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IMPLEMENTATION OF STEAM IN PLAY ACTIVITIES ON THE DEVELOPMENT STUDENTS IN THE PRE-OPERATIONAL STAGE

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Abstract :

The purpose of this qualitative study is to describe the implementation of STEAM education through play-based activities, especially making a fan from origami paper in the pre-operational stage. This study not only focus in outcomes but also in the learning process. This study showed the integration of each elements in STEAM based on play activity. The subject of this study are students in Grade 1 from one of the national school in Pangkalpinang who is in pre-operational stage. The data collected by observation, interview, and documentation. The researchers are in the class to observe the implementation. The interview conducted to students during the class. The documentation are the photos and videos of learning process. The data analyzed using Miles & Huberman Model such as data reduction, data display, conclusion. The results showed that implementation of STEAM through origami paper effectively bridges the gap between abstract mathematical concepts and concrete play. This study concludes that play-based STEAM implementation is effevtive in stimulating the cognitive and sensory motor of pre-operational stage.

Keywords : *STEAM, play-activity, pre-operational stage*

Abstrak :

Tujuan dari penelitian kualitatif ini adalah untuk mendeskripsikan implementasi dari pembelajaran STEAM melalui aktivitas bermain, terutama membuat kipas dari kertas origami pada tahap pra-operasional. Penelitian ini tidak hanya berfokus pada luaran tapi juga proses pembelajarannya. Penelitian ini menunjukkan integrasi antar elemen pada STEAM berdasarkan aktivitas bermain. Subjek dari penelitian ini adalah peserta didik kelas 1 dari salah satu sekolah negeri di Pangkalpinang dimana peserta didik ini berada pada tahap pra-operasional. Data dikumpulkan melalui observasi, wawancara, dan dokumentasi. Peneliti berada di dalam kelas untuk mengobservasi implementasi pembelajaran. Wawancara dilakukan kepada siswa selama proses pembelajaran. Dokumentasi merupakan foto dan video dari proses pembelajara. Data dianalisis menggunakan Model Miles & Huberman yaitu reduksi data, penyajian data, dan penarikan Kesimpulan. Hasil penelitian menunjukkan bahwa implementasi STEAM melalui kertas origami secara efektif dapat menjembatani *gap* antara konsep matematika yang abstrak dan permainan yang konkrit. Penelitian ini menyimpulkan bahwa implementasi STEAM berbasis aktivitas bermain efektif menstimulasi kognitif dan sensorik motorik pada tahap pra-operasional.

Kata Kunci: STEAM, aktivitas bermain, tahap pra-operasional

INTRODUCTION

There are four stages of Piaget's Theory about Cognitive Development Stages such as: sensorimotor stage (newborn – 2 years old), pre-operational stage (2 – 7 years old), concrete stage (7 – 11 years old), and formal operation stage (above 11 years old) (Moreno, 2010). The learning for children in pre-operational stage must be concrete because they start to develop symbolic ability using images and words as symbols to understand the physicial word (Babakr et al., 2019). The best learning method for pre-operational stage is STEAM Education (Yim et al., 2025).

STEAM education integrate Science, Technology, Engineering, Arts, and Mathematics as a whole learning that goes to transdisciplinary (Perales & Aróstegui, 2024). With STEAM education, students can improve their creativity and collaborative that focus on problem solving through exploration and experiment (Belbase et al., 2022). The learning outcomes of STEAM education are students discover new abilities, methods, and approaches to deal with the real word challenges (Roussou et al., 2025).

However, in reality, there are challenges in effectively integrating STEAM in pre-operational stage (Dina & Meiliasari, 2025). Often, learning activities remain stuck in conventional methods that separate play from learning (Lyna Sari et al., 2025). One of the factors that influences the success of STEAM education is meaningful play experiences (Ng et al., 2022). Meaningful play experiences or commonly called as play activities are closely related to children in the pre-operational stage.

Therefore, the purpose of this study is to describe the implemention of STEAM education in play activities on the development students in the pre-operational stage.

RESEARCH METHOD

The type of this study is qualitative. The focus of this study is to observe student's learning process, not just the outcomes. This study only focus on 1 national school in Pangkalpinang. The subjects of this study are students in grade 1 of elementary school which is they are in pre-operational stage. The data collected by observation, interview, and documentation. The researchers are in the class to observe the implementation. The interview conducted to students during the class. The documentation are the photos and videos of learning process. The data analyzed using Miles & Huberman Model such as data reduction, data display, conclusion.

