Delta, Diamond, and Fighter Kites Project in Geometry Class

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Abstract. This research aims to develop teaching materials with didactical phenomenology in math education with the project of making Delta, Diamond and Fighter kites. This research carried out experiments conducted on various types of shapes to make Delta, Diamond, and the most ideal fighter kites based on theoretical of science. In addition, this study tested various materials to make kites. The results of the experiment show that the most ideal shape of the kite in order are, square, circle, rhombus, trapezoid, square, isosceles triangle and kite. While plastic is the most ideal material for making kites that depend on the mass of the material. with the phenomenon of the kites project can be used as teaching material in geometry class.

1. Introduction
Mathematics is an important subject to be mastered by students can actually contribute to the development of 21st century skills. But in reality many people consider that mathematics is a field of knowledge that is often considered a scourge for students. This is caused by 10 factors which include that "not many mathematical books published by Indonesia present questions in the form of context, consequently mathematics feels abstract and difficult to learn" in addition he also explained mathematics was considered difficult because of the students themselves [1]. This study will develop a teaching material to develop 21st century skills by applying mathematics learning using science phenomenology as an implementation of cross curriculum learning in the context of 21st century learning [2,3]. As an implementation of the 21st century learning, mathematical learning based on science phenomena can be used in mathematics learning, because the contexts of mathematics learning are mostly associated with science. This is inseparable from the nature of mathematics as an inseparable knowledge that can help humans understand and master social, economic and natural problems [4, 5]. In addition, Hilton’s said that mathematics is born and developed because of the desire of humans to systematize their life experiences, arrange them, and make them easy to understand, so they can predict and if possible control future events [6]. This is also reinforced by [7] who states that "a learning that explains phenomena and symptoms from the teacher to students, so that the teacher stimulates students to find formulas or mathematical models of phenomena or facts explained by the teacher.

Several studies in Mathematics education with didactical phenomenology is learning to improve cognitive and affective abilities of students/students through mathematics learning has been carried out related to the development of students' mathematical abilities [9, 10, 11, 12]. The results of these studies indicate that mathematical learning based on phenomena can improve students' mathematical abilities (mathematical communication skills, mathematical connections and critical thinking of students). However, these studies have not been directed at developing 21st century skills. Whereas research that has attempted to develop 21st century skills through mathematics learning required by students has been carried out by [12], who developed didactical design of mathematics learning through scientific phenomena and applied to middle school students. In addition, 21st century skills development has been applied to STEM-based integrative mathematics learning [13, 14, 15]. However, those study have not provide the development of preparing the primary school student.
Mathematics learning with the didactical phenomenology that will be reported in this study is learning mathematics with the science related to kites. While student of primary school loves to play, this learning material would be great to give them knowledge and also pleasure. This study reports the experiment using kites to find the best kite to make from the geometry point of view, and develop students 21st century skills.

2. Methods
This research uses R & D (Research and Development) approach, which intends to develop a Mathematics learning model based on science phenomena. The reason for using the R & D approach in this study is that researchers want to explore field data related to 21st century skills through learning mathematics with scientific phenomena. The research design used is quantitative and qualitative research that will be processed quantitatively, namely to reveal the field data needed to form a mathematical phenomenon based on science phenomena to develop 21st century skills. The final product of this research is the formulation of learning models and teaching materials mathematics learning based on scientific phenomena to develop 21st century skills.

This research is focused on developing mathematical learning based on science phenomenology. This study is a study of a problem in a planned manner using systematic methods and steps. The procedure adopted in this study is in accordance with the approach as in research and development (R & D) [16,17]. Research and development is an industry-based development model that is used for products and procedures, which are systematically tested, evaluated and refined criteria of effectiveness, quality, or similar standards [17]. This means that research and development methods are applied to produce products and test the effectiveness of products.

In the context of this research, the research products that will be developed and validated are mathematical instruction models based on science phenomenology. In the approach of the research model took ten (10) steps of activity, namely (1) limited surveys and research and information collection, (2) planning, (3) developing the initial product model design (develop preliminary form of product), (4) conducting initial product trials (preliminary field testing), (5) perfecting the main product (main product revision), (6) conducting the main product field test (main field testing), (7) correcting the results of operational product revision, (8) conducting operational field testing, (9) perfecting the model to develop the final product revision, and (10) dissemination and model dissemination and distribution [17].

