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The Kite Project to Improve Numeracy Skills for Junior High School Students

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Abstract

This research occurred to improve students' numeracy skills. To help students acquire these skills, develop learning projects through a STEAM approach using kite-making and collaborative learning projects. Design collaborative learning projects using a STEAM approach to assist students in acquiring these skills. This study's primary purpose is to create kites to aid junior high school students in addressing problems concerning PLSV and the kite area. This study applies a design research type validation study. The data collection technique used is using images, products, and review documents for data collecting. The research participants were 27 seventh-grade (Phase D) SMP students in Palembang. This study developed a learning trajectory that includes three exercises and post-test questions. Students can investigate and address issues associated with kite construction using PLSV materials. In the second activity, students can create kites and estimate their area based on their kite-making skills. After the kite is built, students fly a kite and study it. Students can improve their numeracy abilities through project-based learning employing STEAM in the context of kite creation, as demonstrated by the findings of this study. This knowledge aids them in overcoming obstacles associated with PLSV content and expands kite-making.

Keywords: Kite Project; Project-based Learning; Design Research; STEAM.

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Introduction

Mathematics is one of the subjects that must be studied by elementary, middle, and high school students. According to Permendikbud, Number 64, students are expected to have logical, critical, analytical, and creative abilities, think carefully, have awareness, responsibility, responsiveness, and problem-solving. Mathematics (Gazali, 2016) is the most challenging field of study and requires intellectual and cognitive preparation. Therefore students not only memorize formulas but also emphasize the formation of knowledge processes and mastery of concepts. Besides that, students must be able to develop and discover their knowledge without relying on what the teacher provides.

The factor of students' creative thinking ability, which is still at a low stage in solving contextual problems, is obtained from a study of the dominant factors that influence Indonesia's less than optimal achievement in PISA studies (Wijayanti, 2021). Indonesia has a PISA score of 379 and ranked 74th out of 79 countries in 2018 (OECD, 2019). The relevance of numeracy abilities in Indonesia is not directly proportionate to the outcomes of this PISA (Basri, 2021; Nusantara, 2021). According to the Ministry of Education and Culture (2021), numeracy is the ability to: 1) use numbers and symbols related to mathematics to solve practical problems in a variety of everyday contexts; and 2) analyze the information displayed (tables, graphs, charts, etc.) and then use the results of the analysis to make predictions or draw conclusions or decisions.

Project-based learning (PjBL) is an effective instructional method that can shape students' scientific, social, and higher-order thinking activities. Implementing PjBL in teaching and learning enables students to plan learning activities, participate in collaborative projects, and develop products (Rahayu, 2021). The study's findings also demonstrate that the PjBL learning approach enhances mathematics skills. PjBL will also have a favorable impact on the development of teamwork and the attainment of learning outcomes. Interactions between students will foster collaboration in completing projects (Putri, 2022).

One of multidisciplinary approach is STEAM (Science, Technology, Engineering, Arts, and Mathematics). Collaboration in STEAM (Nessa, 2017) education will assist students in collecting, analyzing, and solving problems, as well as understanding the relationship between problems. Typically, STEAM (Veerma, 2011) is followed by problem-based, active learning. For instance, STEAM, in conjunction with Project-Based Learning, can help students acquire problem-solving abilities and have an enjoyable learning experience.

Establishing collaborative abilities, the capacity to constructively absorb and use criticism, depict things and situations, and communicate problem-solving results is a crucial step in the STEAM approach to building numeracy (Siregar, 2019). The STEAM environment enables the development of a numeracy framework (Zollman, 2012; Mogens, 2015). Teachers and students value the STEAM approach because it enables them to view problems or design processes from multiple perspectives that can be applied in the real world.

One of the mathematics subjects at school is linear equations of one variable. Previous research has indicated that students lack conceptual and procedural understanding of algebra.

Therefore, teachers must construct learning procedures and tactics to help overcome students' faults (Larino, 2018).

