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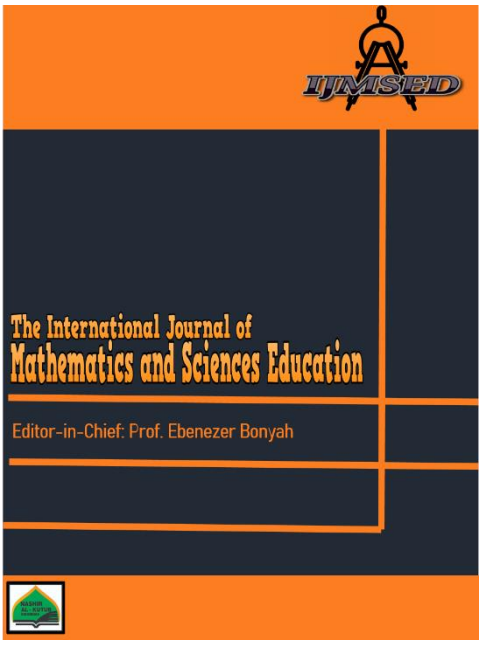

Development of pose estimation machine learning media to introduce two-dimensional shapes

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Orginal Article

Development of pose estimation machine learning media to introduce two-dimensional shapes

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Abstract
Most of the students needed help comprehending the geometry material concepts provided by the teacher. Learning media is one aspect that influences students' comprehension of geometry concepts. With the current situation, the use of the learning media such as pictures in a book or color-shaped paper does not relevant anymore. This project aims for a valid two-dimensional learning media, Pose Estimation Machine Learning (PEML), following students' characteristics and cognitive development. The developed online media facilitates visuals and allows students to move and perform motoric activities to represent the shapes. The method of the research was by using adjusted R&D steps: 1) preliminary investigation, 2) design, 3) realization, 4) test, evaluation, and revision, and 5) implementation. The participants of this study are second-grade students in a private elementary school in Central Jakarta. Data from the observation, students' worksheets, and interviews show that students were enthusiastic during the learning while they could still achieve the learning outcomes. The result indicates that PEML can be a medium for introducing two-dimensional topics.
Keywords: Pose Estimation Machine Learning, Two-Dimensional Shapes, Young Learners

1. Introduction

Meaningful learning in mathematics is essential for individuals, including young learners. Significant mathematics helps student's associate new material with pertinent concepts in their cognitive framework (Ausubel, 1963). Based on this assertion, meaningful mathematics emphasizes that learning is not limited to rote memorization of ideas or facts (root learning) but also involves connecting these concepts or points to generate comprehensive knowledge (meaningful learning. Geometry is one of the mathematical disciplines that must be mastered meaningfully. Geometry studies the attributes and relationships of lines, figures, surfaces, solids, and angles (Timky, 2010; Sudirman et al., 2022). The study of two-dimensional shapes falls under the geometry domain. There is a relationship and connection between concepts for mastering a 2-dimensional shape (Sudirman et al, 2021; Yaniawati et al., 2023). As there are infinite shapes, the relations and connections get complex. It will be easier for students to comprehend the material if they memorize all the concepts with understanding how to connect them.

Young learners in Indonesia have difficulty learning meaningful two-dimensional shapes. As the topic becomes more complex at higher levels, students older than nine loose interest in learning geometry due to the many ideas they should remember (Rosiyanti et al., 2020). The circumstance results in poor student performance and a failure to comprehend geometry's fundamental concepts. The basic idea that the students need help understanding is that Indonesian students erroneously think that a rectangle is a square and a triangle is a right-angled triangle (Fitri & Prabawanto, 2021). Students need help comprehending the features of 2-

dimensional shapes (Huang, 2017). According to van Hieles, the performance of students in geometry is ranked by five levels of geometry thinking (Vojkuvkova, 2012); 1) Level 0 “Visualization”, 2) Level 1 “Analysis", 3) Level 2 “Informal Deduction”, 4) Level 3 “Deduction”, and 5) Level 4 “Rigor”. According to a study (Wu & Ma, 2006), pupils in grade two should be at level 0, “Visualization”. At this level, students recognize and operate shapes (squares, triangles, etc.) and other geometric components (e.g., lines, angles, and grids) based on appearances (Van Hiele, 1984, 1986). Students identify figures based on their overall appearance. They may say triangle, square, cube, etc., but they do not specify the features of the forms specifically (Hoffer, 1983). Indonesian students still need to complete the desired geometry thinking since the students failed to identify a rectangle, a square, a triangle, and a right-angle triangle. A strategy should be applied to improve the geometrical reasoning of Indonesian pupils.

