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DESIGN OF TORSIONAL MODULUS EXPERIMENT TOOLS FOR BASIC PHYSICAL EXPERIMENT

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Abstract

One can explain the material torque through a device called a torsional modulus. The Physics Laboratory of the Faculty of Science and Technology of UIN Walisongo Semarang does not yet have a torsional modulus experiment. With this torsional modulus experiment tool can increase the amount of experiment inventory and can be used as a means of supporting experiment in explaining the concept of torque. The purpose of this research is to design the torsional modulus experiment tool and compile the torsional modulus experiment guide so that it can be used in basic physics experiment courses in the physics laboratory of FST UIN Walisongo Semarang. The design of torsional modulus experiment tools developed with the Research and Development (R&D) procedure has been tested with a very high validity category. The design of the torsional modulus experiment guide has been tested with a very high validity category.

Keywords: *torsional modulus, torsional modulus of elasticity, torsional modulus experiment, experiment guidance*

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Introduction

Education plays a role in preparing intelligent, reliable and creative human resources because education can maximize the potential that exists in students by developing critical, innovative, logical and characterized thinking. So students are able to solve all forms of problems (Hadi & Sudrajad, 2017). The application of the 2013 curriculum to the teaching process requires learning resources for books, practical tools related to the environment (Basri & dkk, 2013). With the help of practical tools, it hopes to encourage scientific skills and attitudes.

Experiment is part of learning in tertiary institutions with the aim that students have the opportunity to compare the real situation with what is obtained through learning in theory (KKBI, 2018). Practical learning is useful for practicing the skills, ways of thinking scientifically and critically needed by students in applying and integrating knowledge acquired in theory with practical reality (Zainuddin, 1996).

The reasons put forward by science education experts about the importance of experiment activities include: experiment can increase the passion and motivation of learning science, experiment can develop skills in developing experiments and creative and scientific ways of thinking, experiment becomes a source of learning through scientific approaches, and experiment can increase understanding subject matter not obtained from theoretical learning (Rustaman, 1995). Experiment activities are one of the factors that greatly support the success of physics learning.

Experiment or experiment is an activity related to laboratory equipment (science). Experiment is useful for discovering something new and knowing the stages that occur in a particular process. Experiment implements experimental methods with coherent work steps so that it trains students to use scientific methods, scientific attitudes, read and process data objectively and as is. Experiment also trains students to be able to draw conclusions based on the facts obtained (Winataputra, 1993).

Experiment is part of learning physics. Experiments usually take place in a laboratory room. Physics students tend to be enthusiastic in practical activities rather than learning in theory. Absorption learning through experiment is more than theoretical learning (Wibowo, 2014).

Experiment guidance is needed in carrying out the experiment process. The experiment guide provides guidance in carrying out the stages of the experiment implementation process. The lab guide contains the development of scientific attitudes and scientific performance. Experiment guidance is used as a means and source of learning, as a supporting tool in experiment implementation and can increase students' interest and motivation in experiment activities. Students can find out how to work and systematic in making experiment reports (Waluyo, 2014).

Torsional modulus is one of physics learning material that has unclear (abstract) concepts. If explained through theory without seeing a clear picture or real example, the concept of torsional modulus is very difficult to understand (Hadi & Sudrajad, 2017). To be able to determine how much the value of torsional modulus or modulus of friction of a material, the researcher wants to design the torsional modulus experiment in laboratory scale. In 2017 Afdal Hadi et al conducted a study on the development of torsional modulus experiment devices for learning physics at high school level. The torsional modulus experimental device in the study was declared valid to be used in high school physics learning.

From the results of the study, motivated researchers wanted to apply the same thing in designing a torsional modulus experiment tool that could be used in a basic physics experiment course in the Physics Laboratory of FST UIN Walisongo. This torsional modulus experiment tool is not available at the FST UIN Walisongo physics laboratory in Semarang. This torsional modulus experiment has never been done by physics students at UIN Walisongo Semarang. With this tool, it is expected to be able to increase students' scientific skills, knowledge and attitude and can support the success of experiment learning in the Physics Laboratory of FST UIN Walisongo Semarang in basic physics experiment courses. With this torsional modulus experiment tool is expected to increase the amount of experiment inventory in the Physics Laboratory.