The setting researchers utilize in learning is the fabrication and flight of a kite. Kite is a traditional game enjoyed in numerous parts of the world, young to old (Amanfaluthi, 2020). However, kites are also a traditional game preferred by children in Indonesia. Kites have long been a traditional game for Indonesian children, with the real-world activity serving as the background (Susanto, 2010).

Methods

This study utilized a design research methodology for validation studies, which consists of three steps: experiment planning, the design experiment, and retrospective analysis (Akker, 2006; Gravemeijer, 2004; Putri, 2022). This investigation was conducted at SMP N 59 Palembang.

The researcher investigates the junior high school mathematics curriculum, PjBL and STEAM learning approaches in preparation for the experimentation phase. Then, researchers and mathematics teachers work together to create a learning design project using the context of kite-making in junior high school.

Pilot Experiment and Teaching Experiment are two stages of experiment design. The first stage was carried out using learning which was carried out in small groups. This group consisted of eight SMP N 59 Palembang students selected based on their mathematical ability (low, medium, and high). The researcher acts as a model educator during the pilot experiment stage. Then the data obtained were analyzed during the retrospective analysis phase.

After the pilot experiment, the researcher, as a model instructor and observer, reflected on the advantages of applying the PjBL model in the retrospective analysis phase. Then, their thoughts and suggestions are utilized to enhance the learning experience (Putri, 2019).

Documents, observations, and interviews are used as means of data collection. During the early design phase, interviews were done with mathematics teachers, and during the pilot experiment phase, observations were conducted in the research class.

The approach employed is a design research method of validation studies. It consists of three steps: preparing for experiment, design experiment, and retrospective analysis (Gravemeijer, 2004; Akker, 2006; Putri, 2022). STEAM analysis on student worksheets is shown below.

Table 1. STEAM Analysis

Science	**Technology**
Applying Lift, Newton's Third Law, and Bernoulli's Law	• Internet to find information on kite making • Kite flight videos
Engineering	**Art**
• Designing kites • Testing and analyzing the results of kites that have been made	• Decorate the kite • Preserving traditional games
Mathematics	

• One Variable Linear Equation • Area of the kite	

Results

The results use the context of making kites as a traditional game to improve students' numeracy skills.

Preparing for Experiment

A literature review was conducted on PjBL, STEAM, and the mathematics curriculum. The results of the kite-making context learning project by applying the stages of the PjBL learning model and the STEAM approach to the learning activities of 27 D-stage students began in seventh grade with the completion of a kite-making project (Phase D). Researcher with grade 7 math teachers (Stage D) Mrs. Hj. Ade Silvia Utari, M.Pd., and Mr. Bastomi, S.Pd., because teachers know the conditions and skills of students. Researchers, together with teachers, explore learning information that students have studied. Therefore, the teacher can build learning tools that will be applied. Interviews were conducted with teachers to determine the initial conditions and abilities of students who would become research subjects.

Researcher with grade 7 math teacher (Stage D) Mrs. Hj. Ade Silvia Utari, M.Pd., and Mr. Bastomi, S.Pd., working on a kite-making project together in grade 7 (class D) because the instructor knows the students' conditions and abilities. Then, they investigate the knowledge that students have acquired. Therefore, they can create learning tools that will be implemented based on the original design's initial phase.

The Design Experiment

At this stage, it is divided into two stages by researchers: pilot experiments and teaching experiments. In pilot experiment phase, which consists of conducting investigations in small groups of eight students from different courses as study participants by dividing into two groups of varying abilities (2 poor ability, 4 medium ability, 2 high ability). What is done at this stage is to test the design. This stage aims to evaluate the suitability of the learning process and the design of the learning process that will be created in the subsequent stage. The researcher serves as an exemplary educator role model.

The next stage after pilot experiment is teaching experiment in class 7.4 (Phase D). Using the phases of the PjBL learning model and STEAM approach, results and discussion of the kite-making context learning project are presented. 27 D-stage students participated in learning activities according to the steps of this design study technique.

