# Construction of Water Rocket Game Props for Science Learning in Primary Schools

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**Abstract**

*A water rocket is one of the simple types of props that comprise many science concepts. Manufacturing the water rocket is simple but every movement of water rocket launch needs high analysis. This research aims to design a scheme of water rocket props and to analyze the factors that affect the furthest distance of the water rocket launch. Some science concepts in the water rocket launch are examined. The results represent that throwing at 45-degree angle produces the furthest distance. The shape of the water rocket's propeller is a trapezoid with a total of 3 propellers. The results also can be used as a reference material for teachers in conveying science knowledge so the learning science will be more concrete and fun, especially in primary school.*

***Keywords:*** *Props, Water Rocket, Learning Science for Primary School*

## 1. Introduction

Water rocket is one of the models that can be used as teaching aids / learning media in schools in introducing the forms and events of space rocket launches that cannot be seen directly by students at school. Water rocket is one of the props that can attract the attention of students, in which there are many aspects of science that have not been known by students so students are interested in learning it. Water rocket props can be made from used items such as used plastic bottles, nozzles from motorcycle hubcaps, mica plastic, and bicycle pumps that are easy for us to get where the items are designed in such a way as to form water rockets. The design of water rocket props carried out by students with teacher guidance is very good for developing cognitive, affective, psychomotor, and creative thinking skills. The basic principle of using water rockets is to issue a volume of water from the rocket nozzle which also means the air pressure difference as energy supply in water rocket launches (Nelson in Fitria, 2016). The making of water rocket needs deep analysis to produce the farthest distance. This depends on the variable used as the assumption in the experiment. The more variables used, the more complex it will be in analyzing the data, but it will produce more varied findings.

Water rocket props can be used as a medium for science learning in elementary schools. Aside from being a learning media, water rocket games are also commonly used as a competition event at the school level. So that teachers and students must be able to make water rocket props by considering several factors to produce a water rocket that glides long distances. As a medium of learning in elementary schools, water rocket props can be analogous to octopus or squid swimming. Squid moves by pushing itself. Squid will take water and remove it from the body in a great style. Water that enters the body of the squid is used as fuel to push the body of the squid. Like water rockets, water used in water rockets is used as fuel to push the rocket's body into the air. Water released works the same style, but is in the opposite direction to a squid or rocket that moves so that the rocket or squid moves forward.

Haryani, Amaliah, Fitrasar, & Viridi (2011) in a paper presented in a science education seminar describing rocket technology. Water rocket is an interesting type of educational toy to study. Although the basic principle is simple, namely using water and air as a push force, motion analysis in each phase is quite complicated. The formulation of an analysis of water rocket motion involves thermodynamic studies, physics of mechanics, and Euler's numerical integration algorithm. Based on the results of the data obtained, it will be explained the effect of variations in input parameter data

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on the motion of water rockets and the size of the maximum height efficiency that the rocket can achieve. (Untung Joko Basuki, 2016), With this water rocket game, children and teenagers explained how the rocket process could glide. This method becomes a process of explanation of technology that is packed with games.

This research is corroborated by previous research conducted by (Intan Irawati, 2016) which states that project-based learning has provided a conducive environment for students to create and design technology products. Students also become more active, enthusiastic, critical, creative in learning physics. (Pina Pitriana, 2018) also stated that the results of research conducted showed that more than 90% or the majority of students gave a positive response to learning and were able to increase students' motivation and learning activities during the learning process. The same thing was expressed by (Muhamad Ijharudin, 2018) who stated the response of students to the existence of this training was positive, because some students felt happy and understood the material presented.

The phenomenon of the movement of squid or octopus can explain one of the concepts of science in elementary schools, namely the concept of style. The teacher can give a problem to students why the squid is moving towards the front. By giving the problem, students think to look for answers. With the answers from students, the teacher then directed the making of water rocket props to explain the phenomenon of the movement of squid having the same concept as water rockets. So that it is expected that creative and critical thinking skills can be cultivated in students through the creation and experiment of water rockets.

## 2. Methods

Making water rocket props comes from used goods that are easily accessible in everyday life. The main ingredient of water rocket props is plastic bottles. In addition to plastic bottles, tools and materials needed in the manufacture are motorcycle nozzle and rubber buffer / foot stove, wooden launcher as a buffer, pumping machine, water, mica plastic to make nose cone, material from polycarbonate to propeller baling / wings. Plastic bottles used are plastic bottles that have a volume of 1500 ml (diameter = 9.03 cm) and 390 ml (diameter = 5.99 cm) as a comparison. The broad size of the trapezoidal rocket propeller is 75 cm2 and the triangle shape is comparable with an area of 112.5 cm2 with the same base length of 15 cm. Nose cones are cone-shaped and non-cone as a comparison. The flow chart of rocket experiments is shown in Figure 1.