A strategy that could be applied to aid students' geometry thinking during learning 2-dimensional shapes is implementing a teaching method that follows students' development. According to Piaget's theory of cognitive development, the construction of knowledge occurs in four hierarchical stages (Akpan & Kennedy, 2020). The four stages are the sensorimotor period, the pre-operational period, the concrete operational period, and the formal operational period. Early elementary students, aged 7 to 11, are in the concrete operational period. Students begin to consider objects and events logically at the concrete operational level. At this level, the student can classify objects based on multiple features/characteristics and sequence them along a single dimension, such as size.

Moreover, Jerome Brunner defines three stages of learning related to thinking about the world: enactive representation, iconic representation, and symbolic representation (Akpan & Kennedy, 2020). One of the stages, or enactive representation, emphasizes that learning could be done through a movement or action. In other words, the student's understanding would be better if the educator used concrete material and allowed the student to do an activity. Based on Piaget and Brunner's theories, young learners suggested having a movement and using an object to classify the characteristics of 2-dimensional shapes to have the geometrical thinking level, or level 0. Visualization, as Van Hieles' theory suggests.

Moreover, with the advancement of technology, educators have started to integrate digital technology as the supporting media in learning two-dimensional shapes. As new digital technologies stimulate visual and physical interactions, the instructor could benefit from utilizing the technology (Clements & Sarama, 2011; Highfield & Mulligan, 2007; Sinclair et al., 2013; Sinclair & Moss, 2012). Young children are also known as "digital natives" because they are born and raised in the digital world (Prensky, 2001). Children do not necessitate adaptation to the new technological society, as they were born into it. The students are also likely to engage more in the learning process when using technology in the classroom.

The researcher develops Pose Estimation Machine Learning media to accommodate students' cognitive development and characteristics. Using the media, students must demonstrate a particular pose before a device's camera. A 2-dimensional shape will show on the screen following the students' pose. Using the media, students will learn 2-dimensional shapes while implementing Piaget and Brunner's theories, and young learners as the digital natives. PEML is an up-to-date

media that combines the current development of technology with motoric activity. The media uses machine learning, one of the technologies in the revolution industry 4.0., which will increase students' interest.

2. Method

This research was designed using Research and Development (R&D) design because the purpose of this research is to develop a learning media, machine learning. According to Plomp (2010), in creating Pose Estimation Machine Learning media, five steps in R&D need to be adjusted. The steps are:

Preliminary Investigation

The researcher interviews the teacher and second-grader students in a private elementary school in Central Jakarta**.** The researcher found that using things in class is the most frequently used media in learning two-dimensional shapes. The teacher points out the objects in the classroom and identifies the objects based on the shapes. However, the variety of shapes in the class is limited. For the distinctive shapes, like triangles or ovals, the teacher draws the shapes on the whiteboard and explains their characteristics. The teacher has yet to use digital media as the learning media in class. Whereas the teacher always brings a laptop to class and a projector available in the classroom. Based on the observation, the research found that the teacher had a coding introduction training for elementary and junior high school educators held by the Indonesian Ministry of Communication and Informatics. The researcher also asks about the students' familiarity with using electronic media. The students state that they are familiar with electronic devices. They use the device at least thrice a week. The preliminary survey was intended to find character references from teachers and students, which helped to build character in the learning media.

Design

After the preliminary observation, the researcher analyzed the second-grade syllabus, the teacher and students' interview results, and the young learners' cognitive development to find the criteria of teaching and learning media needed. In this step, the researcher decides to use machine learning in JavaScript as the designed programming. Then, the Pose Estimation Machine Learning was designed per the preliminary observation to introduce two-dimensional shapes. There are steps in designing the PEML. The detailed steps are: 1) listing the aim of learning, 2) choosing the prototype of two-dimensional shapes, and 3) deciding the pose that implies a shape.

Realization

When the design of the Pose Estimation Machine Learning has been done, then in this step, the machine learning starts to be coded. The code is done in p5.js. Creating Pose Estimation Machine Learning involves making three sketches: 1). Data collection; 2). Train model; and 3). Deploy. Data collection is the first sketch to collect a pose's possible x and y-coordinate points. After the first sketch was made, the train model sketch was designed to give the order to machine learning; What the machine would do to the data. Based on the collected data, the researcher wrote the coding to inform that there would be thirty-four inputs (the total of the humans' skeleton) and three outputs (the numbers of the prototype shapes). The researcher trains the neural network by using epochs=100. Finally, the Deploy sketch was defined to show the output when the user does a particular pose. The media would

work with the needs of the device camera in order to identify individual skeletons. The shape (triangle, rectangle, and circle) would show on the screen when an individual pose follows the pose in the first sketch.

