Development of General Physics Teaching Materials Accompanied by ICARE-Oriented Student Worksheets Based on Mobile Learning Systems to Improve Student Learning Outcomes

Irfandi[1]*, Deo Demonta Panggabean[2] , Yulifda Tanjung[3]

1 Physics Department, Universitas Negeri Medan , Medan, Indonesia
2 Physics Department, Universitas Negeri Medan , Medan, Indonesia
3 Physics Department, Universitas Negeri Medan , Medan, Indonesia

IJASR 2022
VOLUME 5
ISSUE 1 JANUARY – FEBRUARY **ISSN: 2581-7876**

Abstract: In preparing for more innovative learning, it must be related to the models, approaches, methods and techniques that will be applied in the learning process. One of the methods in this case includes the selection and determination of teaching materials, the preparation and possible procurement of remedies and the development of these teaching materials. This study aims to determine the development process, the quality of feasibility and the improvement of student learning outcomes in the General Physics subject using teaching materials accompanied by mobile learning-based ICARE-oriented student worksheets. Judging from the approach, this research is included in mixed methods research, which is a research approach that combines qualitative and quantitative research in one study. The use of this approach is based on considerations because the data collected in this study include two types of data, namely quantitative and qualitative data. The development steps were adapted from the model developed by Dick and Carry with the implementation stages consisting of: (1) analysis, (2) design, (3) development, (4) implementation, (5) evaluation. The instruments used in this study consisted of a material expert validation questionnaire, a validation questionnaire by media experts, and a student response questionnaire. The data analysis technique used is descriptive statistical analysis techniques. The results of this study are: 1) based on the results of data analysis, the validity, distinguishing power, and difficulty level of the 40 items that have been developed, there are 21 valid questions. As for the results of the calculation of the reliability of the test, the reliability coefficient value of 11 = 0.897 was obtained, so that the reliability of the questions was included in the high category. After that, a limited application will be carried out in one class to obtain student learning outcomes data using ICARE-oriented general physics teaching materials based on a mobile learning system.

Keywords: ICAR, Learning Outcomes, Mobile Learning, Teaching Materials

1. INTRODUCTION

At this time the world is starting to enter the industrial revolution 4.0 stages or the fourth world industrial revolution where information technology has become the basis of human life. Everything becomes borderless with the use of unlimited computing power and data, because it is influenced by the development of the internet and massive digital technology as the backbone of human and machine movement and connectivity. This era will also disrupt various human activities, including the fields of science and technology as well as higher education.

The era of the industrial revolution 4.0 also changed the perspective on education, namely internet-based learning of things as basic skills. Currently the implementation of learning can not only take place traditionally in the classroom, but the implementation of learning has started to be modern by utilizing modern technology such as cellphones, androids, tablets and so on. The development of information and technology provides many new things and new approaches that can be developed to support the infrastructure of the learning process. (Andreicheva & Latypov. 2015)[1].

Medan State University (Unimed) as the first public university in North Sumatra to achieve an "A" accreditation rating from National Accreditation Board for Higher Education has a vision that is able to face the challenges in the era of the industrial revolution 4.0, namely to become a leading university in the fields of education, industrial engineering and culture. The leadership of the State University of Medan on various occasions always reminds the entire academic community that one of the 5 important elements that must be considered in facing the challenges in

the era of the industrial revolution 4.0 is the preparation of a more innovative learning system to improve student skills in the IT / ICT and Big Data Analytics fields.

In preparing for more innovative learning, it must be related to the models, approaches, methods and techniques that will be applied in the learning process. One of the methods in this case includes the selection and determination of teaching materials, the preparation and possible procurement of remedies and the development of these teaching materials. Teaching materials are an important component that cannot be ruled out in the learning process, because teaching materials are the core in the learning process (Arsyad, 2008)[2]. Teaching materials are all materials (both information, tools and text) that are arranged systematically, which displays a complete figure of the competencies that will be mastered by students and used in the learning process for the purpose of planning and studying the implementation of learning, for example textbooks, modules, handouts, student worksheet, models or mock-ups, audio teaching materials, interactive teaching materials and so on (Prastowo, 2013)[3].