This torsional modulus material is included in the sub topic of

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basic physics material, namely the moment of force. The basis of this material is torque. The advantages of this torsional modulus experiment tool can be used to simulate various changes in parameters in twisting and determining values and properties such as shear elastic modulus experimentally.

The basic assumptions used in the twisting process include: straight and uniform pivot points at the circumference of the circumference along the stem; torque is applied constant along the rod, torque works on the coordinates of the polar axis; the working force does not exceed the required limits; the cross-section of the flat circle changes back to its original position after twisting; Radial lines return to starting position after twisting (Suganda & Rahmawaty, 2017).

Method

This research uses research and development (R&D) methods. The analysis phase is carried out by extracting data and information sources about torsional modulus material and problems during the basic physics experiment at the basic physics laboratory of Walisongo State Islamic University, Semarang. This stage is intended to gather information in searching for potentials and problems related to research in the development of tools and to determine the design, level of accuracy of the tool in accordance with needs.

The product design phase is the initial step to determine the shape of the tool to be made. The design phase is carried out so that at the time of manufacturing the tool can be completed in a structured, systematic, effective, and efficient manner. At this stage contains the design of tools, making tools and making guidelines for the use of torsional modulus.

Material tools used in the study are: iron, steel, brass, ruler, calipers, micrometer couplers, pulleys, ropes, loads, lager, drill heads, screws, nuts, bolts, protractors, digital arcs, glues, pliers, keys English, screwdriver, digital balance sheet, lathe, and grinding. After preparing the tools and materials, the next step is to design the torsional modulus experiment tool. Iron, steel and brass are the basic ingredients for making sample specimens. For the frame is made of iron.

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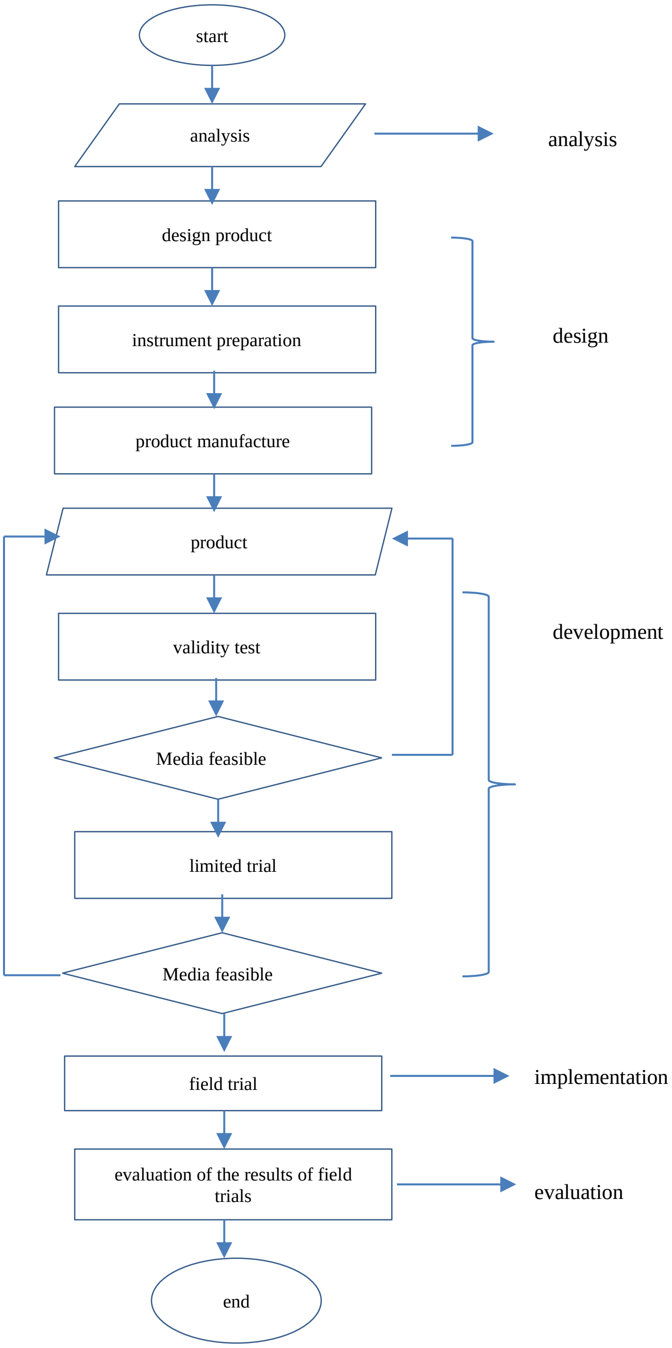

