Development of Archimedes Law Material E-Module on Motion Systems to Improve Student's Concept Understanding

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Abstract: The development research carried out intends to develop an Archimedes Law Material E-Module on the Motion System to improve the understanding of the Learner's Concept. Product development uses the ADDIE model. Validation of material experts, media experts and testing the responses of teachers and students is a product trial design carried out. The validation of the material and the E-module media was carried out by five peer reviewers, the teacher response questionnaire was carried out by four teachers from several schools in Yogyakarta and Central Java. The E-Modul trial was tested on 25 class VIII students of SMPIT Bakti Insani with a quasi-experimental pretest posttest control group design. The results of the material expert validation data showed an average of 96.67% in the "very good" category, the media expert validation data showed an average of 96.83%, and the teacher's response results showed an average of 86.64% with the "very good". Trials were also conducted on students by obtaining an average presentation on each component aspect, namely according to the criteria, language, graphics and usability with an average proportion of e-modules of 82.03% with the criteria of "very good". The results of understanding the concept of students were carried out pretest posttest control group design with experimental and control classes. The results of the increase are quite effective with an average N-Gain of 62.9%. In addition, the acquisition of students who completed the Minimum Passing Criteria was 100 percent, while only 83.33% had completed the Minimum Passing Criteria in the control class. On the whole it can be guaranteed that the E-module is very feasible and effective enough to be applied in learning.

Keywords: E-Modul; Archimedes' Law; Motion System; Concept Understanding

Introduction

Learning science material at the Junior High School level is implemented on an integrated basis in accordance with the 2013 Curriculum Development Guidelines. In science subjects, science is expanded as an integrated subject, not only referred to as a scientific discipline. Aspects of assessment that are integrated in science include three assessments, namely the assessment of attitudes, knowledge and skills. The orientation of science is in the form of application in life, student curiosity, learning ability, caring and responsible attitude and oriented to students' daily lives. Contextually, science can be used as a tool for developing the domains of attitudes, knowledge and skills when learning (Prasetyowati, 2014).

One of the components that need to be prepared for the success of the 2013 curriculum is the readiness of

teachers as teaching staff. Proper preparation will make learning fit, as an example of the form of preparation is making a Learning Implementation Plan. In the preparation of learning media will support students' skills in understanding and understanding science concepts. Teaching materials cannot be separated from learning because they are one of the important things to be prepared. Teaching materials can be in the form of material, student worksheets, which contain learning materials that are arranged in such a way that they are suitable for use during learning (Pannen in Nasution et al., 2017).

There are four kinds of divisions in teaching materials that function in the learning process, namely the first printed materials such as modules, books, student worksheets, mockups, brochures, handouts, pictures and photos. The second is listening or audio teaching materials such as radio, cassettes, LPs. The

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third is audiovisual teaching materials such as videos and films. The last is audiovisual and interactive teaching materials such as Computer Assisted Instruction, interactive CDs, interactive media and learning web (Oktavia et al., 2018).

The electronic version of the module that can be accessed through electronic devices is usually called an E-Modul. Electronic devices in question are computers, gadgets, tablets, or PCs. A digital bool program commonly used to create e-modules such as Flipbook Maker, Caliber, or others. The complete content of e-modules with interactive media makes e-modules have advantages that can be used by students. The existence of interesting pictures, sounds, interactive videos, and animations and their interactivity can make students interested in improving the learning atmosphere. In addition, e-modules can also have good cognitive functions with these advantages. Mahayukti (2013) in Oktavia (2018) explains that critical thinking skills can be improved by using e-modules. The response from students to the e-module is positive so that it can increase students' understanding in understanding science learning materials. The E-Module should be contextual so that it can accommodate the needs of students (Oktavia et al., 2018).

Based on learning observations at SMPIT Bakti Insani Sleman, based on pretest results before given treatment obtained the average value of 57.75 in class control and mean 58.85 in class experiment. The value if connected with draft Criteria Minimum completeness at school result can said not yet finished or under Minimum Passing Criteria. The Minimum Passing Criteria sandards for science subject at SMPIT Bakti Human is 75. Even though the most important part of the learning process is understanding the concepts of science subject matter that could see from score minimum completeness of students. One part related to understanding the concept is problem solving. This problem solving is not only in the learning process but is also related to the problem -solving process of students in everyday life. The ability of students to understand and understand scientific content in the form of theoretical content and its application is the core of understanding the concept. There are seven cognitive processes in understanding the concept presented by Anderson and Krathwohl (2001), namely providing interpretation, giving examples, grouping, being able to make summaries, drawing conclusions, comparing one with another and being able to re-explain what was learned (Pratama and Saregar, 2019).