The flow chart shows that the dependent variable is only the distance of the rocket launch. This is because the science material for students in elementary schools does not explain the concept of bullet motion. So that it does not record the height and time of the water rocket launch. Figure 2 is a water rocket scheme.

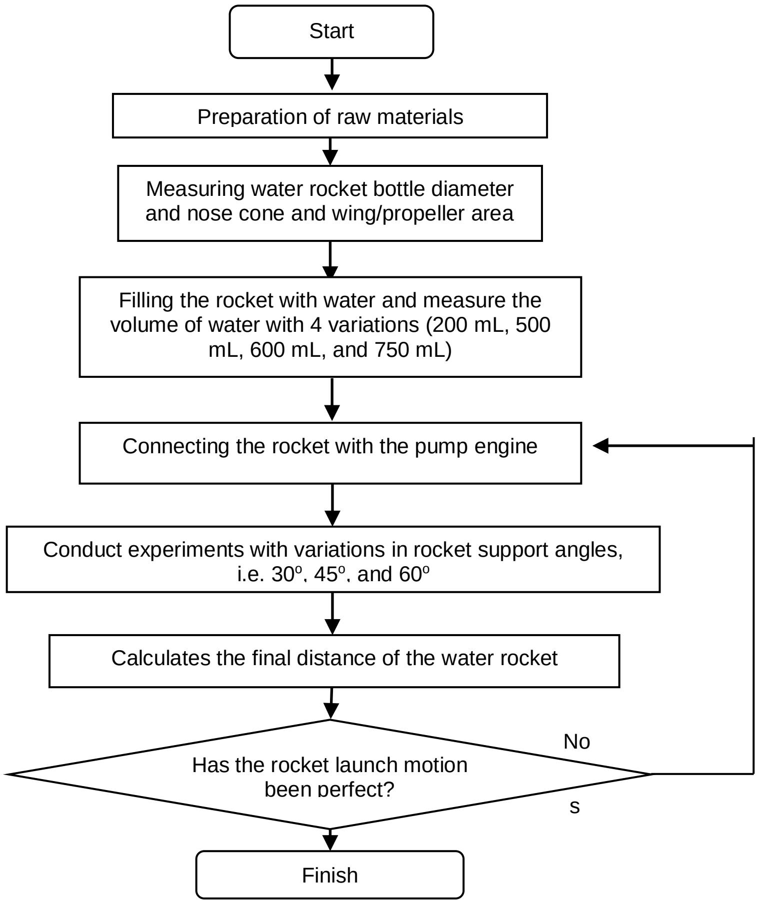


Figure 1. Rocket construction flow chart

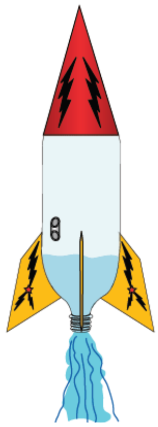

Figure 2. Water Rocket
(Source: www.nasa.gov)

## 3. Results and Discussion

Making water rocket props requires simple materials and techniques. Although simple, it requires accuracy in the selection of tools and materials to get a long sliding distance. The plastic bottle used is a volume of 1500 mL with a diameter of 9.03 cm.

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Water rocket wings with a thickness of 0.3 cm and trapezoidal shape with a vane area of 75 cm2 and a number of propellers as many as three. Nose cone shaped cone with a diameter of 9.21 cm. Table 1 is the result of experimental data.

Table 1. Observation Data

| **No** | **$\vartheta$(°)** | **$x_{max}$ (m)** |
|---|---|---|
| 1 | 30 | 35.1 |
| 2 | 45 | 37.7 |
| 3 | 60 | 36 |

The volume of the bottle used as a comparison is 390 mL with the same thickness of material. The shape of the water rocket wing used as a comparison is a triangular shape with an area of 112.5 cm2. In addition to the triangular shape, the number of wings is also compared by using 4 wings.

Nose cone is divided into 2 variations, not cones and cones.