As for the research developed by researchers, from the ten steps of the research model approach developed by Borg and Gall, researchers modified it into seven steps, namely: (1) preliminary study, (2) field study, (3) analysis of data from field studies, (4) preparation of learning models, results of data analysis, (5) validation of learning models, (6) implementation of recommended learning models, evaluation of impact of learning models. In the research experiments were carried out to get the most ideal kite in some forms of basic kites called delta kites, diamonds and fighters. The third form of this basic kite is basically a flat shape with triangles (isosceles and sides), and quadrilateral shapes have one folding symmetry. In this study experiments were carried out by making kites with the same area and then dropped from a height of 2m, then measured the time needed to reach the ground. Everything is compared to get the longest flat wake floating in the air. The next experiment was carried out to test the kite-making material. As a result of the first experiment, the kite with the ideal shape was made in various versions of the material, then dropped back from a height of 2m to measure the time to reach the ground. Everything is then compared to get the most ideal material to get the most ideal kites.

A kite can fly due to several factors. The first is the design factor that the kite design is symmetrical, meaning that if the longitudinal section is cut it will get two equal size. So that when flying he has balance. Second is the style of Aerodynamic Lift, as well as the force that causes the plane to fly. This lift style is derived from a change in air velocity that opposes the kite. When the wind that blows with velocity v is blocked by a stationary field (such as the surface of a kite) then kinetic energy will occur at (1/2) mv^2 which raises a kite where m is the air mass that blows. So the requirement that the kite
can fly in the sky is the presence of a gust of wind and a rope/thread that can make the kite stay in place. If there is no wind, there will not be an aerodynamic lift force, or if the thread breaks, the kite cannot "fly" but float following the direction of the wind to then fall to the earth due to the presence of gravity which exceeds aerodynamic lift.

A delta kites are a triangular-shaped kite and resembles the fourth letter of the Greek alphabet. A diamond kites are characteristically a flat, elongated diamond shape that require a tail. A fighter kites are used for the sport of kite fighting, most of them are small, unstable single line flat kites where line tension alone is used for control, traditionally an abrasive line is used to cut down other kites.

Some examples of the shape of a kite are shown in the following picture:

![Kite Shapes](image)

**Figure. 1 an example of deltas, diamond and fighter kite**

### 3. Result and Discussion

To do the first experiment related to the aerodynamic shape of a kite, the first step is to identify the basic forms of diamond, delta and fighter kites consisting of 8 flat shapes namely, isosceles triangle, square, rhombus, rectangle, kite, trapezoid is isosceles and circle. After that, the researchers determined the sizes of the flat structures so that they had the same area of 38.5 cm², so that these measurements were produced as shown in table 1.

| No | Geometrical shape | 1st size | 2nd size | Area |
|----|------------------|----------|----------|------|
| 1  | Isosceles triangle | Base = 11cm | Height = 7cm | 38.5cm² |
| 2  | Square            | Length = 6.2cm |       | 38.5cm² |
| 3  | Rectangle         | Length = 5.5cm | Width = 7cm | 38.5cm² |
| 4  | Rhombus           | 1st diagonal = 7cm | 2nd diagonal = 11cm | 38.5cm² |
| 5  | Kite              | 1st diagonal = 7cm | 2nd diagonal = 11cm | 38.5cm² |
| 6  | Trapezoid         | 1st edge = 6 cm, 2nd edge = 5cm | Height = 7cm | 38.5cm² |
| 7  | Circle            | Diameter = 7cm |       | 38.5cm² |

The sizes of the geometrical shape shown in table 1 are alternative sizes, because there are still several other sizes that can be used. The alternative that is input is the size chosen by the researcher. After knowing the measurements, then kite is made by the mm blocks with accuracy of 5mm. Then the experiment was carried out by dropping the kite shapes at a height of 2m in a closed room. Then the time needed to reach the ground was calculated with the help of a stopwatch. Furthermore, each geometrical shape is dropped by 5 repetitions, and the results are shown as in table 2.

Based on the table 2, it can be concluded that the shape of the ideal kite aerodynamically in ordered are square, circle, rhombus, trapezoid, square, isosceles triangle and kite. Based on this, it is quite
surprising that the kite in the form of a kite in mathematics is the least ideal form of aerodynamics. This means that flying kites commonly found by most Indonesian people in general are kites which have the lowest ability to fly. The most ideal form aerodynamically used as a kite is a rectangle and the circle, while the one that is a median is a flat isosceles trapezoidal shape.

