Development of Aid Tool using Arduino Uno Sensor for Dynamic Fluid at Senior High School

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Abstract The purpose of this research is to develop dynamic fluid teaching aids for senior high school. Visualized aid tool based on dynamic fluid material. The methods used in research are the ADDIE development model (analyze, design, development, implementation and evaluation). This device was designed using the Arduino UNO sensor that can be connected to the sensor, the water flow sensor serves as a discharge meter, the LCD display screen serves the result of the calculation of the water flow sensor, the sensors water work so that water is not abundant in the container, and feeding as on/off. There is a certain height of water faucet that can make the students adjust the height that will be calculated flow discharge, the difference in the height of the stream on the venturimeter and the difference in gas pressure in the pitot tubes. The aid tool also have a worksheet for students. Based on the result of expert validation of aid tool is 86% and the validation of material experts on the student's worksheet is 94% and efficiency on learning is 88%. The overall result of the expert validation test gets a good rating so the development of aid tool using the Arduino uno sensor and water flow sensor for dynamic fluid.

1. Introduction
Education is a process to influence students to adapt to the best possible environment, creating a change in it that allows them to function in people's lives[1]. Education is not something static, but something dynamic that requires continuous improvement. The world of education has a goal that must be achieved in the learning process [2]. Physics is one of the branches of science that focuses on direct experience to develop skills so that students explore and understand the concept of physics. The teaching of physics is designed to discover it and do it, it can help students to a deeper understanding. For the students themselves, the physics lesson is difficult and boring, which affects the learning outcomes of the students [3].

Physics has been taught since primary school in order to foster curiosity about physics from the beginning, but in reality, the level of higher school, physics lessons are increasingly considered difficult [4]. The study of physics in senior high school is to solve problems in everyday life using concepts and theories of physics [5].

Media learning is part of a delivery strategy that can be loaded with messages that will be delivered to students, whether in the form of people, tools or materials [6]. Aid tool is a learning tool that can make it easier for students because students can see, observe and understand directly the process of the event in fact [7].
Dynamic fluid is a material physics in senior high school, in his studies based on KD 3.7 and KD 4.7 curriculum 2013. The basic competency (KD) is expected and must be carried out by students of fluid dynamic learning in the 2013 program, i.e. students can apply the principle of dynamic fluid in technology and able to modify the idea or idea of a simple project related to KD 3.7 [8].

It was observed at SMA Negeri 2 Lubuk Pakam, a regency of Deli Serdang, North Sumatra province. The physics learning process in SMA Negeri 2 Lubuk Pakam Teachers More focus on mastering the material as much as possible, so that it feels stiff, and centered on one direction, the teacher. The learning process rarely gives students the opportunity to learn more actively through exploration and discovery of the material being taught.

Based on the results of the survey given to one of the physics teachers of senior high school 2 Lubuk Pakam obtained information, that teachers often apply the learning model and give hot problems to students, aid tool in the laboratory in the dynamic fluid is still limited. In the media, the teacher's information technology displays PowerPoint in the transmission material, as well as the teacher, instructs students to search for learning materials independently and subsequently results.

Based on the results of the observation obtained: (1) Students have difficulty learning physics because physics equipment is more difficult to understand students because of the students' limited ability to understand theory and formula and lack of students so that the semester exam grades are always under the minimum submission criteria (KKM) of 75. (2) Practice is often done, but only on simple material, because tools and materials are not available, the process of learning physics is still using conventional methods and working on hots that are less desirable students. (3) The problem that the teacher has often encountered is a matter of teaching hours, the limited time to complete the internship is the main obstacle for the teacher because the most used time is to pursue the material teaching.

This situation is based on the survey that was given to 28 students, 70% strongly agree physics are not interesting and unpleasant because the teacher rarely uses a variety of learning media, and only agree 30% of students who consider physics very interesting and fun. In addition, 78% of students say they are in full agreement that they are more enthusiastic when the equipment is feasible in the laboratory, while 22% of individuals agree that they do not need a Laboratory. Research by Marsella - Wiyatmo (2017) on Physics Education Journal, effective aid tool in the growing interest of learning is true aid tool, supported by Rusffendi's opinion that learning using real aid tool may increase the interest in learning [9].

Based on the above problems that need to be done to overcome the problem is by developing aids that can help students understand the concept of physics and learning that is effective and effective in completing the 2013 curriculum. Based on the background of the above problem, it is necessary to do the research with the title "Development of Dynamic Fluid Aid tool in Secondary 2 students Lubuk Pakam."