The use of appropriate teaching materials will greatly assist in achieving the effectiveness and delivery of learning content to achieve learning objectives. Teaching materials can also improve students' understanding of the learning messages they want to convey. (Irfandi, I., Faisal, F., Hasibuan, N. I., & Panggabean, D. D, 2018)[4]. Innovative teaching materials are needed to realize interesting, effective and efficient learning. For this reason, a professional educator is required to be creative to be able to compile teaching materials that are innovative, varied, interesting, contextual and in accordance with the needs of students.

To optimize the use of general physics teaching materials in learning activities, these teaching materials are accompanied by ICARE-oriented student worksheets. Student worksheet is one of the teaching materials used as a guide for conducting investigation or problem solving activities. The inclusion of student worksheets, in these teaching materials, lecturers can direct students to be involved in aspects of knowledge, skills, and attitudes together. To make students more active and fun in learning activities, the learning stages contained in the student worksheets refer to the ICARE concept, because the ICARE learning strategy emphasizes the characteristics of: active, creative, and fun (Wahyudin, 2010)[5].

Teaching materials used in general physics lectures at Faculty of Math and Science Unimed by the Basic Mathematics and Natural Sciences lecturer team are the same print-based conventional teaching materials and are the work of a team of author lecturers who just order / live to buy through the course coordinator lecturer without any effort to plan, prepare and compile their own . Thus, it is possible that the teaching materials used are not contextual, monotonous, and not in accordance with current student needs.

Another fact is that the results of the joint exams for the basic Mathematics and Natural Sciences subjects for the last four years 2015, 2016, 2017, 2018 averaged 40-60 <70 (not competent). The factor that is thought to be the cause of the low test results is less interesting learning, one of which can be seen from the use of teaching materials that are not innovative and tend to be monotonous and not in accordance with the needs of the participants.

Experience during being a team of basic Mathematics and Natural Sciences lecturers in the General Physics course through direct observation in lectures, almost all students tend to use information that is accessed directly quickly via a smartphone without being limited by time and place when they present their assignments in front of the class. It can be assumed that students prefer and have a need for access to information in the form of electronic teaching materials that are more practical and can easily be accessed via cellphones, smartphones, ipads, or tablets. The need for access to information from time to time regardless of time and place is an effect of the use of technology and mobile learning is one of the strategies in the learning process (Uysal & Gazibey, 2010)[6].

Based on the explanation above, the focus of the problem in this research and development activity is to develop teaching materials for general physics courses accompanied by ICARE-oriented student worksheets (LKM) based on mobile learning systems to improve learning outcomes of physics education students of Faculty of Math and Science Medan State University.

2. LITERATURE REVIEW

1. Definition of Teaching Materials

This study aims to determine the development process and the quality of the feasibility of teaching materials for general physics courses accompanied by ICARE-oriented student worksheets (LKM) based on mobile learning systems. In addition, with the conditions of education today, a research is needed to determine the increase in student learning outcomes in general physics courses using teaching materials accompanied by ICARE-oriented student worksheets (LKM) based on a mobile learning system. Definition of Teaching Materials.

Mudlofar (2012)[7] defines: "teaching materials are all forms of materials used to assist in the learning process". In more detail, Jasmadi (2008)[8] states: "teaching materials are a set of learning tools or tools that contain learning materials, methods, limitations and ways of evaluating which are designed systematically and attractively in order to achieve the expected goals". This understanding is in line with Prastowo (2014)[3] which states: Teaching materials are basically all materials (both information, tools, and texts) that are arranged systematically, which displays a complete figure of competencies that will be mastered by students and used in the learning process with the aim of planning and study the implementation of learning. Based on some of these opinions, this research is in line with the opinion of Prastowo (2014)[3] that teaching materials are materials that are systematically arranged that show a complete figure of the competencies that students will master in the learning process and help students master the expected competencies.