Test, evaluation, and revision

After getting validation from the expert, the media would be tested to target students. Three beers are tested using the *Pose Estimation Machine Learning*. The students used the media for 15 minutes. The testing, observation, and discussion are conducted to record the students' experience using the PEML. As the media worked well. There is no revision in this step. The result of the testing would be used for considering the needed aspects of the implementation

Implementation

The participants used PEML media in the classroom**.** The media would be used at the beginning of the lesson in order to introduce two-dimensional shapes. The researcher observes during the implementation to identify the teaching and learning process and students' responses. The students are given the pose description sheet and worksheet before they student tries to do the pose. The worksheet would be used to verify students' outcomes and experiences in using the media. Finally, three students are interviewed to confirm the result from the student's perspective.

3. Results and Discussion

Validation Test

All of the validators have reviewed the Pose Estimation Machine Learning (PEML) media and assessed it with the feedback using the rubric provided by the developer. The first validator gave 85 as the total score or 94% as the percentage of the validity score. The first validator noticed that the media could not work in the mobile version and suggested that it would be nice if it could be used in the mobile version. However, because this research focuses on using PC as the supporting media, the Suggestion of the first validation would be the Suggestion for the following study. The second validator gave 79 as the total score or 87% as the percentage of the validity score. The second validator agreed that using the media would be helpful to introduce and visualize the two-dimensional shapes for young learners, especially since the media has novelty as there are not many technologies that can encourage young learners to use their motoric skills while actively learning mathematics concepts. The other highlight that the second validation gives the researcher is ensuring that teachers and students can use the media easily in real class situations.

Student Observation

The researcher observed the teacher and students' responses using Pose Estimation Machine Learning media. Before the teaching and learning begin, the teacher, together with the developer, sets the media in the different areas. While preparing the learning media, the researcher could see the students' enthusiasm for using the new learning media. When the teacher has set the media on the teacher's table and she would like to prepare the media on the students' table, the students try the learning media without having any instruction from the teacher. The students try to pop up the shapes by posing based on their perspective. The new media has taken students' engagement at first sight.

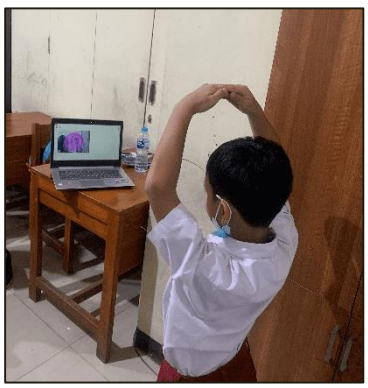
In the introductory session, the teacher informs the students how the Pose Estimation Machine Learning would work. The teacher poses the three poses, and she informed the two-dimensional shapes that show on the screen. After the teacher demonstrated the poses, the students tried the PEML media in their group. While using the media, the students showed enthusiasm in their gestures and facial expressions. The students lined up to try the PEML media with their group members. The students seem not to have any problem remembering the pose, even if they are not looking at the Pose Description, since they already remember the poses. However, the pose did not appear in a group because of the lighting problem. The students initiatively tried to pose using the other group members' laptops. Because of this condition, the teacher immediately tried to solve the problem, and the researcher suggested moving the laptop location. After a few minutes, the problem was solved, and the students returned to their places to try the media using their group's laptops. The implementation of PEML media at the second-grade level runs well following the expected learning scenario.

Figure 1

Students try the PEML media

(1)

(2)



(3)