In the e-module that was created, the researcher took Archimedes' Law material which is connected to the framework of motion in living things. The Basic Competence taken is to explain the pressure of substances related to their application in daily life which is the basic competence material for physics in class VIII.

The material is related to biological material, namely studying the motion of living things, the movement system in humans, and efforts to protect the health of the movement system which. This material is material for class VIII Junior High School. With the integration between physics and biology material, it is hoped that learning can be more conceptual and related to students' lives.

The need for e-modules is very important to support the teaching and learning process of students during the distance learning period. Concept understanding is also needed to make students understand the material presented. Therefore, researchers are encouraged to carry out research with the theme "Development of Archimedes' Law Material E-modules on Motion Systems to Improve Students' Conceptual Understanding". The research intends to develop the Archimedes Law Material E-module on the Motion System to Improve Students' Concept Understanding by testing the feasibility, effectiveness and practicality of the Archimedes Law Material E-module on the Motion System to Improve Students' Conceptual Understanding.

Method

Research development or commonly called Research and Development is the research method used. The teaching material developed in this research is the Archimedes Law Material E-module on the Motion System to Improve Students' Concept Understanding. The ADDIE model was chosen from this development research which included five stages. These stages are analyzed, design, develop, implementation and evaluation (Sugiyono, 2016). In Figure 1, a diagram of the development of the ADDIE model in the development of the E-Module is presented.

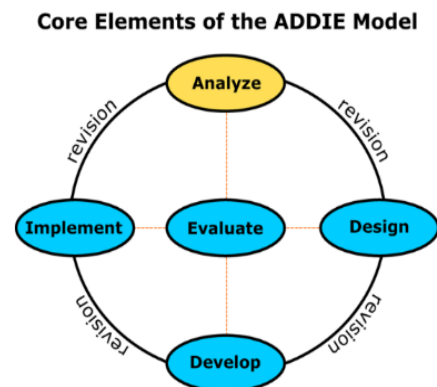

Figure 1. Robert Branch (2009)
Instructional Design; The ADDIE Approach.

Analysis Stage

The process of developing Archimedes' Law Material E-module on motion systems begins with the analysis stage. Through preliminary research, the stage

of collecting information from teachers and students is carried out. In the accumulation stage, the information collected is learning observation information, use of learning media, student characteristics, learning process, school curriculum, observation survey of existing teaching materials and identifying factors experiencing problems. The development of new media is needed to support the learning process. Analysis of the need to develop Archimedes' Law Material E-modules on Motion Systems is also presented at this stage as a development requirement.

Design Stage

At the design stage, it is continued by applying the product development design, namely by developing the Archimedes Law Material E-module on the Motion System as a medium and learning material for students. At the design stage, the researcher began to improvise to determine the type of media used, as well as other equipment needed.

Development Stage

The development stage is the stage that must be carried out after carrying out the design. The activities carried out include validation activities by material experts as well as media as many as 5 people to determine the feasibility level of the Archimedes Law Material E-module on the Motion System. At this stage the validation is done by use questionnaire validation expert Theory as well as media to see the attractiveness, feasibility of content and graphics so that the e-module will later be feasible to be implemented.

Implementation Stage

The Archimedes Law Material E-module on the motion system was implemented through a validation stage by experts who were then judged to be eligible, the Archimedes Law Material E-module on the motion system was implemented for teachers and students to be able to assess the teacher and student responses to the Archimedes Law Material E-module on the Motion System.

Evaluation Stage

The last stage is Evaluation, which is the final improvement activity for the Archimedes Law Material E-module on the motion system as a learning medium. At each stage an evaluation is also carried out including making improvements to the e-module according to suggestions and input from the reviewers, namely material experts, media, teachers and students. So that later we get an e-module that is more interesting than before.