2. Types of teaching materials

According to Setiawan (2007)[9] teaching materials are grouped into two major groups, namely printed and non-printed teaching materials. The printed teaching materials consist of modules, handouts, and worksheets. Non-printed teaching materials are video, audio, display teaching materials, and the internet. Several types of teaching materials above, each of which has advantages and disadvantages. Printed teaching materials have good delivery quality, for example, they can present words, numbers, pictures and others. The use of printed teaching materials is self-sufficient, meaning that it can be used directly or no other tool is needed to use it. Printed teaching materials also have several shortcomings, namely not being able to present movements, presenting material is linear, and it is difficult to provide guidance to readers.

Non-printed teaching materials also have several advantages and disadvantages. Non-printed teaching materials are now widely available in the market, so it is very easy to get them. However, in using non-printed teaching materials, the user must have other tools to support its use, for example the internet, must have a complete computer device to be able to access it. Those are some of the advantages and disadvantages of printed and non-printed teaching materials.

3. ICARE Oriented Learning

ICARE stands for introduction, connect, apply, reflect, and extend. ICARE is an effective learning strategy in an e-learning environment (Salyers, et al., 2010)[4]. The ICARE learning strategy emphasizes the following characteristics: active, creative, and joyful (Wahyudin, 2010). The ICARE strategy is designed for online learning. ICARE is designed to help students learn online effectively. The principle of ICARE is to present essential material for each topic.

According to Wahyudin (2010)[4], the ICARE learning stages are to follow the ICARE acronym:

Phase I: Introduction

At this stage an outline of the overall content of the subject matter is explained, the objectives to be achieved, the prerequisite materials, the time required the activities and evaluations to be carried out, as well as the required reading material. At this stage, it is also intended to determine the extent of students' understanding and interest in following the learning that will be given.

Phase II: Connect

At this stage, facts, concepts, principles, and / or processes related to the material to be studied are introduced. In this activity, it gives students the opportunity to discover facts, concepts, and principles by themselves. There are 4 steps suggested by Pastor in Wahyudin (2010)[4] at this stage, namely: 1) dividing the material into sub-topics to make it easier for students to understand new information; 2) linking information to tasks related to the real world and prior knowledge; 3) facilitate students with information gradually and continuously so that it is a series of meaningful learning; 4) present the material to be given in a more enjoyable manner with various approaches and uses of media.

Stage III: Apply

This stage provides challenges and activities that allow students to apply the knowledge they have acquired in stage II by providing problems related to the real world. Simulation, play, or guessing is best at this stage. Another activity that can also be done at this stage is asking students to look for other relevant sites.

Stage IV: Reflect

At this stage students are asked to reflect on what they have learned, what they have gained and the experiences gained from the connect to apply stage. This can be done in several ways, including: discussing online learning, askingasking students to make concept maps, visually representing the relationship between concepts. Concept maps are very useful for students to help expand new information.

Stage V: Extend

At this stage, it gives students the opportunity to expand the knowledge they have acquired by challenging a wider range of problems. There are two main activities in this final stage, namely: 1) Providing enrichment and remediation activities; 2) Provide an evaluation of students' mastery of material and evaluation of teaching materials or learning designs.