2. Methods
This research is the development research that produces the product in the form of aid tool [9]. Design this research using ADDIE's development model. Regarding the ADDIE development research stage in this study if presented as a graph is as follows:

![ADDIE Charts](image_url)

**Figure 1. ADDIE Charts**
This research procedure adapts ADDIE's five-phase development model that includes analyze (analyze), design, development, implementation, evaluation (assessment). [10] The first step in needs analyze, what learning analyze is needed in schools, teachers, and students. Data are obtained from teachers and students filling out questionnaires. The second stage of accessory design includes the preparation of physical frames, systematic identification, planning assessment tools, namely evaluation instruments and worksheets and components that will be contained in the tool. Step three, develop the aid tool that were produced at the design stage, then perform a validation test against the expert. Then the aid tool will also be evaluated to see how well the aid tool can and are worth using when there is a gap that can be revised back to make the aid tool better. The fourth step, the implementation of aid tool developed in senior high school. Students try aid tool and work on students' worksheets as learning, then complete pre-test, postest and student response surveys. The fifth stage of the research evaluation assesses the overall activity that has been carried out to assess the feasibility of the dynamic fluid aid tool that have been produced and also the analyze of product test results data so that products obtained by suitable dynamic fluid aids.

3. Result and Discussion
The results of this research are aid tool that use Arduino uno sensor, water flow sensor. The first step, the realization of an analyze composed of steps: the analyze of needs, aims to raise and establish the basic problems encountered in learning, so it is necessary for a development of learning media. With this analyze, you will get an overview of the basic facts, expectations and alternatives, which facilitate the determination or selection of the educational material developed. Learning analyze, phase analyze of learning components include basic competency analyze, learning objectives, learning situation analyze, learning content analyze. Student analyze, student analyze is a study of student characteristics that correspond to the design of the development of learning devices. The work of students and the components that will be contained in the media. The second step, in the planning plan, begins with determining the tools and materials to be used to create multimedia aid tool with the working principle of dynamic fluid concepts, taking into account size and shape. Thus, produces dynamic fluid design aid tool that will be developed to know as in the image as follows:

![Figure 2. Initial design of dynamic fluid aid tool](image)

The third stage, at this stage of development will be produced in the form of aid tool based on media design at the design stage. Then the aid tool will also be evaluated to see how well the aid tool can be and worth using. The Arduino Uno sensor works in the discharge stream in the pipeline that is connected to the Venturimeter and pitot pipe. Here is the accessory component in the image below:
The result of validating expert dynamic fluid aid tool in this validation phase, you will know how much the level of aid tool and work sheet are designed so that suggestions will be beneficial after they are developed.

Table 1. Summary of the aid tool validation result

| No | Eligibility aspects                | Total value | Percentage | Description |
|----|-----------------------------------|-------------|------------|-------------|
| 1. | Association with teaching materials | 67          | 89%        | Valid       |
| 2. | Education value                   | 44          | 88%        | Valid       |
| 3. | Endurance tools                   | 84          | 84%        | Valid       |
| 4. | Accuracy                          | 86          | 86%        | Valid       |
| 5. | Efficiency tools                  | 45          | 90%        | Valid       |
| 6. | Safety for students               | 65          | 87%        | Valid       |
| 7. | Aesthetic                         | 65          | 87%        | Valid       |
| 8. | Equipment completeness            | 43          | 86%        | Valid       |
|    | **Total value (conclusion)**      | **499**     | **86%**    |             |
The total value of the accessory eligibility aspect is 499 from the maximum value of 575 with a percentage of 86%. Based on the percentage of validation results indicates that the average eligibility value is in a valid or viable category.

Figure 7. Expert validation scoring results graph on every aspect

Summary of the results of Student worksheets Validation (work sheet) Dynamic fluid aid tool:

| No | Eligibility aspects     | Total value | Percentage | Description |
|----|-------------------------|-------------|------------|-------------|
| 1. | Content conformity      | 88          | 88 %       | Valid       |
| 2. | Concept Compliance      | 65          | 87 %       | Valid       |
| 3. | Visual display          | 84          | 84 %       | Valid       |
|    | Total value (conclusion)| 237         | 86 %       |             |

The results of the valider evaluation show that dynamic fluid aid tool are valid or viable for use in the learning process with a percentage of 86%. The content compliance aspect gains a percentage of 88%, 87% of the relevance of the concept, the visual display 84%.