Research on the development of Archimedes' legal material e-modules on the motion system uses instruments, namely a questionnaire validation sheet for media experts, material experts, teacher and student response questionnaires. The results of filling out the questionnaire were then revised to improve the e-module for the better. The data analysis technique used is descriptive quantitative and qualitative. The instrument is displayed in a questionnaire with a Likert scale score of 1-4 with the provision that a score of 1 means less good, 2 means quite good, 3 means good, and the last score 4 means very good.

Assessments that have received scores are then converted into values according to tables 1 and 2. Score 4 is the highest score and score 1 is the lowest score. The score will be averaged. The average score obtained for each component assessed is calculated using the following Formula 1.

$$X = \frac{\sum X}{n} \qquad (2)$$

Information:
X = average score; X = total score of each component; n = number of raters

After calculating the average of all assessment items, it becomes the average score so that it becomes quantitative. Then the quantitative value is changed to a qualitative value based on the conversion of values in Tables 1 and 2.

Table 1. Average Score Conversion

Score Range	Score
X Mi + 1.5. SDi	X 3.25
Mi + 1.5. SDi > X Mi	3.25 > X 2.5
Mi > X Mi – 1.5. SDi	2.5 > X 1.75
X < Mi – 1.5. SDi	X < 1.75

Adaptation from Djemari Mardapi (2007)

Table 2. Conversion of Average Score in Percent

Percentage (%)	Letter Value	Value Description
X 81.25	A	Very good
81.25 > X 62.5	B	Well
62.5 > X 43.75	C	Not enough
X < 43.75	D	Very less

The limited test conducted in this study was implemented in a small class using a quasi-experimental method with a control group design pretest posttest. It is oriented to test the improvement of students' conceptual understanding of e-modules. The next steps to analyze the data are as follows:

Giving Pre-test and Post-test.

All students' pretest and posttest answers were checked and then data analysis was carried out. The questions given are descriptions of three questions in accordance with the concept of Archimedes' law material on the motion system. Each item answered correctly will be given a value of 30 to 40 so that the total

score is 100. In answering questions, students' answers must use logical explanations and use a known, asked and answered system. For incorrect questions, a score of 2-5 will be given according to the students' answers. Pretest and posttest were carried out with the control class and the experimental class.

Calculating the N-gain of pre-test and post-test scores.

The difference between the pre-test and post-test scores is the N-Gain score. The normalized average gain formula is then used as the basis for measuring the increase in the average score of the pre-test with the post-test. (Hake, 1998) (Halim & Mursal, 2016). The formula can be written mathematically as follows:

$$\text{Gain} = \frac{Skor\ Postest - Skor\ Pretest}{Skor\ Ideal - Skor\ Pretest} \qquad (2)$$

Information:
The ideal score is the highest score obtained by students The category of N-Gain interpretation in the form of a percentage can be seen in Table 3.

Table 3. Categories Effectiveness N - Gain

Percentage (%)	Category Interpretation
< 40	Not Effective
40 – 55	Less Effective
56 – 75	Enough Effective
> 76	Effective
	Hake, (1999)

Counting students who pass the Minimum Passing Criteria based on school curriculum documents.

The Science *Minimum Passing Criteria* which is declared complete must obtain a minimum score of 75, so students whose scores are below the Minimum Passing Criteria are declared incomplete.

The next step before analyzing the data with the N-Gain test must be tested for requirements, namely normality and homogeneity tests. The normality test was carried out to check whether the research data was normal or not. Meanwhile, the homogeneity test was examined to check whether the sample in the population studied was homogeneous or not. (Halim and Mursal, 2016).

Result and Discussion

Teaching materials in the form of E- modules Archimedes' Law Material on System motion for Increase Understanding Draft Student is product results this study. ADDIE Development Model selected for carry out the research process. A number of results from ADDIE stage in study E- module development Archimedes' Law Material on System motion for Increase Understanding Draft Participant Educate namely:

1. Stage analysis (*analyze*)
   E- module development process Archimedes' Law Material on *System motion* starts with Step analysis. Through study preliminary conducted Step collection information from the teacher at once students. In Step collection information collected _ is information observation learning, use of learning media, characteristics students, learning process, curriculum school, observation survey existing teaching materials exist and identify factors experiencing problem. New media development is urgently needed for support the learning process. Analysis the need E-module development Archimedes' Law Material on System Motion is also shown in Step this as condition development Stage.