The duration of apperception during the learning process is 7 minutes; the students sat in groups. Mrs. Hj. Ade Silvia Utari, M.Pd., is the instructor for this stage and distributes worksheet to students. Three to four students with a certain level of problem-solving ability are grouped together for cooperative learning. Figure 1 depicts the instructor's view on project-based learning.

Figure 1. Apperception teacher in class

The worksheet is divided into two, namely kite-making with two stages of activity; the first stage is the planning stage, and the second stage includes the activities of building and flying (testing) kites, as well as the evaluation stage. When a student who does not understand asks his group members for help by saying "Please teach me," the student who is asked to teach must teach his group members until he can do it himself.In addition, the teacher divides the class into groups of three to four students who work collaboratively to address the challenge stated in Activity 1, namely kite planning. Figure 2 depicts students collaborating across groups.

Figure 2. Students collaborate in groups.

The teacher monitors students according to the PjBL learning model's stages when they are engaged in activity 1. There should be no teacher intervention with students. They are encouraged to ask their classmates so that groups can collaborate if there are questions from students who need help comprehending (Figure 3). The project-based approach has two benefits (Kokotsaki, Menzies, & Wiggins, 2016): teaching students the skills needed to create products independently and making students competent by developing knowledge from a deeper understanding of concepts.

Figure 3. Students ask their friends

The next day will focus on implementation-stage learning. The implementation phase consists of two activities, namely kite-making and kite-flying. Following the apperception, the instructor reviewed the previous lesson. The instructor reminded the class of the materials and time required to construct the kite. Students work collaboratively to construct kites. Students will compare the planning and implementation phases of kite-making to determine whether the kite-making process will be the same.

Analysis Retrospective

The final stage is a retrospective study of previous research outcomes, particularly student responses, product presentations, and constructed kite items. The outcomes of the students' responses consisted of two steps: the planning stage in activity 1, which involved planning the stages of kite construction, and the implementation stage in activity 2 and 3, which included the ability to construct and fly (trial) kites.

Student Activity Sheet (SAS): Planning and Design Stages

The instructor gives out Student Answer Sheet 1 (SAS). The objective of action 1 Students can evaluate and resolve challenges in planning kite construction or the initial phases of project planning/design based on their prior understanding of PLSV and Area of Kites. Pratama (2016) and Rahayu (2021), PjBL seeks to resolve issues by encouraging daily actions to discover new information related to necessary knowledge. Then, students employ the prerequisite knowledge to address typical life challenges, including the construction of kites. The instructor provides an outlook on engaging learning: the students will construct kites.

For this reason, it is vital to grasp the material that has been studied earlier, particularly PLSV and the area of the kite. Explaining the learning objectives by exploring past information relating kite games and participating in preserving traditional games, one of which is kites. Some questions asked by the teacher to students.

"Does anyone know about traditional games in Indonesia that also exist in other countries?"

"What are the benefits of flying kites as a traditional game?"

"Have you ever played a kite?"

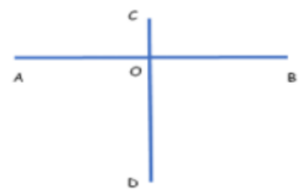
"Have you ever made it?"

The following is an example of questions at the planning stage (Figure 4):

Tahap Perencanan dan Perancangan

Buatlah layang-layang dengan ketentuan sebagai berikut:

Misalkan kerangka layang-layang tersebut terdiri dari garis horizontal AB dan garis vertikal CD pada gambar berikut :



Gambar 1. Kerangka Layang-layang

Pada layang-layang terdapat dua bilah bambu yang berpotongan. Bilah bambu digunakan sebagai sayap (bambu horizontal) dan punggung (bambu vertikal). Ukuran bambu yang disiapkan masing-masing 58 cm untuk sayap dan 50 cm untuk punggung layang-layang.

1. Diketahui panjang ruas garis CO adalah 10 cm. Jika panjang ruas garis OD dimisalkan sebagai x, maka hitunglah panjang ruas garis OD tersebut.