4. Mobile Learning

The efficiency of implementing constructivist learning methods has shifted from computer-based learning to web-based learning and the most developing now is mobile learning-based learning which is often known as M-Learning. Mobile-Learning or M-learning is an implementation of the modern learning process, in which students can learn anytime and anywhere. *(Adegbija & Bola. 2014)*[10]. Mobile learning is a transition from subordinate electronic learning methods to independent learning and is being studied a lot (*Pollara & Broussard, 2011).*

M-Learning is unique learning because students can access learning materials, directions and applications related to learning, anytime and anywhere through telecommunications devices such as mobile phones, smartphones and tablets (*Gedik, Hanci, Kursun & Caglitay. 2012*)[11]. This will increase attention to learning material, make learning persuasive and can encourage learner motivation towards long life learning. In addition, compared to conventional learning, M-Learning allows more opportunities for collaboration and interacting informally among learners.

5. Teaching Materials accompanied by ICARE-Oriented student worksheet based on Mobile Learning System

Teaching materials accompanied by ICARE-oriented student worksheet based on mobile learning systems that will be developed are digital teaching materials that can be accessed online which contain discussion of basic physics concepts according to the subject matter, sample questions, practice questions, student worksheetcontains activities oriented to ICARE steps to train students' science process skills. The ICARE learning strategy emphasizes the following characteristics: active, creative, and joyful (*Wahyudin, 2010)*[4]. This soft teaching material will be developed using Eclipse which is a software or IDE (Integrated Development Environment) so that the results can be run on all platforms, namely smartphones, ipad, tablets and desktop PCs (*Murya, 2014*)[7].

The mobile learning system was chosen as one of the learning services, because it also has several advantages compared to other learning, including that it can be used anywhere and anytime, most mobile portable media have a relatively cheaper price than the price of a desktop PC, the size of teaching materials is small and light than a PC desktop, and it is estimated that more learners can be included because the mobile learning system utilizes technology commonly used in everyday life (*Tamimudin, 2007*)[12].

3. RESEARCH METHODOLOGY

The research method used in this research is the research and development (R&D) method adapted from Dick and Carry (1996) (*Sari, 2017*) with the implementation stages consisting of: 1) analysis, (2) design, (3) development, (4)) implementation, (5) evaluation. The research development procedure can be seen in Figure 1.

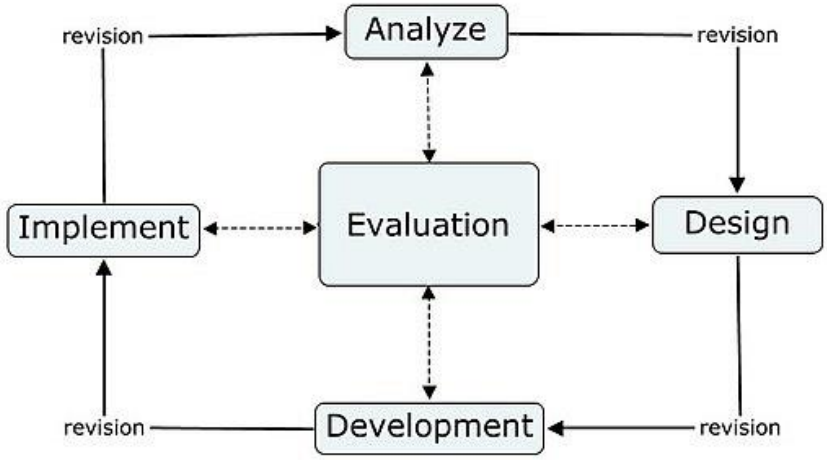

Figure .1. Research Stages

In the first stage, the analysis is carried out, namely analyzing the curriculum and material, analyzing user needs, analyzing program content, analyzing specifications, analyzing work, and preparing instruments. In the second stage the design is carried out, namely designing teaching material data for material needs, student worksheets and questions, designing navigation, designing user interfaces, and designing algorithms.

In the third stage of development carried out, namely making teaching material products assisted by Photoshop software, color cop, Dreamwaver and Android Studio. In the fourth stage of the implementation, the product results are in the form of digital teaching materials that can be accessed using an android smartphone. After the teaching material is in the form of an apk file. system testing will be carried out to determine the functionality of the digital teaching materials being developed. Revisions are made when there is a shortage of the product.