2. Design (*design*)
   At stage design, continued with apply design product development that is with developing E- module Archimedes' Law Material on System motion as media and learning teaching materials participant educate. At stage this researcher start make design the type of media used, as well as other necessary equipment.

3. Stage *Develop* (Development)
   Is activity validation by experts' material is also media experts as many as 5 people for knowing level E-module eligibility Archimedes' Law Material on Motion system. At stage this obtained results validation expert the material contained in table 4. There are three rated components that is appropriateness content, language and truth E- module concept. On validation expert obtained the average score is 96.67%. Up to E- module it's really worth it by material. Truth draft in E- module related Archimedes' Law material obtained score 100% so that the concepts contained in the E-Module have been right.

Table 4. Percentage Results score validation expert Theory

Aspect	Ideal score (%)	Category
Appropriateness contents	95	Very Good
Appropriateness language	95	Very Good
Truth E- module concept	100	Very Good
Average	96.67	Very Good

Table 4 is table results percentage score validation expert Theory with an average score of 96.67% with "very good" category. This thing because appropriateness content, language and truth draft already in accordance with Theory Archimedes' law of motion systems. In addition to quantitative data, qualitative data were also obtained, namely from suggestions as well comment expert material. Comments, suggestions and follow carry on could seen

in table 5. Due to comment and the advice already good so no conducted plan act continued.

Table 5. Comments, suggestions and actions carry on validation expert Theory

Comments and Suggestions	Follow Carry on
Already clear material presented	None
Already good	None
E- module nice and interesting. Worthy used	None
Material flipbook physics in system human motion inside it already complete and clear in explanation theory and accompanied a number of interesting pictures and videos attention reader.	None

Stage next after validation expert Theory is perform validation test to media expert. Test done covers aspect language, presentation, graphics and clarity information. For results percentage score validation media experts can be seen in table 6. In table seen that the average score validation media experts by 96.83% with "very good " category. because of it, E-module Theory Archimedes' law on *the system motion* Very Worthy used. This thing due to e- module already interesting in graphics, then the information and language conveyed has also been clear.

Table 6. Results of the Percentage of Validation Scores media expert

Aspect	Ideal Score (%)	Category
Appropriateness language	96.67	Very Good
Presentation and Graphics	97.14	Very Good
Clarity information	96.67	Very Good
Average	96.83	Very Good

Data comments and suggestions from media experts are listed in table 7. In table mentioned that added profile writer after bibliography, and video background is turned off for clarify gift Theory in videos.

Table 7. Comments, suggestions and actions carry on alidation media expert

| Comments and Suggestions	Follow Carry on
Already good	
Already nice and very interesting flipbook material physics in system human motion. However, how good if the background video in language England it's better to just mute it, or added preface _ in the video, the hope so that participant educate can more understand meaning from the video presented. Accept love.	*Background video muted*
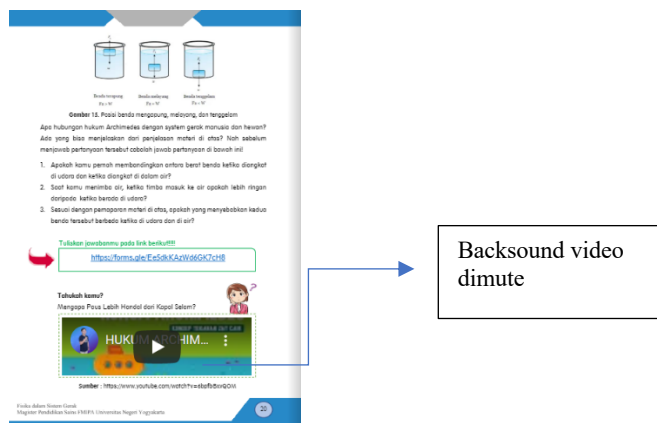
Figure 2. Change Backsound E - module

Validation expert materials and media experts carried out get results conclusion that E- module possible for implemented to participant students who get category "very good".