Figure 4. Problem 1 during the Planning and Design Stage (in Indonesian)

The first planning problem is in English (Figure 5).

Planning and Design Stage

Make kites with the following conditions:

Suppose the kite framework consists of a horizontal line AB and a vertical line CD in the following figure:

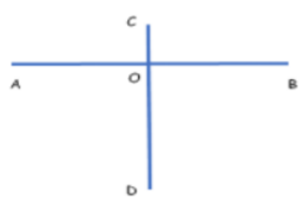


Figure 1. Kite's Frame

In the kite there are two intersecting bamboo blades. Bamboo slats are used for wings (horizontal bamboo) and back (vertical bamboo). The size of the bamboo prepared was 58 cm for the wings and 50 cm for the kite's back, respectively.

1. The length of the line segment CO is 10 cm. If the length of the line segment OD is assumed to be x, calculate the length of the line segment OD.

Figure 5. Problem 1 during the Planning and Design Stage (in English)

Students finally responded to questions based on the guidelines provided in SAS and student responses in SAS 1.

1. If the length of the line segment OD is considered to be x and the length of the line segment CO is 10 cm. cCompute the length of the line segment OD.

   Students' answer :

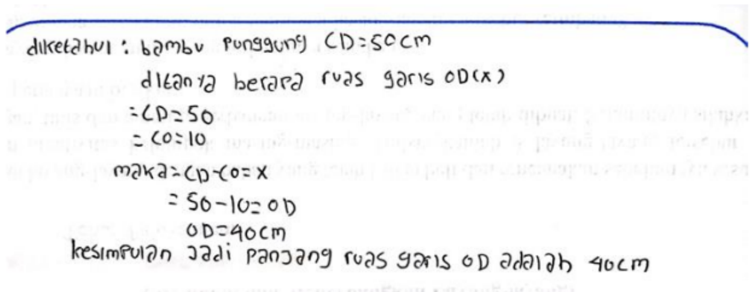


Figure 6. Student responds to the first question during the planning stage

Figure 6 displays student responses as evidence that they can analyze and solve issues using one-variable linear equation content. This demonstrates the use of representation in the analysis received from the supplied information (graphs, tables, charts, diagrams, etc.), as measured by the numeracy indicators (Han, 2017).

2. Isilah tabel di bawah ini. Buat ukuran panjang sayap kiri (AO) dan kanan (BO) pada garis AB yang akan kamu buat dengan ketentuan sebagai berikut:

Tabel 1. Ketentuan Model Layang-layang

Model A	Model B	Model C
Misalkan panjang sayap adalah p. Sayap kiri lebih pendek 10 cm daripada sayap kanan.	Misalkan panjang sayap adalah q. Sayap kanan lebih panjang 14 cm daripada sayap kiri.	Sayap kiri dan kanan memiliki panjang yang sama. Misalkan panjang sayap adalah r.

Lengkapi Tabel 2 berikut dari informasi yang disajikan pada Tabel 1!

Tabel 2. Ukuran Sayap Layang-layang

Panjang Sayap		Jumlah Panjang Sayap (58 cm)
Sayap Kiri (p-10)	Sayap Kanan (p)	......
......	......	......
Sayap Kiri (q)	Sayap Kanan (q+14)	......
......	......	......
Sayap Kiri (r)	Sayap Kanan (r)	......
......	......	......

Figure 7. Problem 2 during the Planning and Design Stage (in Indonesian)

2. Fill in the table below. Measure the length of the left (AO) and right (BO) wings on the AB line that you will make with the following conditions:

Table 1. Kite Model Terms

Model A	Model B	Model C
Let the wing length be p. The left-wing is 10 cm shorter than the right-wing.	Let the wing length be q. The right-wing is 14 cm longer than the left-wing.	The left and right wings are the same lengths. Let the wing length be r.

Complete Table 2 below from the information presented in Table 1!