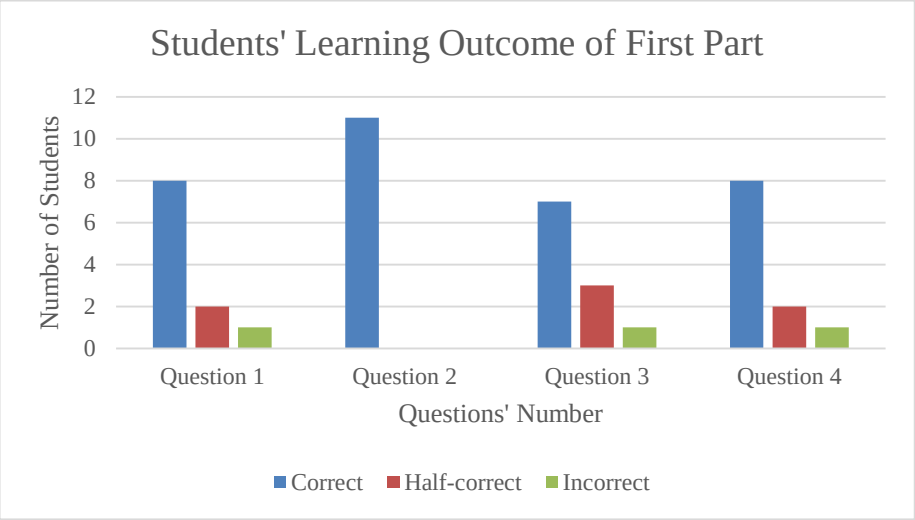
Student Worksheet

A student worksheet is held to determine students' outcomes after using Pose Estimation Machine Learning Media. The worksheet consists of two sections. The first asks about the material or the two-dimensional concept, and the second asks about students' feelings or reflections while using the PEML media. The part that would be scored is the first part only.

Part I. Two-Dimensional Shapes

There are four questions that the students need to answer. The first question asks the students to draw shapes and mention their characteristics in the provided table. The second question expects the student to link the picture of two-dimensional shapes with the name of the shapes. The third question asks the student to mention the difference between each shape. Lastly, the fourth question requires the student to mention the example of the two-dimensional shapes near them. Here is the diagram of students' outcomes of part one (See Figure 2).

Figure 2
Diagram of Students' Learning Outcome of the First Part

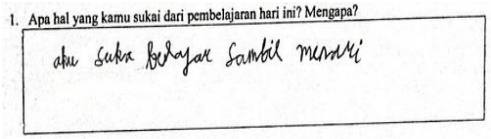


The outcomes of students' answers are grouped into three categories: correct, half-correct, and incorrect. Based on the chart, at least 7 out of 11 students could answer each question correctly, and only one student answered each question incorrectly. The situation indicates that most students understand the two-dimensional topic when using PEML as the teaching and learning media. The analysis of each number in parts I and II is shown below.

Part II. Reflection

There are four questions in the part two. The first question asked about the part of PEML media that the students like. All the students stated that they enjoy playing during learning. They liked to pose, sing, and discuss with friends.

Figure 3
Student's responses for number 1



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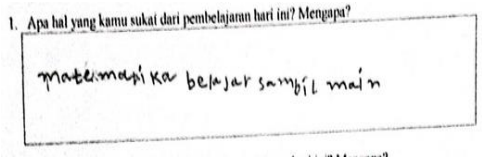

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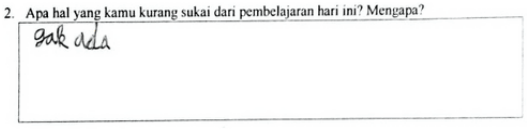
The second question asked about the dislike part in the media. Some students stated that they did not have any aspect that they unlike in the learning. However, there was a student who stated that she did not like posing because the circle shapes did not pop up. The student was part of the group that had a lighting problem.

Figure 4
Student's responses for number 2



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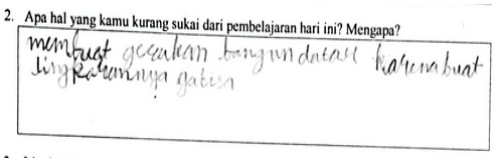

(2)

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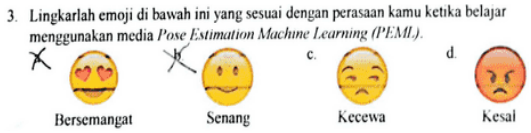
In the next question, the researcher asked the students to choose the emoji representing their feeling, the student chose options A and/or B. None of the students choose either C or D. Even two students chose both A and B because they stated they were excited and happy during the learning.

Figure 5

Student's responses for number 3



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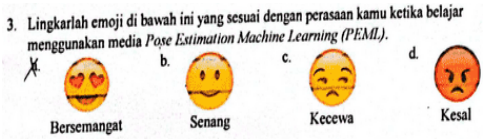
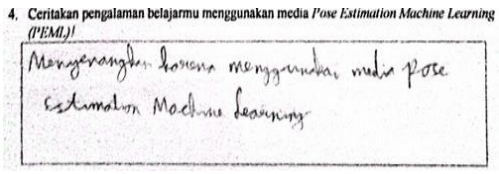


(2)

In the last question of the reflection part, the researcher asked the students experience in more detail. The students said they enjoyed learning because they could play while learning. PEML media requires them to do the pose, makes them active, and takes students' attention.