4. Stage Implementation Product

Appropriateness test validation expert materials and media obtained then made ingredient for e- module repair. Products that have been repaired then enter to Step implementation product. Implementation conducted to teachers and students for knowing usefulness of E- module Archimedes' Law Material on Motion system. The teacher 's response test is tested to four science teachers who have teaching in DIY and Central Java schools. The teacher response test consists of from appropriateness content, language, presentation as well as graphic. In truth draft put in appropriateness contents. The results of the teacher 's response test can be pay attention to table 8. From the results validation obtained an average of 86.44 with very good category. So that according to response E- module educator Archimedes' Law Material on System proper motion used.

Table 8. Percentage Results Teacher Response

Aspect	Ideal Score (%)	Category
Contents	88.02	Very Good
language	85.42	Very Good
Presentation	87.50	Very Good
Media/ Graphics	84.82	Very Good
Average	86.44	Very Good

Besides give evaluation with score, the teacher also gives input related E-module Archimedes' Law Material. Input as well as suggestions can decimal in table 9.

Table 9. Suggestions and Comments as well as act carry on teacher response

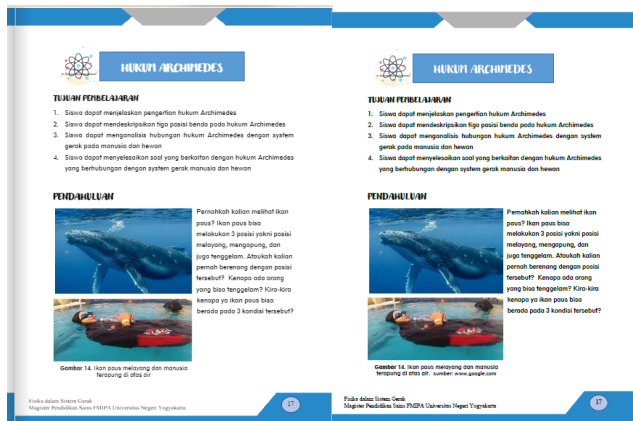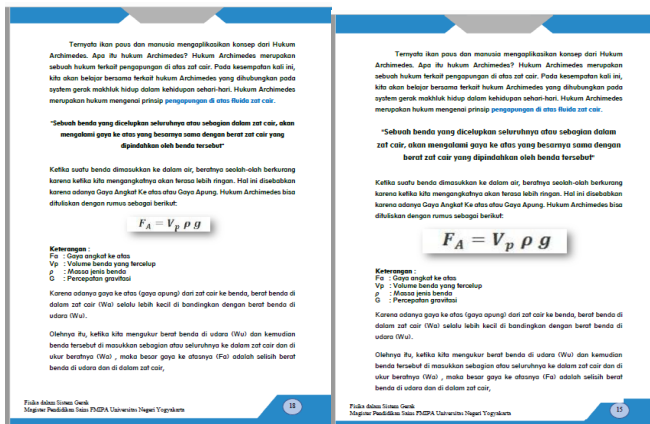| Comments and Suggestions	Follow Carry on
SDH module is good, multiply sheet work participant teach and illustration language which used more communicative again so that more children delicious and comfortable in read it	More languages communicative on sheet work participant educate
already good, a little need zoomed in font size on writing formulas and maps draft Theory	Font on writing formulas and maps draft Theory zoomed in
For picture possible can written the source	Image given source
Image not yet given description the source. There are some words still use spelling foreign but no italicized	Spelling foreign italicized

Figure 3. Before and after revision

Figure 4. Before and after revised

Implementation is also done to participant educate. Aspects tested on the response student is appropriateness content, language, usefulness, graphics, and understanding concept. From result response student get the average percentage is 82.03% with "very good " category. Whereas in Thing understanding draft get percentage score of 79.35% with " good " category. So that researcher concludes based on the data that the E-module E- module Archimedes' Law Material on *System motion* worthy used by students.

Table 10. Results of Response Score Presentation Participant Educate

Aspect	Ideal Score (%)	Category
Contents	82.88	Very Good
Graphics	85.33	Very Good
Usefulness	79.81	Well
language	82.79	Very Good
Understanding Draft	79.35	Well
Average	82.03	Very Good

Participant teach also give response related E - module Archimedes' Law Material on Motion system. A number of comments they nice, easy understood, and learning more fun.