FINDINGS AND DISCUSSION

Findings

The implementation of STEAM education in play activities conducted through making a fan from origami paper. The main phases of this learning are:

1. **Mathematics: Conceptualizing the Square**

   The teacher provide students with origami paper. Most of students successfully identify the paper as a square. The teacher asked students what

they know about the origami paper. One of students raised the hand to tell the teacher about what he knows about the origami paper and can be showed in Figure 1.

Figure 1. The Participation of Student to Answer about Identify the Origami Paper

The student A stated that "there are four straight lines in the origami paper". Student B also stated that "the lines form a square". This sentecens mades the teacher curious how Student B knows about a square so the conversation happened in the class.

Teacher : How do you know the shape of origami paper is a square?
Student B : I know it from Roblox. Many squares and cubics in Roblox
Teacher : What about the others? Do you guys know about a square?

Most of students answered they know it from games. Indirectly, the development of technology also can increase students' insight. Then, the teacher introduce the elements of square such as side and vertex.

2. **Technology and Engineering: The Art of Folding**

Students asked to fold the origami paper to make a fan. This required high-level of fine motor coordination. From the observation, there are still students have a difficulty on folding the origami paper but most of students didn't find the the difficulties on folding the origami paper. The student's process of folding the origami paper can be showed in Figure 2.

(a) Students fold the origami paper by themselves

(b) Student who find the difficulties to fold the origami paper

Figure 2. Students' Process of Folding the Origami Paper

To make a fan from origami paper, students should fold the paper repetitively. The repetitive allowed the students to self-correct their folding. It is a key component of the engineering design process.

3. Science and Art: Aesthetics and Airflow

After all the steps were conducted by students, the teacher guided the students to explore about the airflow. It is a part of Science. The teacher asked the students to wave the fan and asked what they feel. From the waving fan, they feel a breee, linking the physical object to the concept of wind energy. The Art element was integrated where the students making the improvisation to make a fan from what they like and it can be showed in Figure 3.

Figure 3. The Improvisation of Student in Making Fan

Figure 4 below showed the student's work on folding the origami paper to make a fan.

Figure 4. Student's Artworks of Fan

Before closing the class, the teacher asked the students to take a photo for documentary. From the Figure 4, it can be showed that students chose their own color of origami paper. Their artworks are variety based on their folding the origami paper.

Discussion

From the results, the implementation of STEAM through origami paper effectively bridges the gap between abstract mathematical concepts and concrete play. According to Hunter-Doniger (2021), STEAM education in pre-operational stage can not be shown as the separate subjects but as an integrated subjects like Science, Technology, Engineering, Arts, and Mathematics that fosters holistic development. When students fold the origami paper, indirectly they exercise their sensory motor. This aligns the result of study by Deans & Wright (2021) that stated STEAM-based play significantly improves hand-eye coordination and patience in young learners.

At the first step, students observe the teacher how to making a fan by folding the origami paper. Then, students are asked to choose the color of origami paper. And then, they make a plan and in the end, they execute the planning. Yuliantino et al. (2024) stated that folding origami paper falls under the field of technology and engineering because students need a plan to execute them.

The activity of making a fan from origami paper, help the teacher to reduce the mathematics anxiety in learning geometry. By framing the elements of a square within creative project, students perceive the mathematical properties as a part of the art rather than a rigid rules. This aligns to Maria et al. (2022) that stated that Art in STEAM can imboost the engagement and emotional expression in pre-operational stage.

CONCLUSION

Based on the findings and discussion, this study concludes that the implementation of STEAM in play activities in the pre-operational stage through making a fan by folding the origami paper can support the development of students both in cognitive and sensory motor. The transdisciplinary such as the shape of origami paper which is a square as a concrete mathematical tool (Mathematics), then transformed by folding (Technology and Engineering) into a fan (Art). In the end, the students waved the fan that demonstrates the principle of airflow (Science).

Implementation of STEAM in play activities where the students make a fan by folding the origami paper is not merely an art project, it is a holistic pedagogical tool that aligns perfectly in the pre-operational stage.

This study only explore the origami paper to make a fan. The future studies could explore the other objects. This study also limited by one school. The future studies also could make in large subjects.

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