Table 2. Kite Wing Size

Wing Length		Total Wing Length (58cm)
Left Wing (p-10)	Right Wing (p)	......
......	......	......
Left Wing (q)	Right Wing (q+14)	......
......	......	......
Left Wing (r)	Right Wing (r)	......
......	......	......

Figure 8. Question table in English

Students' answer:

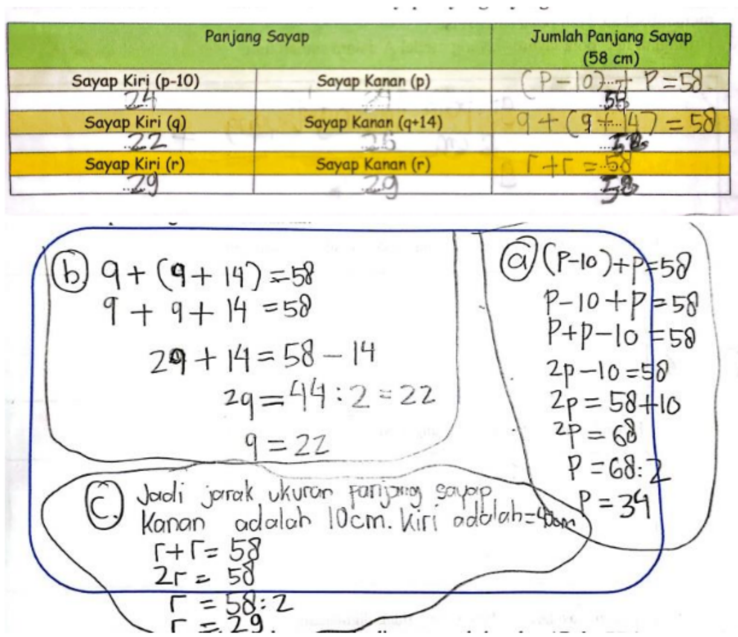


Figure 9. Students' answers to number 2 at the planning stage

Figure 9 depicts students' responses to number 2 during the planning phase as evidence that they can use one of the numeracy indicators, namely the use of representations in the form of various numbers and symbols related to elementary mathematics, to solve problems (Han, 2017).

Student Activity Sheet (SAS) : Implementation Stage

On the second day of instruction, the instructor reviewed the prior session, which involved designing kites in response to the questions posed in activity 1. The instructor then instructed pupils to construct and fly kites during the Project implementation phase. Throughout the process of kite construction, pupils work in the preceding group. The instructor reviews the necessary materials and the duration of kite-making.

Figure 10. Apperception teacher on the second day

On the second day of instruction, the principal project implementation activities consist of kite construction and kite testing, which are detailed in Activities 2 and 3. The activity's plans determine materials for kite construction. Students create kites in collaboration. Students will examine the planning and implementation phases of kite-making to determine whether the kite-making process will be the same.

Figure 11. The process of making a kite

Following are questions and instructions for the kite flight trial stage:

Letakkan kerangka yang telah dibuat pada kertas yang disediakan.
Jiplaklah 3 pola layang-layang yang akan dibuat pada kertas yang disediakan dengan menambahkan 2 cm pada setiap sisi.
Hitunglah luas pola layang-layang model A dalam satuan unit.
Hitunglah luas pola layang-layang model B dalam satuan unit.
Hitunglah luas pola layang-layang model C dalam satuan unit.
Tentukan luas dari sisa kertas yang tidak digunakan.

Figure 12. Questions at the Implementation Stage (in Indonesian)

1. Place the framework that has been made on the paper provided. Trace the three kite patterns that will be made on the paper provided by adding 2 cm on each side.
   a) Calculate the area of the model kite pattern A in units.
   b) Calculate the area of the model kite pattern B in units.
   c) Calculate the area of the model kite pattern C in units.
   d) Determine the area of the remaining unused paper.