At stage implementation get e- module next ending tested to participant educate class VIII SMPIT Bakti Humans totaling 25 students. Quasi design experiment with use *control group pre-test post-test* with control and experimental classes. E-module effectiveness researched with statistical test with count increase in average participants educate related understanding draft before and after question tested. Analysis results of pre-test with post-test on both analyzed class show the average score in the control and experimental classes. In the pre-test the control class was 53.31% while get score 58.85% in class experiment. Temporary post-test scores get an average score of 83.85% in the control class and 88.85% in the class experiment. From result percentage second mean value class so could concluded that there is difference pretest and posttest scores from second class. This thing can show if understanding draft students on the post-test better than when pre-test.

This thing in line with study from (Lasmiati et al., 2014) that effectiveness module caused by the designed module interesting as well as use communicative and simple language , so that could understood by students. Besides that, in learning use module, equipped with questions contextual nor question open that can done student by individual and independent.

Normality and homogeneity test is very important conducted before analyze the post-test N-Gain test in class experiment and class control. Based on normality test data *output* using SPSS 25 got results possible significance seen in Table 11.

Table 11. Data of Normality Test Results

	Class		Kolmogorov-Smirnov	Shapiro-Wilk
Value result student	Class experiment	pre-test	0.200	0.162
	Class experiment	post-test	0.200	0.085
	Class pre-test control		0.200	0.917
	Class post-test control		0.200	0.084

Based on the data above, if tested normality with Shapiro wilk and Kolmogorov - smirnov obtained that normality test value both of them get score > 0.05. In normality test if score > 0.05 then could taken decision that the tested data normally distributed.

Next process analyzing homogeneity test with SPSS 25 application due to previous data already normally distributed. Rule in homogeneity test is if score significance (sig) significance > 0.05 then the data homogeneous, will but if the data < 0.05 then the data no homogeneous. If the data homogeneous so could next to Step next. From the homogeneity test data obtained score of 0.170. Based on rule the so could concluded that posttest data the homogeneous so that can next to test next.

Tests carried out next is a paired t test, because the sample data obtained is same with two different data/variables. Based on rule from the paired sample t test, then if result data *1* get sig value. (2 tailed) is 0.0000 < 0.05 then could concluded that there is difference in average results study participant educate for class pre-test control with class experiment. Output data *2* get sig value. (2 tailed) is 0.0000 < 0.05 then could taken decision that found difference between the average results study participant educate posttest class control and experiment. The results of the paired t test can be seen in Table 12:

Table 12. Paired Sample T Test Results

Experiment Class	Control Class
0.000	0.000

The conclusion of the paired t test is that results end score 0.000 significance. Could taken conclusion that there is mean difference between pretest and posttest Among class control with class experiment. Whereas for the average value of the class pretest experiment of 58.85 while for posttest class experiment is 88.85. So that from the data occur improvement, so that the e- module take effect to enhancement understanding draft students.

From several prerequisite tests carried out there is difference so next by N-Gain test with spss 25. The average percentage value of pretest and posttest for class control could seen in Figure 5. Graphics show that there is enhancement Among percentage pretest and posttest scores in class experiment. Difference percentage post-test scores with participants pre-test educate as well as more N-Gain value clear shown in Figure 7.

Output data analysis score understanding draft participant educate before as well as after conducted learning with using e- module Archimedes' law on the system motion concludes that there is enhancement by significant before as well as after use of e- modules. Student experience enhancement results study based on pretest score and posttest. Percentage of N-Gain