The last stage is Evaluation. At this stage, the assessment of quality by media experts and material experts and providing user responses by students is carried out. Input from experts and student responses become the basis for making final revisions of teaching material products. After that, the application will be limited to one class to obtain data on student learning outcomes using teaching materials with a mobile learning system-based scientific approach. In the form of a fishbone diagram, the research flow diagram is as follows.

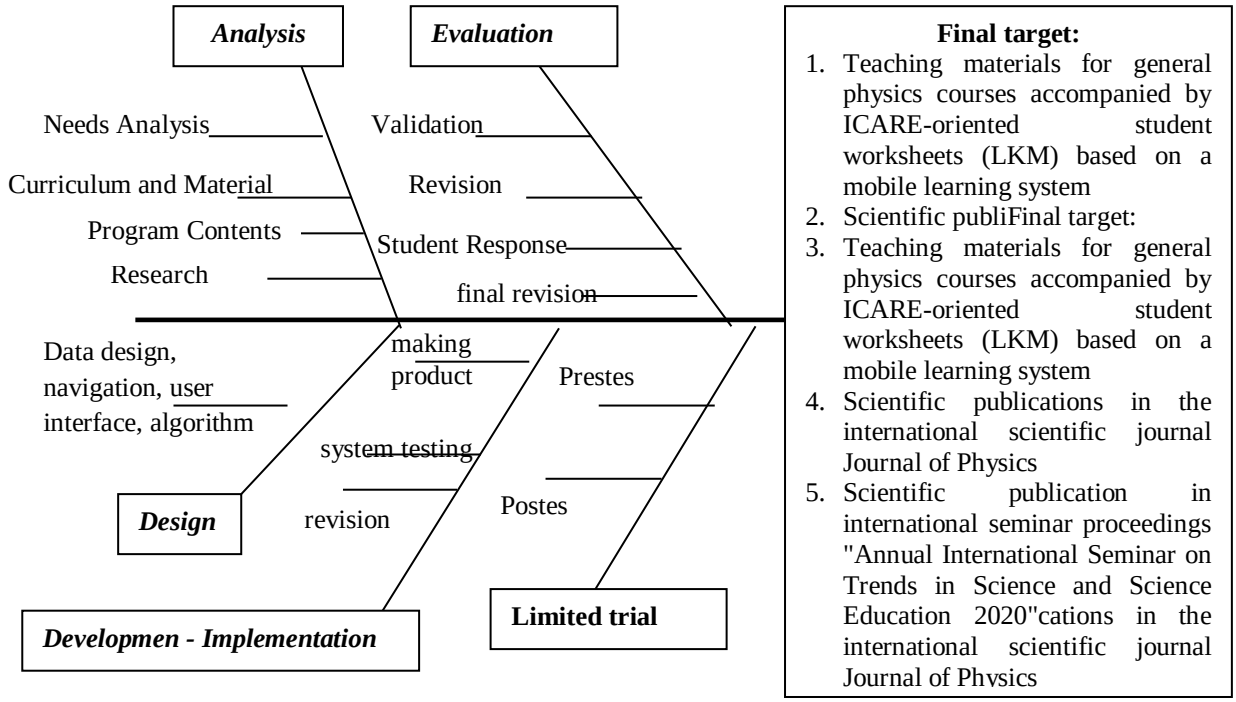

Figure 2. Fishbone Research Flowchart

a. Data Collection Techniques

Data collection techniques were carried out using expert validation sheets, student response sheets, and learning outcomes tests. The data obtained from this study are qualitative data and quantitative data. Qualitative data in the form of responses and suggestions for improvement from validators and students on teaching materials. Meanwhile, quantitative data were obtained from the limited trial phase of the application of teaching materials in the form of student pretest and posttest results.

b. Data Analysis Techniques

Any data that has been collected will be analyzed. The data from the needs analysis results obtained from lecturers and students are used to prepare the background and determine the level of development program needs. The data from the identification of needs is then complemented by the data from the identification of resources used to determine product specifications that might be developed.