Figure 8. Percentage of student work sheet validation assessment results

Then test the first test, the students calculate the speed, distance of Toricelli's theory and flow discharge. Students record the results on the observation board as below. The result of the discharge
calculation can also be determined with Arduino Uno. This data is used to calculate speed and distance.

**Table 3. Experimental Data Toricelli theory**

| No | Trial | $h_1$ | $h_2$ | $y$ | $g$ | Velocity | Distance | Debit |
|----|-------|-------|-------|-----|-----|----------|----------|-------|
| 1  | 1     | 63    | 48    | 48  | 9,8 | 1,71 m/s | 0,52 m   | 0,0217 m/s |
| 2  | 2     | 62,5  | 48,1  | 48,1| 9,8 | 1,65 m/s | 0,561 m  | 0,209 m/s  |
| 3  | 3     | 63    | 48    | 48  | 9,8 | 1,65 m/s | 0,516 m  | 0,209 m/s  |
| 4  | 4     | 63    | 48    | 48  | 9,8 | 1,71 m/s | 0,52 m   | 0,217 m/s  |
| 5  | 5     | 62,5  | 48    | 48  | 9,8 | 1,71 m/s | 0,516 m  | 0,217 m/s  |

Second practicum, students perform a venturimeter practice to determine the velocity of flow to the broad cross section. From the experiment, students got the concept that the flow rate is inversely proportional to the area of cross.

**Table 4. Experimental Data venturimeter**

| No | $h_1$ | $h_2$ | $A_1$ | $A_2$ | $g$ | Water surface height difference $\Delta h$ | $V_1$ | $V_2$ |
|----|-------|-------|-------|-------|-----|-----------------------------------------|-------|-------|
| 1  | 10    | 8     | 4,45  | 3,1   | 9,8 | 2 cm                                    | 13,79 | 19,44 |
| 2  | 10    | 8     | 4,3   | 3,4   | 9,8 | 2 cm                                    | 11,02 | 13,88 |
| 3  | 10    | 8     | 4,3   | 3,4   | 9,8 | 2 cm                                    | 11,02 | 13,88 |

The third practicum, the student performs a pitot tube lab to determine the speed of flow with the density of the flow in the section of pipe $A_1$ to the right. The flow of gas will also flow into the cross section of the $A_2$ pipe pushing fluids that are as high as $h$ and then retained, so that the gas speed entering section $A_2$ will be equal to 0.

**Table 5. Experimental Data Pitot Tubes**

| No | $\rho_1$ (gas) | $\rho_2$ (liquid) | $h_1$ | $h_2$ | $g$ | Water surface height difference $\Delta h$ | Flow speed |
|----|----------------|------------------|-------|-------|-----|-----------------------------------------|------------|
| 1  | 1,293          | 1                | 8     | 6     | 9,8 | 2 cm                                    | 0,37 m/s   |
| 2  | 1,293          | 1                | 8     | 6     | 9,8 | 2 cm                                    | 0,37 m/s   |
| 3  | 1,293          | 1                | 8     | 6     | 9,8 | 2 cm                                    | 0,37 m/s   |

The fourth stage of implementation for students is to find out to what extent the use of dynamic fluid aids and work sheet has a positive impact on increased student outcomes. Practical activities using dynamic fluid aid tool and work sheet aid tool that have been developed and have provided a response to students who aim to know students’ response to dynamic fluid aid tool and work sheet.

**Tabel 6. Value Data N-gain**

| Class         | Gain | Description |
|---------------|------|-------------|
| Experiment I  | 0.73 | High        |
| Experiment II | 0.65 | Medium      |

According to Table 4.6 showed that there was an increase in average student learning outcomes in Class I experience of 0.73 in the upper category, the Experiment II class gained 0.65 in the middle category. In addition to the percentage gained by students in the experimental class is 88%, which means that dynamic fluid aid tool are effectively used in learning. The overall response of students to
SMA Negeri 2 Lubuk Pakam was 36 students of fluid equipment with a percentage of 77% in the experimental class is good.

4. Conclusion
This dynamic fluid trainer can help students understand the concept of dynamic fluid i.e. discharge flow, Toricelli theory, Venturimeter, and pitot tubes. Based on the result of expert validation of aid tool is 86% and the validation of material experts on the student's worksheet is 94% and efficiency on learning is 88%. The overall result of the expert validation test gets a good evaluation so the development of aid tool using the Arduino uno sensor and water flow sensor for dynamic fluid so that it deserves to be used as a means learning at school.

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