Air pressure in mini hovercraft

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Abstract. calculate the pressure on the mini hovercraft experiments by using the formula by knowing the mass of large balloon is 20.49 gr with a force of 0.2045 N was counted after balloon filled by air. The surface area was 0.011304 m$^2$ so the obtained pressure was 18.09 Pa. Calculation of a small balloon pressure with a mass of 20.3 g calculated after the balloon is filled with air by the force of surface area 0.203 the N of the surface area 0.011304 m$^2$ then the pressure of Pa is 17.95. A simple mini hovercraft that used for physics learning media on the pressure principal explains the utilization of air pressure on the mini hovercraft. The making of this mini hovercraft as a learning media is aimed to show the concept of pressure. From the results of observation and analysis of the data, it was proved that air pressure generated can produce bigger lift than the mini hovercraft weight. The air flowing out from the balloon in the bottom caused the mini hovercraft to be pushed upward.

1. Introduction
Physics, chemical, and biological aspects have been integrated to be the subject of Natural Science. Science is concerned with how to systematically inquire about nature. Science is not only the mastery of knowledge collection in the form of facts, concepts or principles but also a process of discovery. The science learning process emphasizes on the provision of direct experience to develop competencies by exploring and understanding the natural environment scientifically.

In understanding physics as one of the subjects that is considered difficult and in delivering the physics lesson, teachers often give explanation and lecture by using the whiteboard as a learning medium so that it seems to be monotonous. The concept is abstract and it seems to be unrealistic. In fact, not all physics concepts are abstract but it can also be concrete. Science and technology have been developing in this era of globalization and the world of education is required to be able to follow these developments. Many technological devices are being developed in the education world, but in some remote areas the use of technology-based media is still limited. In this case, teachers need to be more creative. Even with the limitations of the school, mini hovercraft can still be made and used to explain the concept of air pressure and provide a direct experience in understanding air pressure.

Air pressure is the power that works to move the air mass in any given unit area. It is measured using a barometer. The unit of air pressure is millibars (mb). Lines connecting places equal to air pressure are called isobars. Air pressure is measured by the force pressure on surfaces of a certain extent, for example 1 cm$^2$. The units used are atmospheric (atm), millimetres of mercury column (mmHg) or millibar (mbar). The standard air pressure (also often called normal air pressure) is the air column pressure as high as the Earth's atmosphere layer at the latitude 450 and the temperature of 0 °C [1]. The amount of air pressure is measured as 1 atm. The pressure of 1 atm is equivalent to the pressure given by the mercury column
as high as 760 mm. The pressure unit other than atm or mmHg is kg/m². Air pressure is the level of air wetness because in the air, water always exists in the form of water vapor. The moisture in warm air is more than the content in cold air. If the air containing a lot of water vapor is cooled and the temperature goes down, the air cannot hold much water vapor. The water vapor turns into water droplets. The air that contains much moisture is called saturated air [2].

The results of previous research, regarding the design and testing of vehicles integrated hovercraft, model obtained the greater the burden of hovercraft, the higher the skirt the more down and the heavier the burden of hovercraft, then the time required to raise the skirt takes a long time [3]. The design of the wireless hovercraft prototype was successfully realized and worked well and found that wind and ground / water levels greatly affect the stability of hovercraft [4]. The concept of hovercraft is very simple, but the actual construction of it is a difficult task. The calculations involved are very complex and they must be very accurate. Weights should be evenly distributed and the centre of gravity must be correctly identified [5]. Based on the results of literature studies conducted that no one discussed the concept of pressure on hovercraft that is easy to understand for elementary school.

Based on the description above, to provide direct experience to teach the concept of air pressure, a mini hovercraft is needed. Hovercraft creates air vents, which are trapped under the vehicle with a curtain around the base. Air currents can make air cushion on the soil, smooth surface or water. A mini hovercraft is a vehicle that drifts above the ground or water because of its air cushion. As we know that one of the essence of physics is doing the experiment or practicum. With this mini hovercraft, students are no longer see physics as a troublesome lesson. Based on the background and problem formulation, this research aimed to give understanding to the concept of pressure on a mini hovercraft. This research was expected to provide benefits; they are (1) for researchers to understand the concept of pressure on a mini hovercraft media; (2) for other researchers, this study could be an additional reference in conducting research related to air pressure.