Data on the suitability of design and learning material on products is obtained from material experts, design experts or practitioners through expert testing / validation. The suitability data is used to determine the feasibility level of the resulting product. From the results of the expert test questionnaire, several suggestions for improvement will be obtained that can be used as a reference in perfecting teaching material products accompanied by ICARE-oriented student worksheets based on the mobile learning system that has been made. Test results data to measure the level of effectiveness of the use of teaching materials are compared with the passing criteria applicable at Unimed. If 75% of students score> 70, then the teaching materials for general physics courses accompanied by ICARE-oriented student worksheets (LKM) based on the mobile learning system are appropriate.

c. Analysis of the Media Validation Sheet

The results of the validation of media and material from the validator on all aspects being assessed are presented in tabular form. Furthermore, the score validity value is calculated using the formula:

$$\% \text{ Suitability score } = \frac{\text{Total score obtained}}{\text{Total ideal score}} \text{ x } 100\%$$

or by using the percentage eligibility formula below:

$$P = \frac{f}{N} \text{ x } 100\%$$

with: P = Percentage of answers matched
f = Number or frequency of answers per category (alternative answers)
N = Total availability of the respondent's answer score

The results of the calculation are then interpreted with the following criteria:

Interval Percentage	*Validity interpretation*
80 % ≤ X ≤ 100 %	Very Valid
60 % ≤ X<80 %	Valid
40 % ≤ X<60 %	Enough Valid
20 % ≤ X<40 %	Less Valid
0 % ≤ X<20 %	Invalid

d. Analysis of student response

Analysis of student response data is the analysis of student response data in small group trials. This response is obtained by providing questionnaire sheets to students. Student response data in small group trials was obtained by calculating the scores of students who answered each item. Data on the results of student responses through a collected questionnaire were then tabulated. The result of tabulation of each item is calculated the response value with the formula:

$$P = \frac{f}{N} \text{ x } 100\%$$

with: P = Percentage of answers matched
f = Number or frequency of answers
N = Total availability of the respondent's answer score

The results of the calculation are then interpreted with the following criteria:

Interval	*Criteria*
0-20	Not good
21-40	Not good
41-60	Pretty good
61-80	Well
81-100	Very good

4. RESULT AND DISCUSSION

1. Results of the Teaching Material Development Process

The results of the process of developing general physics teaching materials (Basic Mechanics and Heat) based on a mobile learning system. among others :

a. Teaching materials are developed with the material of Measurement, Kinematics, Dynamics, Work and Energy
b. Prepare the initial product of teaching materials with a systematic teaching material, namely the description of the basic competencies that students will have, learning materials, sample questions, practice questions / competency tests and worksheet Student.

c. In the initial product testing phase, small groups to see student responses, generally suggest improving the appearance and reproducing / making examples of questions for each sub-material.
d. At the design and manufacturing stage of the system, a mobile learning system product has been produced by the name of *e-Fisum*.
e. At the system testing stage by media experts, suggestions for improving the contents / menu and appearance of the system were obtained.
f. The limited testing phase that has been carried out is still in the form of a manual pretest due to the incomplete system when the lecture activities have been running. Furthermore, learning is carried out by direct learning using printed teaching material products. In the learning process, students were enthusiastic when working on the worksheet Student.

2. Small Group Trial Results

Small group trials were carried out to get student responses about the suitability of the initial product of teaching materials against the 6 components assessed, namely: relevance, adequacy of material to achieve objectives, depth of material, language used, appearance of teaching materials, availability of sample questions. The trial implementation was carried out on 5 respondents by giving a student response questionnaire to the teaching materials consisting of 6 questions, each consisting of 4 answer choices, namely: appropriate / good / interesting / complete with a score of 4, enough with a score of 3, Less with a score of 2 and deviating from a score of 1. The results of the student responses are tabulated in a table then the total score of each component assessed is calculated, after which the total score is converted into a percentage which can be seen in Table .1.