Figure 6

Student's responses for number 4



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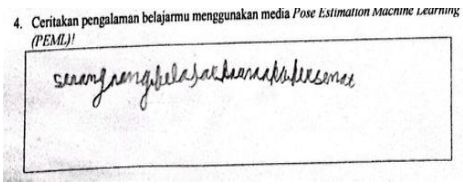

(2)

Interview Key Findings

The researcher held a structured interview to clarify the prior finding from the participants' perspectives. The researcher would ask three chosen students (One has a high result, one has a moderate result, and the other has a low result) one by one and discuss students' experiences while using PEML media. Based on the interview, all participants stated that they were happy using it since it was fun and easy to follow. They prefer to use PEML media rather than objects in the class. Student B shared that it is because PEML media involved movement, which makes learning more fun.

Nonetheless, all the participants get the primary purpose of using PEML media: learning two-dimensional topics. When the researcher asks about the topic, they could mention two-dimensional shapes' characteristics. All the participants could mention that a rectangle has four sides, a triangle has three sides, and a circle has no side. The researcher also asked what they needed to change in the learning media. The students' answers varied. Student A stated none of the aspects that she needs to change. However, student B states that he needed to add other two-dimensional shapes, such as hexagons. Student C adds that she needs to change the shapes; the square into a rectangle and the triangle into a star. All the interview participants did not have any problem with the color or size of the shapes. It shows

that the participants have no problem with the current media. They need more variety in the media.

Based on the results, students showed enthusiasm during the observation, confirmed by the reflection worksheet and interview, where they explicitly stated that they were happy using the media. The situation happens because Pose Estimation Machine Learning media is developed following students' cognitive development. Greenhow & Robelia (2009) stated that using appropriate learning media in the teaching and learning process can generate motivation and stimulation for learning activities within the student. The existence of learning motivation in students makes these students more enthusiastic in the learning process.

Based on the student's worksheet in Part 1, most students could answer the questions correctly. Ismail et al. (2017) stated that as the students are more enthusiastic in the learning process, the learning outcomes obtained can be optimal. The students can answer the worksheet regarding distinctive shapes, drawing shapes, and mentioning the example of two-dimensional shapes. The learning outcomes obtained by students are seen from the cognitive aspects and the affective and psychomotor aspects. Based on the student's worksheet in part 2. Reflection, most of the participants liked the developed learning media. The students said they liked the media since they liked learning while playing. The students enjoyed doing the pose, singing, and participating in learning. The PEML also covers different learning styles of students, namely visual, auditory, and kinesthetic, so that the mathematics learning process becomes more meaningful. Pose Estimation Machine Learning supports students' visual learning style through the two-dimensional shapes shown on the screen. The students who have audio learning styles are also supported by the music played during the media implementation. As the main activity, doing poses, students with kinesthetic learning styles are supported through the activity.

The students' data was clarified in the interview process. Students stated that they enjoyed and were excited about using the developed media. The students even said they prefer Pose Estimation Machine Learning to the usual learning media, such as nearest objects or shaped paper. The PEML media is developed following the characteristics of young learners. According to Brown (2001), there are five characteristics of young learners: having a short attention span, being very active, responding very well in praising, enjoying the acquisition, which is learning while playing, and enjoying fantasy, imagination, and movement. The learning scenario supports the students' characteristics where engaging students to be active every minute helps gain students' attention. The students were also asked to learn by playing, which did the pose in front of the camera. Understanding the characteristics of young learners is essential for a teacher. By understanding the characteristics of young learners, the teacher can integrate more suitable teaching and learning media in the classroom.

4. Conclusion

Based on the research and discussion results, the development of Pose Estimation Machine Learning media in introducing two-dimensional shapes to second-grade students can be a medium for introducing two-dimensional shapes to second-grade students. Data on the observation, students' worksheets, and interviews showed that the students are interested in using the media, which implies a great understanding

of two-dimensional topics. For further research, the researcher suggests developing the PEML in the mobile version as the consideration of the first validator. Also, as the research is a prototype, the different outcomes possible occur when the media has complete shapes. Finally, PEML media does not have its domain, and the coding is seen while using the media. Furthermore, PEML can be used at a higher level of education, not only at the lower-grade SD level but also at the upper-grade SD level. It could be implemented at junior high school, high school, and college levels.

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