The selection of plastic bottles as a rocket body and mica plastic made from polycarbonate as rocket propellers aims to reduce pressure in the air and keep the motion of the rocket launch stable. If the rocket's body and wings are made of bottles and thin mica plastic, there will be greater friction and the rocket's movement in the air becomes unstable. The size of a plastic bottle as a rocket body has a volume size of 1500 mL because it is more able to accommodate more air and water and has a stronger pressure. Rocket volume determines the maximum amount of energy that can be stored in compressed gases because energy is proportional to pressure and volume (Podesta, 2006). In contrast to the volume of bottles, 390 mL with the same thickness results in shorter sliding distances than bottles with a volume of 1500 mL. This is consistent with the results of the experiment Podesta (2006) explains that large bottle volumes are more likely to produce a longer launch distance than small volume of bottles.

In addition to the type of material, the shape and size of the wings need to be considered. Based on the results of the experiment the trapezoidal wing shape produces a sliding distance farther than the triangle shape. This is because the wing shape is related to the cross-sectional area. The greater the cross-sectional area of the rocket, the greater the resistance the rocket receives when gliding. By calculating the area of each rocket wing shape, the trapezoidal shape has a smaller area than the triangle shape with the same length so that the trapezoidal wing can be used as a recommendation in making ideal water rocket props. The number and position of wings / water rocket propellers need to be considered. This is because it greatly influences the movement of the rocket launch in the air. According to Podesta (2006) the making of water rocket wings needs to be considered several aspects, namely all fins must be equal to each other, positioned at the rear of the rocket, must be symmetrical around the rocket (every 120o if three fins / wings will be made and every 90o if four wings will be made). Based on the results of the experiment the number of wings / propellers with 3 pieces yields a sliding distance farther than the number 4 which is 37.7 m and 26 m. Conical nose cones produce farther rocket launch distances than non cone-shaped nose cones . Based on the data generated that at an angle of 45o and the volume of water of 500 mL resulted in a rocket launch distance with a cone and cone nose cone were 35.1 m and 37.7 m. This is because the cone-shaped nose cone makes it easier for the rocket body to pass through friction in the air and the rocket movement in the air is more aerodynamic (Podesta, 2006). The results of Nuril's study, et al. (2012) show that of the six throwing angle variations, the 45o angle produces the farthest distance.

Water rocket props are able to explain the concept of force and pressure more real and fun than just explaining the concept of force and pressure through lectures. This is because students get direct experience to create and practice themselves so that they are expected to be able to activate students and improve student learning achievement and produce meaningful learning. This is in agreement with Dale in Arsyad (2002) that a person's memory reaches 90% when directly involved in learning is different from the memory of someone who reaches 10% who is only involved in reading activities during the learning process.

Learning is meaningful is one thing that is important because students make a concept search through the process of discovery and linking information to the cognitive structure that already exists in students. Ausubel in Wilis (1989: 112) states that meaningful learning is a process of linking new information to relevant concepts contained in one's cognitive structure.

The making of this rocket props in accordance with Nurlaila's research, et al. (2016) shows that teaching aids (mock-up types of water rockets) can be used as alternatives in science learning in elementary schools. The presence of media in learning can increase students' enthusiasm for learning. Agreeing with Ismail (2015) in his research states that "... it is important for schools to develop new, comprehensive media ...". This is because learning media can explain abstract concepts to concrete. This is in agreement with Mustaqim in Jamilah.S & Reza Oktiana. A (2016) which states that teaching aids / media can help students to think creatively because with teaching aids / media students are able to develop existing concepts by practicing directly or applying theory in real conditions. Trianto (2013) explains that media has some practical values, one of which is making concrete abstract concepts. According to Piaget in Wilis (1989) students at the level of development of primary schools are at the concrete operational level (7-11 years) and formal operations (11 years and above). Although elementary school students have been able to think abstractly and are able to form more complex operations, guidance from the teacher is still needed to find the right concept. Learning science in elementary schools using water rockets can be used to convey the concept of force and pressure. In addition to the science concept, learning in elementary schools using water rocket props can be used as thematic material in accordance with the 2013 curriculum. Water rocket props can explain the concept of force and pressure in science materials, the concept of the area and volume of a flat building in the MTK map, and making artworks and creative works on SBDP subject matter.

## 4. Conclusion

The results showed that at 45o throwing angle resulted in the farthest launching distance (xmax) with a bottle volume of 1500 mL, the shape of the propeller (wing) which was trapezoid which amounted to 3 pieces and a water valume of 500 ml cone shaped cone.

Learning in elementary schools using water rocket props can be used as thematic material in accordance with the 2013 curriculum. Water rocket props can explain the concepts of force and pressure in science materials, the concept of area and volume of a flat building in MTK maps, and making artwork and creative work on SBdP subject matter.

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