**DEVELOPMENT OF RIPPLE TANK TOWER TO INCREASE SCIENCE PROCESS SKILL PRINCIPLES IN MECHANICAL WAVE MATERIALS**

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Abstract

This research aims to produce a worthy (valid, practical, and effective) ripple tank teaching aid to increase science process skills on the topic of mechanical wave. The methods in this research refer to ADDIE research model (Analysis, Design, Develop, Implementation, Evaluation). The developed teaching aid, was reviewed by two physics' experts from The State University of Surabaya, then was validated by two lecturers from The State University of Surabaya and a physics teacher in SMA Muhammadiyah 1 Jombang. Based on the result of validation that has been done, the developed teaching aid is worth to use if it is viewed from validity aspect. To know its worth from effectiveness, restricted trial was conducted towards 30 students on grade XI MIA-1 in SMA Muhammadiyah 1 Jombang. Achieving effectiveness is viewed from skills aspect, skills aspect in this research is science process skill, using pre-test and post-test. Based on the pre-test and post-test analysis, it shows that the students' science process skill is increasing. As for practical aspect, it was obtained by the students' response questionnaire. Based on questionnaire analysis, it is known that the students' response towards the teaching aid was positive and learning engagement was very good hence it can be stated that the developed teaching aid is worth to use from practical aspect.

**Keywords:** Ripple tank teaching aid, The worth of teaching aid, Science process skills.

# **PRELIMINARY**

Education must be obtained by every citizen, especially in Indonesia according to the 1945 Constitution Article 31 Paragraph 1 concerning the right of Indonesian citizens in obtaining proper education. Clearly listed in the preamble of the 1945 Constitution, one of the goals in the formation of a government based on Pancasila is the intellectual life of the nation. In other words, one of the ideals of Indonesian independence is to form a state government that has a smart society through education. Good education is reflected in the learning process (Argandi, 2013).

Learning is an activity that involves a person in an effort to gain knowledge, skills, and positive values ​​by utilizing the media as a source for learning (Baharuddin, 2015). Learning media is one component of learning that has an important role in the learning process. In accordance with the Government Regulation Number 32 of 2013 on the national standard of education, one of them is required to every educational unit has a means that includes educational media to support a regular and continuous learning process. Based on this, then media utilization should be one of the parts that should get the attention of the teacher as a facilitator in every learning activity.

Visual aids have an important role in learning activities. The visual aids can provide a visual experience to learners of the phenomena that occur directly, among others, to encourage learning motivation, clarify and simplify the concept of abstract and enhance the learning ability of learners. Phenomena in physics that can not be seen directly by the eye need props to visualize in the learning process. Learning directly through practicum and demonstration with visual aids will help learners be able to understand concepts more easily, effectively, attractively and efficiently. The use of teaching aids as a learning medium should be equipped with LKPD (Worksheet Learners) as a guide to its use. LKPD is a sheet that contains about the activities to be done learners (Prastowo, 2015). The props can be used by learners to provide a real experience in learning. Waves are one of the phenomena that require special props to show the elusive wave properties when only verbally explained.