2. Methods
Design best research by using development of model that oriented to Hannafin and Peck’s product. Hannafin and Peck's development model consists of three phases of development: (1) necessary of analysis; (2) design / planning; And (3) development and implementation. A product-oriented model for Learning media. Needs analysis phase, aims to prepare all that is needed for hovercraft design and engineering, then the literature study aims to find information about hovercraft, how it works, as well as data for hovercraft design and engineering. Next the design / planning stage, this stage of information from the requirements analysis phase is transferred into the document form which will be the purpose of manufacture. To make a mini hovercraft, the tools and materials needed are as follows: Pop- up caps from recycled plastic drink bottles, a compact disc (CD), craft glue, Balloons of different sizes (small mass 20,30 gr, force 0,203 N and large mass 20,49 gr, 0,2045N), and Stopwatch. Initially design the hovercraft. Then, the tools and materials are assembled to resemble the original hovercraft with the concept of pressure. Remove the pop-up cap from the plastic beverage bottle so that the mini hovercraft media can move and air cannot escape. Next, test the mini hovercraft using balloons with different sizes (small and big balloons). Start the timer, open the top pop-up, and push the mini the hovercraft. Stop the timer when the mini hovercraft stops hovering.

The next stage of development and implementation, activities undertaken by researchers at this stage is the income of testing. Next retrieval and processing of test result data which continued with analysis of test data. The data of test results that have been taken is presented in the form of tables and graphics so it is easier to analyze and know the performance of mini hovercraft.

Mini hovercraft is a miniature of the real hovercraft. Hovercraft is a vehicle that glides above the surface by hovering over an air cushion. Therefore, hovercraft is also called Air-Cushion Vehicle or ACV. Hovercraft creates air vents, which are trapped under the vehicle with a curtain around the base [6]. Air currents can make air cushion on the soil, smooth surface or water. Mini hovercraft is a vehicle that drifts above the ground or water by using air cushion. A balloon installed on the mini hovercraft supply the air above and all around the mini hovercraft to go down under the CD. In this
mini hovercraft experiments the thing discussed was air pressure and that air pressure is not affected by temperature and altitude. The author used a mini hovercraft as a medium to explain how air pressure caused lifting in this case. Pressure, F is the weight of the mini hovercraft plus the weight of the pop-up caps and A is the surface area of the CD.

A medium is anything that can be used to transmit messages from the sender to the recipient so that it can stimulate the thoughts, feelings, attention and interests and attention of students in such a way that the learning process occurs [7]. According to Marshall McLuhan [8] the media is an extension of humans that enables them affects others who do not do direct contacts with them. Thus, it can be said that learning medium is everything that is used during a learning process so that it grows the student’s interest and makes teaching and learning activities to take place. Various types of media are created by teachers to make it easier for students to understand the material presented by teachers.

The concept of pressure on the mini hovercraft media is defined as the force per unit area, where the force of F is understood to work perpendicularly to surface A. If we look at a fluid-filled closed surface then the surface element is represented by vector A whose magnitude represents the area of the element and its direction is taken outward in the normal directio

the force (F) applied by the fluid against the surface element is,

\[ F = PA \]  

where P as pressure in Pa, A is area in m2, F is total weight of the mini hovercraft + crew (N). The International Unit for pressure is N/m^2. This unit has the official name Pascal (Pa), in honour of Blaise Pascal [9]. 1 N / m^2 = 1 Pa and 1 atm = 76 cmHg = 1.01 x 10^5 Pa.

This is related to the surface vector element (normal vector to the surface) with the total weight of the mini hovercraft working on it. Pressure, as a scalar, has a direction. This is the force given by the previous relationship with a quantity that has direction, not pressure. If we change the orientation of the surface element, the direction of the normal force changes accordingly, but the pressure remains the same. A pressured fluid will direct a force on each surface in contact with the fluid density. Fluid pressure is the pressure at a certain point inside the fluids, such as water or air. In a natural open conditions, it can usually be estimated that pressure is "static" or immovable conditions (even in seas where there are waves and currents), since the motion is ignored when the pressure changes. The conditions are in accordance with the principles fluid statics.

The pressure at a particular point of the immobile fluid (static) is called hydrostatic pressure [7]. The body is covered in either "static" liquid, when the liquid is immobile, or "dynamic", when the liquid can move as in the pipe or by compressing the air gap in a sealed container. The pressure is in closed condition according to the principles fluid dynamics.

To lift the mini hovercraft, adequate air flow and air pressure is required. The debit of the incoming air is greater than the outflow of air [10] he debits or air volume is

\[ Q = \frac{V}{t} = A. v \]  

3. Result and Discussion

The experiments were conducted using large and small balloons. To calculate the time required by the mini hovercraft to stop a stopwatch was used. Based on the five times of experiments, the results obtained was presented in following data.
Figure 1. media mini hovercraft

Table 1. Time required by mini hovercraft to stop moving.

| Experiment | Small balloon (s) | Big balloon (s) |
|------------|------------------|-----------------|
| 1.         | 4.9              | 19              |
| 2.         | 5.0              | 19.5            |
| 3.         | 5.0              | 18.0            |
| 4.         | 5.1              | 19.0            |
| 5.         | 4.9              | 19.0            |
| **Average** | **4.98**        | **18.90**       |

Based on the average of the small balloons it was obtained an average of 4.98 seconds while in large balloons it was obtained an average of 18.90. Based on the data obtained during the 5 times the experiment on the small balloons the amount of time required was faster than large balloons because the balloon dimensions are different.