understanding draft Archimedes' law on the system motion before learning average of 58,3% in the control class and 62,9% in the class experiment. If interpreted in table interpretation the effectiveness of N-Gain then scores the enter in category enough effective that is Among range 56 - 75. With so E-module this enough effective for used. This thing because the concept in the module already clear and participant educate interested study using e- module Archimedes' law of motion systems.
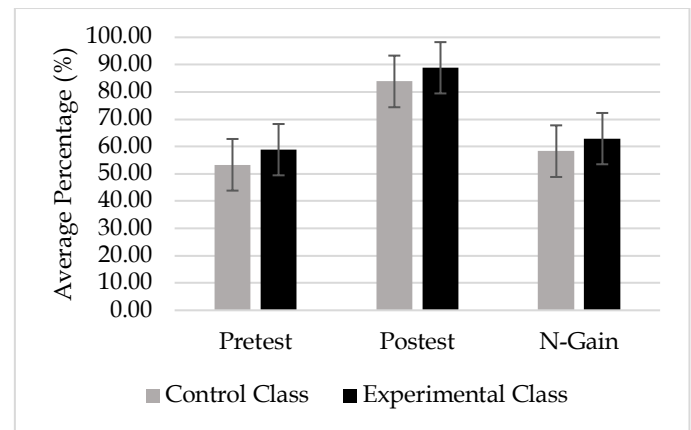

Figure 5. Percentage of pretest, posttest, and N-Gain for Control and Experimental Class

Output data analysis score understanding draft participant educate before as well as after conducted learning with using e- module Archimedes' law on the system motion concludes that there is enhancement by significant before as well as after use of e-modules. Student experience enhancement results study based on pretest score and posttest. Percentage of N-Gain understanding draft Archimedes' law on the system move before learning average of 58.3% in the control class and 62.9% in the class experiment. If interpreted in table interpretation the effectiveness of N-Gain then scores the enter in category enough effective that is Among range 56 - 75. With so e-module this enough effective for used. This thing because the concept in the module already clear and participants educate interested study using e- module Archimedes' law of motion systems.

Table 13. Results of Posttest Score

Class	Min	Max	Ave	Participant educate complete *Minimum Passing Criteria*
Control	40.00	100.00	82.50	10
Experiment	75.00	100.00	88.85	13

Table 12 shows the data that can be is known that all students in class experiment have already score in

accordance with *Minimum Passing Criteria* apart from that student in class control only a total of 10 students of 12 people who passed the *Minimum Passing Criteria* standard.

From picture 6 it can be seen that 100% of participants learn in a given class treatment have score posttest in accordance with *Minimum Passing Criteria* apart from it's in class control only by 83.33% of participants students who have score according to *Minimum Passing Criteria*. This thing shows that understanding draft Theory Archimedes' law on the movement system in participants learn in the added class treatment better compared to participants teach in class control.

100% participants teach in class when given treatment with understanding draft have post-test scores that have been completed. This isi different with control class that doesn't given treatment, only 83.33% of students are still below the *Minimum Passing Criteria.* Possible conclusion our take from the data that has been analyzed that understanding draft Archimedes' Law material on the motion system in class when added treatment higher compared to students in the class control.

Based on study from (Rezeki et al., 2021) , the increase in students' conceptual understanding is caused by because the implementation of learning uses e-module media that can make students learn independently so that they will train their understanding of the concept . According to According to research by Atep and Dewi, (2019) in (Prosperity et al., 2021) Good media or teaching materials can improve the learning process in relation to the benefits of media or teaching materials. P presentation as well display of media or e-module teaching materials that can attract students' attention can create enthusiasm for understanding the concept of the material being studied.

Based on results study (Aniati et al., 2020) above, the product of the science learning media e module under study interesting for student class VII SMP Negeri 1 Sugio. Students who use science learning media e module the have understanding more concept good compared with students who use conventional teaching materials. It means an increase in the value of control and experiment class consequence the attractiveness of the e - module presented.

Conclusion

E-Archimedes' law material module on the motion system to improve students' understanding of concepts, namely the development product of the research carried out. Material expert validation got an average score percentage of 96.67% in the "very good" category, media expert validation got an average score percentage of 96.83% in the "very good" category. The teacher response

test got an average score percentage of 86.64% and the results of student responses by assessing the feasibility of content, graphic, linguistic, and usefulness components got an average score percentage of 82.03% with the "very good" criteria.

The results of students' understanding of the concept that was applied to the pretest posttest control group design with the results showed that the increase was quite effective. The results of the N-Gain test score with an average N-Gain of 62.9% for the experimental class. In addition, in the experimental class 100 percent of students have reached the *Minimum Passing Criteria* while for the control class 83.33% have reached the *Minimum Passing Criteria.* Overall, it can be concluded that the e-module is very feasible and effective enough to be used in learning.

Acknowledgements

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