   Student's answer :

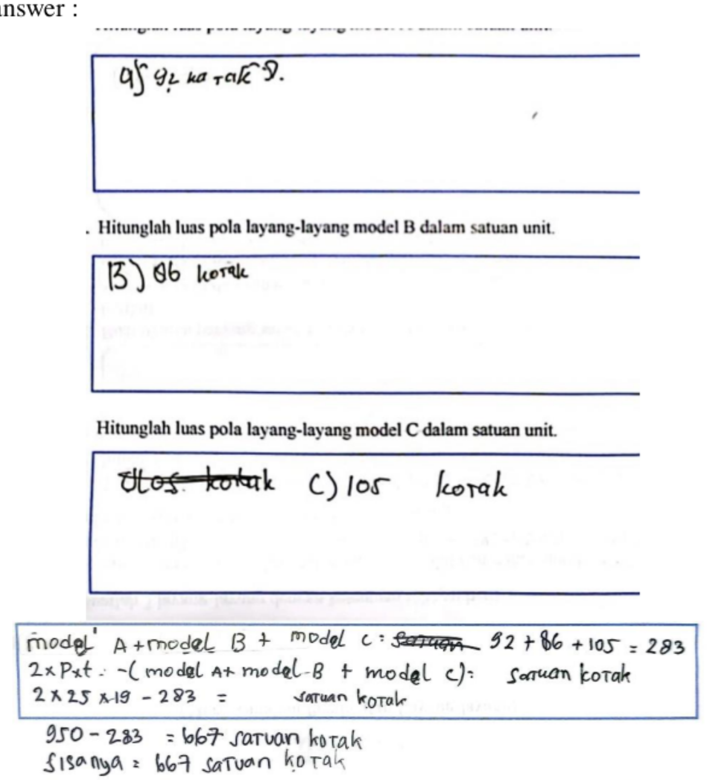


Figure 13. Student answers the question of the implementation stage of making a kite

Figure 13 displays the students' responses to the implementation phase of kite-making, indicating that they can solve the problem by calculating the area of paper used to make kites by making assessments and decisions.

After the kite has been constructed, it will be flown (trial) alongside questions that students must answer while viewing its flight. Figure 14 illustrates the procedure via which students pilot kite flights.

Figure 14. Students try out the kites they have made

The questions that students must answer after observing the kites being flown are as follows:

1. Terbangkanlah layang-layang yang telah kamu buat.
2. Amati layang-layang yang diterbangkan. Apa yang terjadi pada layang-layang A, B, dan C?
3. Layang-layang mana yang seimbang saat diterbangkan? Mengapa itu bisa terjadi?
4. Setelah menerbangkan layang-layang, kemukakan pendapatmu tentang apa itu "seimbang"? dan bagaimana cara kalian untuk menjaga layang-layang tersebut tetap terbang seimbang!

Figure 15. Questions at the Implementation Stage (in Indonesian)

1. Fly the kite that you have made.
2. Observe the flying kite. What happened to kites A, B, and C?

Student's answer:

Amatilah layang-layang yang diterbangkan. Apa yang terjadi pada layang-layang A, B, dan C?

a. Tidak terbang
b. Tidak terbang
C. bisa Terbang

Figure 16. Students' answer in activity 3

Student's answer that kites A and B cannot be flown, while kite C can be flown.

3. Which kite balances when flying? Why did it happen?

Student's answer:

layang layang C
memiliki Ukuran yg sama dan Sismetris dan udara/angin yg mendukung layang-layang untuk terbang yg menyebabkan gaya angkat (lift) yaitu perbedaan kecepatan permukaan layang-layang sesuai hukum bernoulli.
Hukum newton III pada layang-layang dibelokan.

Figure 17. Students' answers about kites that can be flown

Students write that "Model C kites have the same size and are symmetrical and the air/wind supports the kite to fly which causes lift, namely the difference in the surface speed of the kite according to Bernoulli's law. As well as newton's third law occurs when a kite is flowing". This student's answer supports the STEAM analysis in the Science section, namely observing Lift, Newton III's Law, and Bernoulli's Law during the trial phase.

4. After flying kite, express your opinion about what "balance" means? Moreover, how do you guys keep the kite flying in balance?

