applicable and participatory.

There are also limitations that need to be considered. Although students' understanding has improved, there are still students who experience difficulties in the aspect of angle measurement precision or in more complex flat shapes (Putri & Fitriyani, 2024). Constructions using toothpicks and plasticine also have limitations in measuring angles accurately. Time and material factors can affect the effectiveness of learning in each group (Samsudin, 2020). This kind of difficulty implies that the use of manipulative media needs to be supported by more precise measuring tools or visual instruments if the learning focus requires angular precision (Ananda & Salamah, 2025).

From a theoretical perspective, these results reinforce the constructivist theory that students learn more effectively through direct and manipulative activities (Pujianto, 2024). This also supports the theory of visual learning or multimodal learning, which states that visual and physical representations, as well as dialogue or reflection, strengthen memory and understanding of abstract mathematical concepts (Lestari & Rayungsari, 2024). The results of this study are consistent with the literature stating that concrete and interactive media increase student motivation, confidence, and engagement (Anggraini et al., 2025).

The practical significance of this study is that teachers can adopt flashcards along with simple manipulatives such as toothpicks and plasticine as an effective combination for flat shape materials, especially in schools with limited resources. Learning becomes more interesting, concrete, and provides space for students to think critically and

creatively (Rizki et al., 2024). Thus, this study not only contributes to theory, but also provides an applicable model.

CONCLUSION

The conclusion of this study shows that the use of flashcards in STEAM-based mathematics learning can help fourth-grade elementary school students understand flat shape concepts more deeply while fostering 21st-century skills, such as critical thinking, problem solving, creativity, collaboration, and mathematical communication, thereby answering the research objective that focuses on exploring this innovative learning phenomenon. The contribution of this research lies in its efforts to advance knowledge in the field of mathematics education by presenting a learning model that integrates simple visual media with STEAM-based manipulative activities, unlike previous studies that tended to focus solely on cognitive learning outcomes. Scientifically, these results are in line with constructivism and visual learning theories that emphasize the importance of concrete experiences in building abstract understanding, and show that simple media can be used effectively to support integrative and applied learning. These findings open up broader opportunities for elementary school teachers, particularly in designing mathematics learning that is relevant to the demands of the 21st-century curriculum, while also providing a new direction for further research that can test the effectiveness of combining flashcards with other more precise instruments or expand the study to different geometry materials and grade levels, thereby providing a foundation for the development of increasingly innovative and sustainable learning strategies.

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