Tabel .1.Small Group Trial Results

Resp	**Components Are Rated**					
	Relevance	**Adequacy**	**Depth**	**Language**	**Appearance**	**Example Questions**
M1	3	3	3	3	2	3
M2	4	3	3	4	3	3
M3	3	4	3	3	3	3
M4	4	3	3	3	3	3
M5	3	3	3	4	3	3
Amount	17	16	15	17	14	15
%	**85**	**80**	**75**	**85**	**70**	**75**
%Rt	**78,33**					
Kes	**Baik**					

The percentage of the score for each component in Table .1 can be visualized in the form of an image as shown in Figure 3. Below

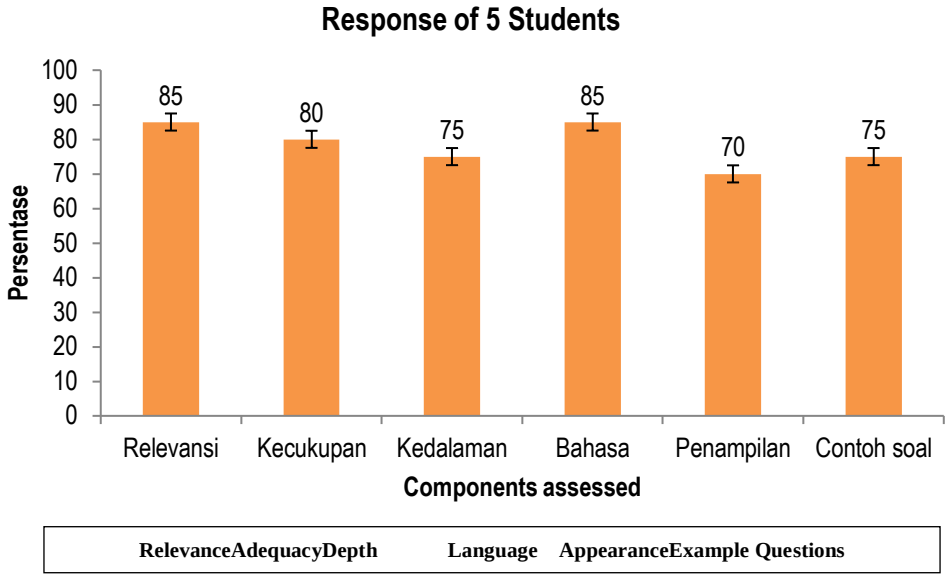

Figure 3. Percentage of Student Responses

Based on Figure 3. the components of relevance, material adequacy and language are categorized as appropriate / good, while for the components of material depth, the appearance of teaching materials and the availability of sample questions in sufficient categories. Based on the results obtained in the small group test then revisions were made by increasing the depth of the material, improving the appearance and adding sample questions.

3. Limited Trial Results

After the test results in the small group were improved, then the trial was limited to 1 (one) class of students, namely Class 2020 Class C Physics Education Study Program. This stage still produces data on the average pretest score of each student (contained in the attachment) with different materials namely Kinematics, Dynamics, Work and Energy which can be seen in Figure 4.