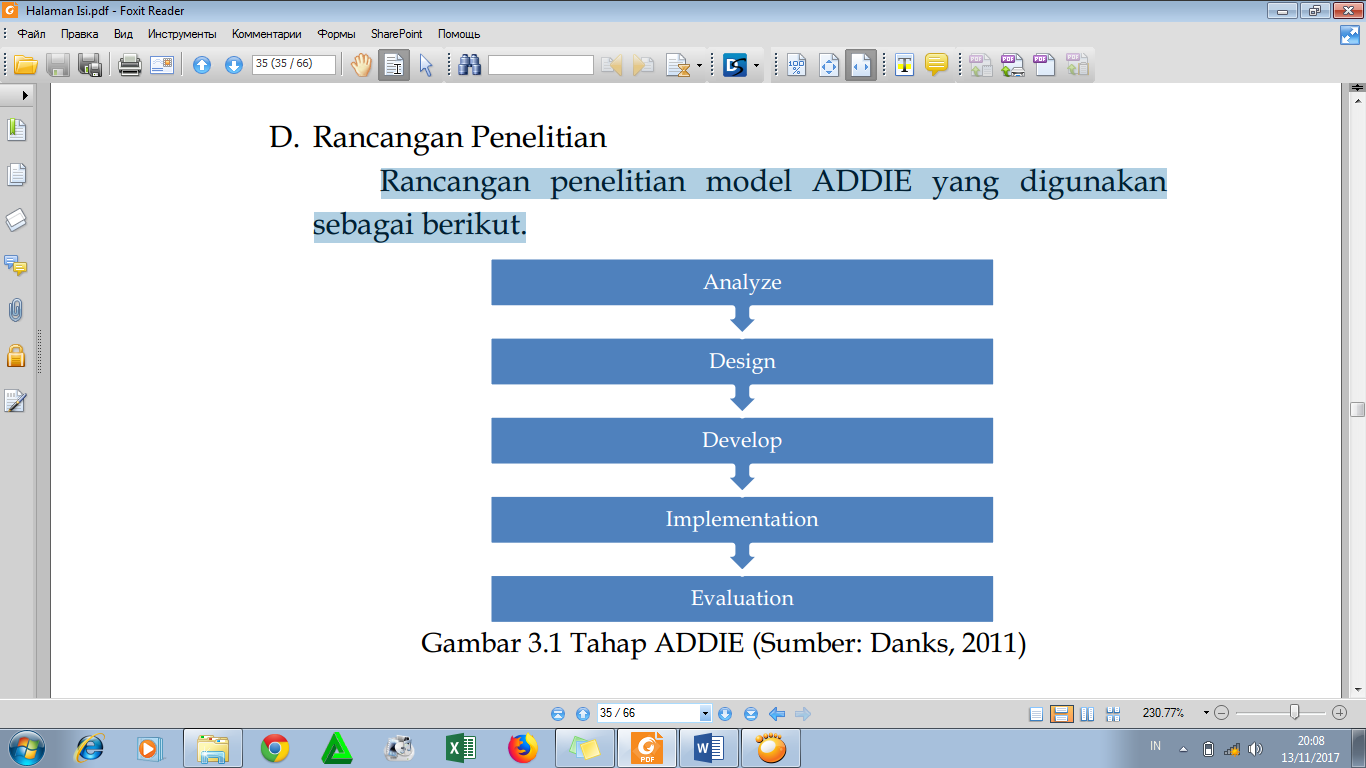
In the 2013 curriculum of 2017 revision, the waves are studied by learners in high school (X1 High School) semester even with mechanical wave material, sound waves, light waves and electromagnetic waves. If learners can visualize mechanical waves well, learners will more easily learn the next material of sound waves, light waves and electromagnetic waves.

Based on the relevant research by Eka Wahyudi entitled "Development of Tangki Riak Learning Media as a Physical Practicum Tool on Material of Wave Properties for SMA XI Class" obtained the analysis result of the learners response to conformity aspect 90,5% (very good), ease 78,6% (good), attractiveness of 83,7% (very good) and 85,7% (very good) accuracy means that the aspect of conformity, ease, attractiveness and accuracy of ripple tank is very well used as a practicum tool. From the results of this study concluded that the ripple tank learning media as a tool of physics practicum on the material properties of the waves worth to be used as a tool of practice.

The result of observation at SMA Muhammadiyah 1 Jombang conducted by interview to one of the physics teacher namely Mr. Samsul Mu'arif, S.Pd on 03 October 2017. In general, the need of physics learning media has been provided by the school in the presence of physics laboratory. However, the needs of teachers in developing learning materials are not all met in the laboratory. One of the learning materials of physics that have not found a learning medium and felt necessary to be held to help learners is the concept of wave and physical properties. In addition to the unavailability of media in the laboratory, KPS (Skills Process of Science) is rarely applied so that PPP learners are still low and mechanical wave materials are considered learners are still too abstract and need visualization. So it is necessary to use instructional media in the form of a tool that can visualize wave properties. Based on the background of the problem, in detail identified the problem of no props and LKPD to study the characteristics of the wave especially in SMA Muhammadiyah 1 Jombang. Therefore, it has developed props for the material properties of the wave that is in the form of ripple tank tools along with LKPD to provide an alternative solution to the problem.

**METHOD**

The type of research used is the development of ADDIE (Analysis, Design, Development, Implementation and Evaluation). This research develops ripple tank props as a medium of physics learning on mechanical wave material.