Table 2. Pressure calculation result.

| Balloon Size | Mass (Gr) | Power (N) | Surface Area (M²) | Pressure     |
|--------------|-----------|-----------|-------------------|--------------|
| Big          | 20.49     | 0.2045    | 0.011304          | 18.09 Pa     |
| Small        | 20.30     | 0.203     |                   | 17.95 Pa     |

Based on the above table, we can calculate the pressure on the mini hovercraft experiments by using the formula by knowing the mass of large balloon is 20.49 gr with a force of 0.2045 N was counted after balloon filled by air. The surface area was 0.011304 m² so the obtained pressure was 18.09 Pa. Calculation of a small balloon pressure with a mass of 20.3 g calculated after the balloon is filled with air by the force of surface area 0.203 the N of the surface area 0.011304 m² then the pressure of Pa is 17.95. The width of the CD surface or surface area of the circle was $A = \pi r^2$. Where A is surface area, $\pi$ is 3.14 and r is jari-jari.

The conditions of different balloon volumes with the same cross-sectional area that cause the time difference was the air outflow. The incoming air debit was greater than the outgoing air. For the air debit of large balloon

$$ Q = \frac{v}{r} $$

(3)
Table 3. Calculating debit.

| Balloon Size | Debit          | Volume  |
|--------------|---------------|---------|
| big          | $8.83 \times 10^{-4}$ m$^3$ / s | 0.017 m$^3$ |
| small        | $3.2 \times 10^{-3}$ m$^3$ / s  | 0.016 m$^3$ |

To lift the mini hovercraft a large air discharge was required in accordance with the surface volume and sufficient air pressure so that the mini hovercraft can drift on the surface traversed. Air flowed out of the balloon under the CD. When the CD was placed close to the table, the air pressure under the CD was higher than the upper air pressure. This applied also to upward pressure on the CD so that it floated in the air, greatly reduced the friction or even no friction between the CD and the desk. Air was pushed under the using balloons. The blue arrows explain the air pressure.

![Figure 2](image1.png)

**Figure 2.** The image of air pressure under the CD was higher than upper part. Yellow is surface area. Blue is air pressure.

![Figure 3](image2.png)

**Figure 3.** The image of air pressure under the CD was higher than the upper part so the mini hovercraft can drift. Yellow is surface area. Blue is air pressure.

The black arrows explain the air pressure generated by the air blow. Around the air source, the pressure is greater than the source of pressure at the edge of the CD and the farther is the air source the pressure disappears. The air under the CD will be at a higher pressure than the surrounding air so that the CD is pushed up. If the surface is not smooth then the air pressure moves to the lower part.

![Figure 4](image3.png)

**Figure 4.** When the surface is not smooth enough (purple), air can pass through the lower area. Blue is air pressure.

Mini hovercraft involves air to pressure and to send to channels in order to create air cushion under the mini hovercraft. To do that, an abundant supply of air is required.

The next thing is the board in this case was the CD pieces as the stand. Another purpose was to help distribute the surface air below it. With the appropriate speed, the air should be able to create a bottom layer. It happened when there was pressure. To build mini hovercraft, the pressure should be increased.

From the results of the direct observation, it appears that Mini hovercraft was able to lift by using a combination of pressure. Pressure was given by the balloon with the side of the hole of the balloon facing down. The resulting air pressure produced a lift larger than *the mini hovercraft* weight. Blowing air from the bottom of the balloon flowed out and caused the mini hovercraft to be pushed upwards.
This is the result of the third Newton’s Law which states that for every action there exist the same and opposite reaction.

The big balloon pressure was bigger than the small balloon pressure. Since the blowing air balloon was not continuous, at certain times the mini hovercraft stopped. The association between pressure and the time required was directly proportional. In the experiments the time required for large balloons was longer than the small balloon. However, it does not close the possibility of a small balloon to be faster to stop when the cross-sectional area is dilated. The mini hovercraft was lifted and was propelled by the thrust system [11].

4. Conclusion
To lift a mini hovercraft a large air discharge is required in accordance with the surface volume and sufficient air pressure so that mini hovercraft can drift on a surface in a certain amount of time. From the above experimental results, it can be concluded that large balloon pressure was greater than the small balloon pressure as well as the time required for mini hovercraft with big balloons longer than the small balloons. Air pressure can generate greater lift than the mini hovercraft weight. The air discharge for large balloons is greater than the air discharge for small balloon volumes under the same conditions of the cross-sectional area. Mini hovercraft can be used as a learning medium. This medium is very simple and easy to make, then this tool should be utilized as a medium of learning on the discussion of pressure at the elementary school level.

5. References
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