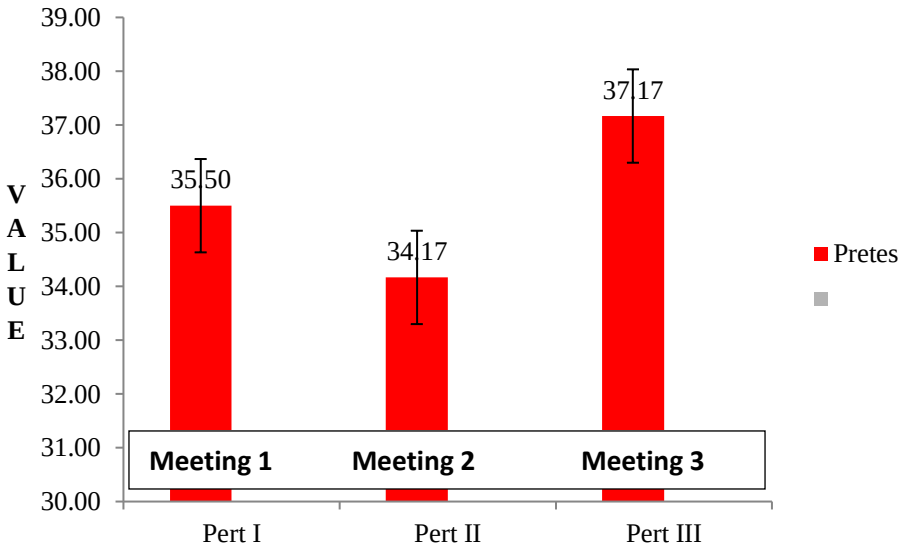

Figure 4. Average Pretest Value

5. CONCLUSION

Based on the processing of student response data to the teaching materials developed, it was found that the printed teaching materials produced in the form of modules were suitable for use in lectures. The components of the assessment of teaching materials include relevance 85%, adequacy of 80%, depth of 75%, language 85%, appearance 70% and sample questions of 75%. Overall average 78.33%.Temporary conclusions from the implementation of this research are, The printed teaching materials produced in the form of modules comply with the criteria set to be used in lectures and can be uploaded to the system and Based on the pretest data, it is known that the students' initial knowledge of kinematics, dynamics, and Business & Energy is still very low

References

1. 1.Andreicheva, L., Latypov, R. (2015). Design of ELearning Systems: M-Learning Component. Procedia-Social Behavioral Sciences 191 (2015) 628-633
2. 2.Arsyad, A. (2008). Media Pembelajaran, Jakarta: PT Raja Grafindo Persada.
3. 3.Prastowo, A. (2014). Panduan Kreatif Membuat Bahan Ajar Inovatif. Yogyakarta : Diva Press
4. Irfandi, I., Faisal, F., Hasibuan, N. I., & Panggabean, D. D. (2018). The Dissemination Of Technology-Based Learning Media For Elementary School Teachers In The District Of Sijunjung. JCRS (Journal of Community Research and Service), 2(1), 198-205.
5. Wahyudin, D. (2010). Model Pembelajaran ICARE pada Kurikulum Mata Pelajaran TIK di SMP (ICARE based Instructional Model on ICT Curriculum in Yunior Secondary School). Jurnal Penelitian Pendidikan Vol. 11, No. 1, April 2010. UPI, Bandung.
6. Uysal, M.P.,& Gazibey, Y. (2010).E-Learning in Turkey: Developments and Applications, Yamamoto
7. Murya, Y. (2014). Pemrograman Android Black Box. Purwokerto: Jasakom.
8. Jasmadi, C. S. (2008). Panduan Menyusun Bahan Ajar Berbasis Kompetensi. Jakarta: PT Elex Media Kompetindo.
9. Setiawan, D dkk. (2007). *Pengembangan Bahan Ajar*. Jakarta : Universitas Terbuka.
10. 10.Adegbija, M.V & Bola, O.O. (2015). Perception of Undergraduatea on the adoption of mobile technologies for learning in selected Universities in Kwara State, Nigeria. Procedia Social Behavioral Sciences 176 (2015) 352356.
11. Gedik, N., A. Hanci-Karademirci, E. Kursun and K. Caglitay.(2012). Key instructional design issues in a cellular phone-based mobile learning project. Computers and Education, 58, 1149-1159.
12. Tamimudin, M. 2007. Mengenal Mobile Leraning (M-Learning). LIMA