**Figure 3.1** ADDIE Stage. (Source: Danks, 2011)

This study was conducted on 30 students in class XI MIA-1 SMA Muhammadiyah 1 Jombang in the even semester, academic year 2017/2018 until the stage of limited trials.

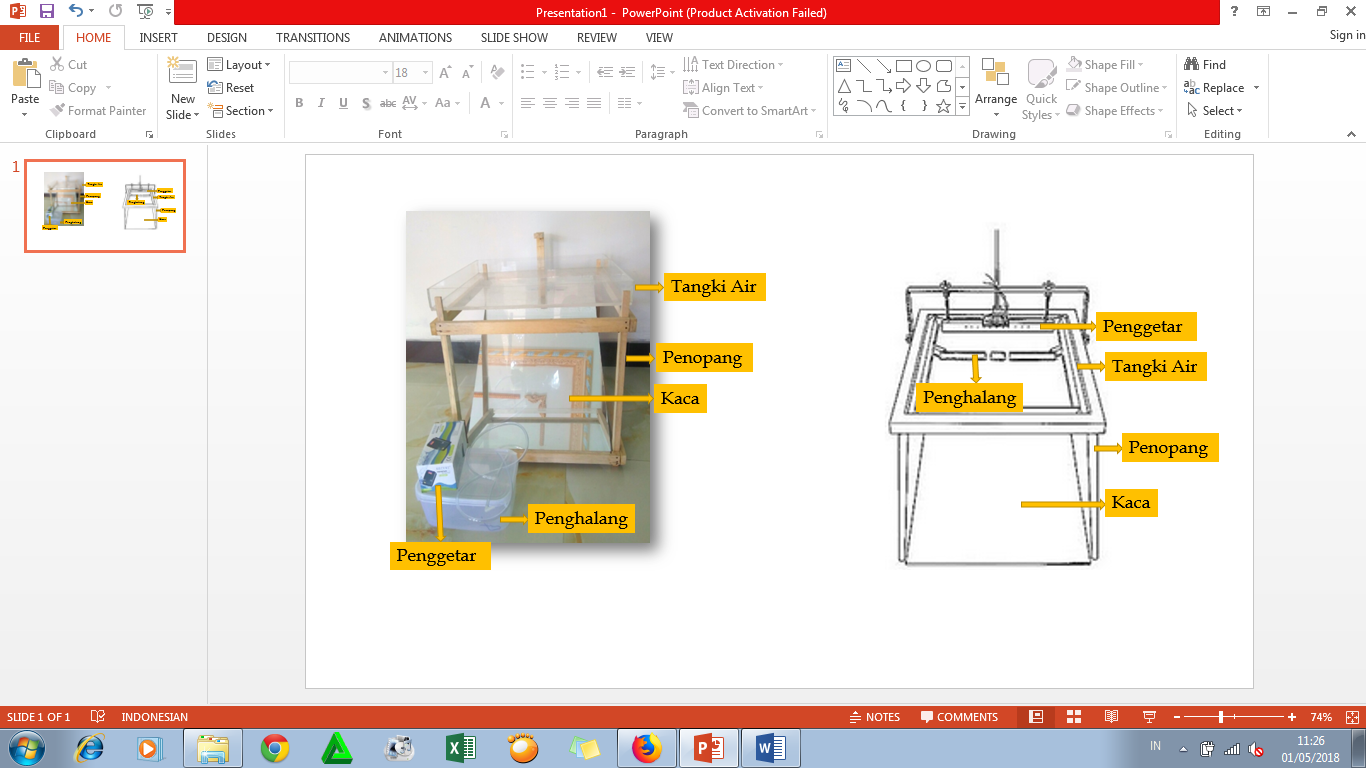
**RESULTS AND DISCUSSION**

The research undertaken is the development of ripple tank props to improve students' science process skills on mechanical wave material. The study refers to the ADDIE model.

The analyze stage. In the analysis phase, the analysis of the learning in the school with the results obtained information that the mechanical waves studied in the X1-MIA class in the even semester but, the level of understanding of learners is still low because the material is considered too abstract and PPP has not been applied in SMA Muhammadiyah 1 Jombang . Analyzes were also performed to analyze ripple tank tools in schools. Based on the analysis, there is no ripple tank props and LKPD. So that researchers develop ripple tank props and LKPD to help improve the KPS learners in SMA Muhammadiyah 1 Jombang.