Figure 1. Flow Chart of Research

The goal is to obtain a strong tool, the possibility of shrinkage or

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expansion is very small, not easy to shake, and resistant to weather conditions.

Trial of practical tools used to determine the success of the tool as expected. Tool testing is done by testing the accuracy and precision of the tools and analyzing errors that occur. The test equipment was conducted at the physics laboratory of the Faculty of Science and Technology of UIN Walisongo Semarang on August 14-30, 2019.

In the validation stage, the experiment tools validation and experiment validations are carried out. From the results of the validation, it is possible to improve the prototype of the torsional modulus experiment tool and the experiment guidance. Validation is done by asking for expert material considerations, namely basic physics experiment lecturers namely Qisthi Fariyani, M.Pd and Sheilla Rully Anggita, M.Si by filling out the validation sheets that have been provided which are carried out together with the practical test equipment. It aims to obtain values and responses regarding experiment tools that are made viewed from the aspects of effectiveness, efficiency, resilience, accuracy, aesthetics and safety. The validation of the practical guide covers aspects of the accuracy of the content, appearance and convenience.

The validity of practical tools is carried out by material experts using a rating scale. This instrument is given four categories of answer choices and scores with the following conditions:

Score 4 = Very Good

Score 3 = Good

Score 2 = Less

Score 1 = Very Poor

Instruments that have been validated by expert validators are then analyzed using the following equation:

$X (\%) = A/(B) \times 100\%$

Information :

X = Percentage score

A = Score the results of data collection

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B = Ideal score

The percentage results obtained are then converted to a qualitative scale based on categories that can be seen in Table 1.

Table 1. Scoring Criteria for Experiment Assessment

Interval Score (%)	Interpretation
75 < X< 100	Very Good
50 < X< 75	Well
25 < X< 50	Less
0 < X< 25	Very Less

(Sugiyono, 2015)

Result and Discussions

The process of making the torsional modulus experiment takes 1 month, from July 10 to August 10, 2019. In making the torsional modulus experiment, the researcher is assisted by one of the lathe operators. This turning process aims to get a neat and precise shape according to size.

The work steps of making the torsional modulus experiment are as follows:

1) Draw the design of the tool
2) Prepare the tools and materials needed
3) Measure the iron according to size and needs
4) Cutting iron according to size and needs
5) Hollow out the iron according to size
6) Make a tool frame
7) Connecting iron with a frame that has been made
8) Making iron tongs
9) Putting the frame together
10) Make a protractor and digital arcs so they can be shifted to adjust the length of the twisting point
11) Making a deviation needle
12) Install a pulley that functions as a sample turning wheel

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13) Attach a strap to the pulley

14) Install the load on the sample turning wheel

The torsional modulus experiment tool can be seen in Figure 3.

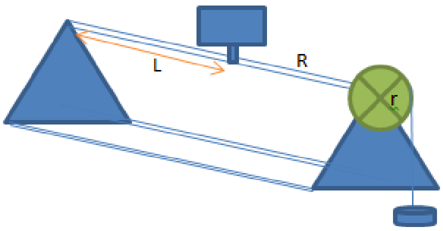

Figure 2. Design of Punch Modulus Experiment

Figure 3. The Torsional Modulus Experiment Tool

The working principle of this torsional modulus experiment is when the rope is given a mass of load (m), the twisting wheel will move to twist the metal rod with a certain angle of deviation (α) at each distance of the twisting point from the metal clamp.