Student's answer :

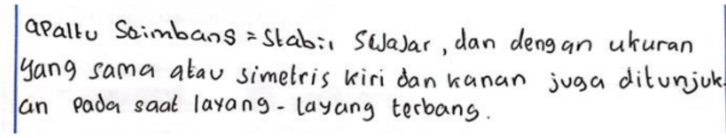


Figure 18. Students' answers conclude kites that can be flown

Students wrote, "Balanced means stable/parallel and of the same size or symmetrical left and right are also shown when the kite is flying". This answer directs students to know that the PLSV material in the project is proven by the balance when the kite is flown. Novitasari's research (2018) uses a balancing tool.

The final step involves evaluating the results of the product by exhibiting the kites that have been constructed. The instructor inquires about the procedure and its outcomes. Students are shown displaying their work in Figure 19.

Figure 19. Students presenting product results

The outcomes of students' responses during the planning phase of each topic are weighted differently based on their preferences for the material. Nonetheless, they received the answer of 40 cm and measured the left and right wings during planning. Some students measure kite wing plans with a ruler to verify their calculations. A minor difference determines the kite's left and right sides during the implementation phase.

Discussion

From the entire process of making and testing products (Fauziah, 2017; Repko, 2017), students can conclude clearly and accurately, based on the results of observations and measurements, that the manufacturing process applies and integrates existing concepts and procedures while enhancing professional skills. This also supports the Buck Institute for

Education's (2002) assertion that project-based learning assists students in mastering subjects and processes.

STEAM-based learning can boost critical thinking, creativity, and 4C skills (Henriksen, 2014; Engelman, 2017). The STEAM method prepares pupils for 21st-century abilities (Siregar, 2020). STEAM-based techniques (Nagdi, 2018; Sungyong, 2014) are adaptable, collaborative, and cognizant of recent teaching and learning trends.

In the prior study, such as Rohimah's research (2022), the material for one-variable linear equations employing STEM is discussed in the dynamo-powered toy vehicle project. In addition, Novitasari, Zulkardi, and Darmawjioyo studied the material of one-variable linear equations utilizing a balancing tool. In addition to Mustopo's (2019) research on the project to determine the area of a flat shape. The PLSV material and geometry, especially the area of the kite, were designed by researchers as a project-based learning trajectory. Thus, pupils comprehend information and apply it to their daily lives by building their own kites and preserving traditional games.

Conclusion

The project's learning trajectory through PLSV and Geometry, particularly kite, assists students in improving the material and the process of making and flying kites collaboratively with groups through problem-solving contexts that can enhance student numeracy skills. There are two stages to the progression of learning. Through the processes of collectively creating, implementing, and assessing products, 21st-century skills such as teamwork, communication, creativity, problem-solving, and critical thinking can emerge, thereby enhancing student numeracy. Due to their learning trajectories involving disciplined material in context, kites serve as a jumping-off point for project-based learning. Based on a review of the STEAM approach, these values include knowledge in relevant contexts and the process of developing fascinating and engaging skills for students.

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Conflicts of Interest

Nabila Putri Isamer, Ratu Ilma Indra Putri, and Zulkardi have no competing interests. In addition, the writers have addressed ethical concerns like plagiarism, misconduct, data fabrication and falsification, double publishing and submission, and redundancy.

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Author Contributions

Nabila Putri Isamer: Conceptualization, writing - original draft, editing, and visualization; **Ratu Ilma Indra Putri:** Writing - review, formal analysis, corresponding author and methodology; **Zulkardi:** Validation and supervision.

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PAGE 2

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Possessive This word may be a plural noun and may not need an apostrophe.

Sentence Cap. Remember to capitalize the first word of each sentence.

Possessive This word may be a plural noun and may not need an apostrophe.

Wrong Article You may have used the wrong article or pronoun. Proofread the sentence to make sure that the article or pronoun agrees with the word it describes.

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PAGE 11

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PAGE 13

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PAGE 14

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