Design stage is a stage designing tools that will be developed in LKPD. The LKPD design consists of: Basic competencies, Problems / phenomena, Problem formulation, Objectives, Hypotheses, Basic theory, Tools and materials, Experimental design, Data analysis, conclusions.

The development stage is the making stage of the tool according to the design, but in this research the 2nd medium is used using transparent glass because only to observe one wave characteristic is refraction. Then the vibrator is made from aerator modification because of review of the validator's validation or validation that the aerator is cheaper and easier to find. The following ripple tank props are developed (**Figure 3.3** Ripple Tank Viewer Tool):



Phase Implementation is a test stage of props developed after passing validation. Tests conducted to 30 students SMA Muhammadiyah 1 Jombang on 23-27 February 2018 even semester. The following data research results that have been done:

**1. Validation**

The props have been made validated by two experts and one physics teacher. There are some revised suggestions from experts related to the material and the media. Some of the revised suggestions are as follows:

**Table 4.1** Expert revision suggestion

|  |  |  |  |
| --- | --- | --- | --- |
| No | Before Revision | Revision Suggestions | After Revision |
| 1 | The wave face is less obvious | Replace the medium with a more transparent glass | Surface wave is clearly visible |
| 2 | The source of the vibrator is less suitable | Replace the source of the vibrator | The vibrator bucket is replaced with the Aerator |
| 3 | The container is less suitable | Replacing the container container | Replaced with plastic jars |

After a revision according to the advice of the expert further validation by two experts and one physics teacher. The data validation results are listed in **Table 4.2:**

**Table 4.2** Results of validation of props

|  |  |  |  |
| --- | --- | --- | --- |
| NO | ASPECT ASSESSMENT | SKORE | PERCENTAGE |
| 1 | Compatibility with the concepts taught. | 12 | 100% |
| 2 | Compatibility with intellectual development of learners. | 12 | 100% |
| 3 | Ease of maintenance tool | 10 | 83,33% |
| 4 | Resilience of components in position. | 11 | 91,67% |
| 5 | Ease of operation of the tool. | 9 | 75% |
| 6 | Security of use of tools. | 10 | 83,33% |
| 7 | Aesthetic value (color, shape). | 9 | 75% |
| 8 | Ease of finding, retrieving and storing tools. | 9 | 75% |
| TOTAL SCORE | | 82 | |
| MAXIMUM SCORES | | 96 | |
| VALIDATION PRESENTASE | | 85,42% | |

Based on data validation results that have been done by the validator, developed props obtained a percentage of learning and learning kevalidan 85.42% with very valid criteria.

**2. Practicality**

Once the developed props meet the criteria of validity, it will be applied to 30 learners through classroom learning to test the practicality and effectiveness of props. Practicality of props in terms of observation of the implementation and learning constraints conducted by two observers and the response of learners. The following is the result of observation of the implementation of learning.

**Tabel 4.3** learning activities

|  |  |  |  |
| --- | --- | --- | --- |
| NO | ASPECT ASSESSMENT | SKORE | PERCENTAGE |
| 1 | PRELIMINARY ACTIVITIES | 7,67 | 95,83% |
| 2 | CORE ACTIVITIES | 7,27 | 90,9% |
| 3 | CLOSING ACTIVITIES | 7 | 87,5% |
| 4 | CLASS MANAGEMENT | 7,25 | 90,63% |
| 5 | TEACHING TOOLS | 8 | 100% |
| TOTAL SCORE | | 37,19 | |
| MAXIMUM SCORES | | 40 | |
| TOTAL PRESENTASE | | 92,98% | |

Based on the observations made by two observers, the percentage of learning achievement is 92.98% with very good criteria. Judging from the implementation of learning, practicality and questionnaire response of learners to props. The following is the questionnaire results of the students:

**Tabel 4.4** Recapitulation of questionnaire response of learners

|  |  |  |  |
| --- | --- | --- | --- |
| No | Question | Percentage (%) | |
| Yes | No |
| 1 | Does this ripple tank props match the material of the wave properties you are studying? | 100 | 0 |
| 2 | Does this ripple tank props help you to understand refraction on mechanical waves? | 100 | 0 |
| 3 | Does the ripple tank props add to your understanding of the wave properties? | 100 | 0 |
| 4 | Do you think this ripple tank tool is easy to maintain? | 96,67 | 3,33 |
| 5 | Does this ripple tank props endure in its position? | 83,33 | 16,67 |
| 6 | Do you easily operate this ripple tank tool? | 76,67 | 23,33 |
| 7 | Do you feel safe using this ripple tank tool? | 90 | 10 |
| 8 | Do you think this ripple tank tool is interesting in terms of appearance? | 93,33 | 6,67 |
| 9 | Are these ripple tank props easy to find, retrieve and store? | 83,33 | 16,67 |
| 10 | Do you think this ripple tank props add to your spirit in the learning process on mechanical wave material? | 100 | 0 |
| RATA-RATA | | 92,33 | 7,67 |

Based on the recapitulation of students' response questionnaire to ripple tank props, the percentage of "Yes" answers between (76.67-100)%.

**3. Effectiveness**

Successful development of ripple tank props in improving PPP of learners in terms of pretest and posttes result learners, obtained data as follows:

**Figure 4.1** KPS Upgrade Chart

Based on the diagram above, there is an increase in the skills of each indicator of the average pretest and posttest result of the learner. Observing skills are obtained from questions 1 and 2. The skills of proposing hypotheses are derived from questions 3, 4 and 5. The skills of applying the concepts are derived from question number 6. Experimental planning skills are derived from questions 7 and 8. The skills of carrying out the experiment are obtained from the question of number 9. Skills of learners in communicating is obtained from question number 10. In accordance with Table 3.3, the category of increase in PPP has a high category with an average value of N-gain of 0.73 where the recapitulation of improvement as follows:

**Tabel 4.5** Recapitulation of KPS Increase

|  |  |  |  |
| --- | --- | --- | --- |
| NO | PRETEST | POSTTEST | N-GAIN |
| 1 | 49 | 87 | 0,75 |
| 2 | 52 | 95 | 0,9 |
| 3 | 52 | 87 | 0,73 |
| 4 | 50 | 81 | 0,62 |
| 5 | 54 | 95 | 0,89 |
| 6 | 50 | 83 | 0,66 |
| 7 | 50 | 83 | 0,66 |
| 8 | 50 | 85 | 0,7 |
| 9 | 50 | 85 | 0,7 |
| 10 | 50 | 83 | 0,66 |
| 11 | 50 | 83 | 0,66 |
| 12 | 52 | 83 | 0,65 |
| 13 | 50 | 83 | 0,66 |
| 14 | 52 | 85 | 0,69 |
| 15 | 21 | 83 | 0,78 |
| 16 | 52 | 95 | 0,9 |
| 17 | 50 | 85 | 0,7 |
| 18 | 52 | 85 | 0,69 |
| 19 | 50 | 83 | 0,66 |
| 20 | 50 | 85 | 0,7 |
| 21 | 54 | 95 | 0,89 |
| 22 | 50 | 83 | 0,66 |
| 23 | 50 | 87 | 0,74 |
| 24 | 52 | 87 | 0,73 |
| 25 | 52 | 83 | 0,65 |
| 26 | 52 | 81 | 0,6 |
| 27 | 50 | 87 | 0,74 |
| 28 | 56 | 95 | 0,89 |
| 29 | 27 | 87 | 0,82 |
| 30 | 50 | 87 | 0,74 |
| Mean | | | 0,73 |

1. **Discussion**

**1. Validation**

Ripple tank props otherwise valid if, the percentage of validation results ≥ 61% with very good category. At the time of validation, assessed aspects include conformity with the concepts taught, conformity with the intellectual development of learners, the ease of tool maintenance, the resilience of components in position, the ease of operation of the tool, the security of the use of tools, aesthetic value (color and shape) and ease of searching, , and save the tool. The following is a breakdown of the validation results:

1. Assessment results on the conformity aspect of ripple tank props with the material is 100% included in the category very well. The results show that the ripple tank props are developed in accordance with the wave mechanics subject of the wave characteristics characteristic taught in the SMA Muhammadiyah 1 Jombang in the X1 MIA-1 semester class.
2. The result of appraisal of conformity aspect of ripple tank props with intellectual development of learners is 100% included in very good category. These results indicate that the ripple tank props developed are in line with the intellectual development of learners according to the Curriculum 2013 that learners should have qualified intellectual abilities that include attitudes, knowledge, and skills.
3. The results of the aspect of the ease of care of ripple tank auxiliary equipment is 96,67% including in very good category. This hasill shows that the whole components of ripple tank props are easy to maintain because they do not cost big and easy to remove each component so it is easy to clean.
4. The result of the component endurance aspect on the stand is 83.33% included in the good category. This indicates that the props components are arranged on the framework firmly when used but are easily removed when finished.
5. The result of the assessment of the ease of operation of the tool is 76.67% included in either category. These results indicate that in the operation of ripple tank props developed easy to use learners in carrying out experimental activities.
6. The results of the assessment of the safety aspects of ripple tank props are 90% included in the excellent category. These results indicate that in operation, ripple tank props are safe to use when conducting experiments but must be kept under surveillance.
7. The result of the aesthetic aspect is 93.33% is included in very good category.
8. Percentage Assessment of the aspect of ease of finding, retrieving and storing ripple tank props is 83,33% including in very good category. This result can be achieved because the design of the tool is sleek and light so easy to search, store and retrieve. Overall the tool developed got a percentage value of 90% of these results indicate that the tool developed is very valid.

**2. Practicality**

The props developed are considered to be practical if the percentage of learning activities and the learner's response is ≥ 61%. The observational data of learning achievement of 92.98% are included in very good criteria. while the questionnaire results of the response of learners showed that the percentage of yes answers for each aspect in question is 76.67% to 100%. Thus, the developed ripple tank tool meets the criteria of practicality and feasible in learning. Based on the observation data, the lowest percentage is in the closing activities aspect. As for the cause of the limited time given the school because it must follow the schedule set by the school, cut off time lessons because of teacher turnover in a class. Based on Table 4.3 the learners response to the ripple tank. The lowest percentage of response is in the ease of use of the tool, based on the learner's comments because the sink in the school is damaged so that learners find it difficult to take water and to dispose of water. While the highest response percentage is in the conformity aspect of the tool with the material being studied. This is the influence of the process of tool review and advice by experts so that when tested the tool is in accordance with the theory to be delivered. Based on Table 4.4 respondents learners. The lowest percentage of learners' responses is also found in the ease of operation of the appliance, this is caused by the same thing that is damaged water sink.

**3. Effectiveness**

The developed ripple tank tool is effective and increases the KPS if the Gain (g) value is> 0.3. The effectiveness of ripple tank props is analyzed from the learners' learning outcomes. Learning outcomes of learners are obtained from pretest and posttest results that contain indicators from KPS. this assessment is used to assess the KPS improvements that the learners have based on indicators of KPS analyzed using a normalized gain test.

 Based on Table 4.5, it can be seen the average N-gain value of 0.73 which is included in the category of "High" increase with the lowest gain score of 0.60 and the highest gain score of 0.90. This indicates that the learners are all improving in the realm of KPS.

Based on the overall data obtained, the props developed have met the criteria of validity, practicality, and effectiveness. Thus, the props developed are considered worthy of use in learning, even more so to improve the KPS of learners.

**COVER**

**Conclution**

Based on the research and analysis done, it was found that the ripple tank props were developed:

1. Meet the criteria of validity and with a validity percentage of 82.42% in criteria is very valid.

2. Meet the criteria of practicality with the percentage of learning implementation of 92.98% in very good criteria, as well as the percentage of positive responses of learners between 76.67% - 100%.

3. Meets the criteria of effectiveness with the category of KPS improvement being proved with an average value of gain of 0,57.

Based on the results of the above analysis can be seen that the ripple tank props developed to meet the three aspects of the validity, validity and effectiveness that it can be concluded that the ripple tank props are developed feasible used to improve the KPS on mechanical wave materials in SMA Muhammadiyah 1 Jombang.

**Suggestion**

1. Ripple tank props should be colored to attract learners in learning

2. The number of props made should be adjusted to the number of groups to be tested so that at the time of the experiment the learner did not wait for the experiment.

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