Experiment guides are made to guide students in the process of experiment implementation. The experiment guide makes it easy for students to practice in operating the experiment equipment. The torsional modulus experiment guide covers the elements of title, objectives, tools and materials, basic theories, ways of working, and references. In addition to the practical guide preliminary questions and

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observation tables are added. The experiment guide is made in detail, so that it allows students to do experiment quickly, precisely and efficiently. The contents of the experiment guide are as follows:

a. Purpose of the Experiment

   The purpose of the experiment contains indicators of the achievements that will be achieved by students in experiment activities.

b. Basic theory

   Basic theory includes brief theories related to practical material. Basic theory can contain formulas, pictures or series that support practical material.

c. Tools and materials

   The tools and materials used during the experiment process are written in this section both the main tools and the supporting tools. Also included are specifications, accuracy, quantity and other information needed.

d. Work procedures

   Work procedures or work methods are written coherently using sentences in standard and clear language. Work safety procedures must also be included in the work steps.

e. Data analysis

   Data analysis includes both qualitative data and quantitative data. This section contains mathematical calculations that are equipped with formulas and include standard data that is used as a reference. If using a formula, the formula that is written is not a finished formula or a practical formula so that students are trained to be able to process raw data into data that is ready to be reported in accordance with the stages in work procedures. Writing the formula is equipped with units that refer to the SI system.

f. Question

   Questions are needed to arouse the curiosity of students so as to encourage students to analyze the phenomena observed in the laboratory with existing theories. Questions can also help students to examine and record and report any important data during the

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experiment, organize, process and conclude data correctly.

g. References

Library books and references used in each experiment title are written using the APA format.

h. Observation Table

Observation table contains all the data or quantities observed in the experiment.

The torsional modulus experiment aims to determine the elasticity properties of the material caused by the twisting, determining the torsional modulus of a metal material and determining the factors affecting the torsional modulus to determine the amount of twisting moment (G) produced by a particular metal rod.

In the torsional modulus experiment, variations in the types of metals used are steel, iron, and brass, variations in the mass of the load (m) and variations in the distance of the twisting point from the metal clamp (L). The magnitudes that can be observed in the torsional modulus experiment include: the mass of the load (m), the radius of the metal (R), the radius of the turning wheel (r) and the resulting twist angle (α). The working principle of torsional modulus is when the rope is given a mass of load (m), the twisting wheel will move to twist the metal rod with a certain twist angle (α) at each distance of the twisting point from the metal clamp.

The torsional modulus experiment tool was then tested on two professors supporting basic physics experiment courses. These lecturers, Qisthi Fariyani, M.Pd and Sheilla Rully Anggita, M.Si, were assigned as expert validators to test the feasibility or validity of the torsional modulus experiment.

The validation of the torsional modulus experiment tools includes aspects of effectiveness, efficiency, durability, accuracy, aesthetics and safety. The results of the assessment of each aspect can be seen in Table 2.

Based on table 2 the results of the assessment of each aspect obtained a percentage score range between 94% - 100%, this can be categorized that the tool of torsional modulus made has a very high assessment. This is in line with the practical test results that have been obtained with a very small percentage of relative errors.

Table 2. Recapitulation of the Validity Assessment of Torsional Modulus Experiment Tools

No	Aspect	Percentage Score (%)	Category
1	Effectiveness	100	Very High
2	Efficiency	100	Very High
3	Endurance	94	Very High
4	Accuracy	88	Very High
5	Aesthetics	100	Very High
6	Security	100	Very High

After conducting the tool validation test, the next process is the validation of the experiment guidance. The experiment guide that was made was tested by two expert validators. The validation of the practical guide covers aspects of the accuracy of the content, appearance and convenience. The results of the recapitulation of the practical test validation test can be seen in Table 3.

Table 3. Recapitulation of the Validity Assessment of Torsional Modulus Experiment Guidelines.

No	Aspects	Percentage Score (%)	Category
1	Content Accuracy	100	Very High
2	Appearance	88	Very High
3	Facilities	94	Very High

Based on the results of the assessment of each aspect obtained a percentage score range between 88% - 100%, this can be categorized that the guideline of the torsional modulus experiment has a very high assessment.

Conclusion

From the results of the research conducted it can be concluded that the design of the torsion modulus experiment tool in accordance with the research and development (R&D) procedures has been tested with a very high validity category. The design of the torsional modulus experiment guide has been tested in a very high category.

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