Table 2. The time shapes needed to reaches the ground in seconds

| No | Geometrical shape | 1st exp | 2nd exp | 3rd exp | 4th exp | 5th exp | average | Std Deviation |
|----|-------------------|---------|---------|---------|---------|---------|---------|-------------|
| 1  | Isosceles triangle| 2.86    | 2.18    | 2.65    | 2.63    | 2.73    | 2.61    | 0.26        |
| 2  | Square            | 3.6     | 3.2     | 2.51    | 2.65    | 3.26    | 3.04    | 0.45        |
| 3  | Rectangle         | 2.68    | 3.37    | 2.93    | 2.18    | 2.12    | 2.66    | 0.52        |
| 4  | Rhombus           | 2.61    | 2.66    | 2.35    | 2.995   | 2.91    | 2.71    | 0.26        |
| 5  | Kite              | 1.94    | 2.1     | 3.2     | 1.77    | 2.23    | 2.25    | 0.56        |
| 6  | Trapezoid         | 2.12    | 3.12    | 2.79    | 3.03    | 2.33    | 2.68    | 0.44        |
| 7  | Circle            | 2.98    | 2.65    | 2.63    | 2.53    | 2.98    | 2.75    | 0.21        |

Max avg. score = 3.04  Min avg. score = 2.25

The second experiment was carried out after concluding that the ideal kite was a square kite, or a rhombus whose diagonals had the same size. Then, the researchers made other squares, from gold paper, plastic (paper), newspaper and HVS paper. The shape of the kite from various materials is then measured so that the data in table 3.

Table 3. Square Kite Mass

| No | Material       | Mass (Gram) |
|----|----------------|-------------|
| 1  | Mm block paper | 0.23        |
| 2  | Gold Paper     | 0.22        |
| 3  | Plastic        | 0.05        |
| 4  | Newspaper      | 0.18        |
| 5  | HVS            | 0.27        |

Based on table 3, the lightest mass of kite-making material is plastic while the hardest is HVS paper. The experiment was then carried out by dropping the material at a height of 2m, then measuring the time needed to reach the ground. Results of 5 trials on each materials are shown in table 4.

Table 4. The time needed in second to square with various materials reaches the ground

| No | Kind of Paper | 1st exp | 2nd exp | 3rd exp | 4th exp | 5th exp | average | Std Deviation |
|----|---------------|---------|---------|---------|---------|---------|---------|-------------|
| 1  | Mm block paper| 2.3     | 3.25    | 2.64    | 3.01    | 2.56    | 2.75    | 0.38        |
| 2  | Gold Paper    | 3.66    | 3.01    | 2.61    | 2.66    | 3.29    | 3.05    | 0.44        |
| 3  | Plastic       | 5.12    | 4.87    | 6.59    | 4.34    | 5.14    | 5.21    | 0.84        |
| 4  | Newspaper     | 4.09    | 3.22    | 3.27    | 3.55    | 2.74    | 3.37    | 0.50        |
| 5  | HVS           | 2.84    | 2.78    | 2.72    | 2.34    | 2.47    | 2.63    | 0.21        |

Max avg. score = 5.21  Min avg. score = 2.25

The results of this experiment shown in table 4 that plastic is the most ideal material for making kites. This is consistent with the prediction that the most ideal material is the lightest material. The next ideal materials for making kites are newspaper, gold paper, mm block paper paper and HVS paper. The relationship between the mass and the average time needed to reach the land is shown in Table 5.

Based on table 5, it can be concluded that between the mass and the time needed to reach the land have a very high relationship with the opposite direction. This means that the greater the mass of material to make a kite, the less time it will take to reach the ground when dropped from a certain height, and
conversely the smaller the mass of material to make a kite, the longer the kite will be for floating in the air.

Table 5. Correlation between mass and time needed to reach the ground

| Kind of Paper       | Mass (gram) | Time (second) |
|---------------------|-------------|---------------|
| Paper Scratch       | 0.23        | 2.75          |
| Gold Paper          | 0.22        | 3.05          |
| Plastic             | 0.05        | 5.21          |
| Newspaper           | 0.18        | 3.37          |
| Paper Scratch       | 0.27        | 2.63          |

4. Conclusion

Based on the results of the above research, a teaching material has been developed to develop 21st century skills with learning mathematics with the phenomenology of kites. Kites are very popular toys for children. Therefore this teaching material will be able to provide experience for elementary school teachers until later it can be delivered to students. Based on the experiment, it has been found that the most ideal shape of kite and its materials. Learning materials with scientific phenomenology will also be suitable with the 2013 Indonesian curriculum for elementary school students with integrated thematic concepts. Students can be given a kite-making project which is a combination of shape to form Diamond, Delta or Fighter kites.

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