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THE DEVELOPMENT NEWTON'S LAW HANDOUT BASED ON ANDROID INTEGRATED STEM (SCIENCE, TECHNOLOGY, ENGINEERING, MATHEMATICS)

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Abstract

This study aims to develop a newton's law handout in highschool that meets covering feasibiliy aspect, language aspect, presentation aspect, and graphics aspect. This typer of research is research development or Research and Development (R&D), with 4-D model. The population of this study were all student of SMA Negeri 2 Percut Sei Tuan with the subject of all student of class XI IPA1 SMA Negeri 2 Percut Sei Tuan. The testing phase for Newton's legal handouts was carried out by means of product validation by three experts, namely content experts, material experts, and teachers. The results showed that the value of product validity in the very valid category was an average percentage of 92.61% with a description of validator 1 87.73%, validator 2 98.14%, and validator 3 91.97%. while the response value in the category was very good/practical. The n-gain result obtained is 0.6, this indicates that there is an increase in learning outcomes in the medium category. Students give a positive response to the product being developed. Aspects of Ease of Understanding obtained a percentage of 78% (Good), Aspects of Learning Independence 83.75% (Good), Aspects of Learning Activeness 92.50% (Very Good), Aspects of Interest in Handout 86.25% (Very Good), Aspects of Presentation of Handout 93.30% (Very Good), Aspect The Use of Handout 81% (Good), and also the whole response to the handout developed as much 86.43% (Very Good). Teacher also give very positive response with percentage of 100%. Based on the results obtained, it can be concluded that the STEM integrated Newton's law handout is very valid and very good so that it can be used in the learning process.

Keywords: *Handout, Newton's law, Android, Feasibility, STEM*

Education is something that cannot be separated from human life along with the times. Even in this era of globalization, education is used as the key to a country's development. The success of development in a country is influenced by its Human Resources (HR). Quality human resources are the main capital in competition in the era of globalization. This is due to the increasing number of people in the world so that competition is getting tighter, natural resources are decreasing and technological developments are getting faster.

Clearly, educational objectives in the 21st century will need to distinguish between knowledge and skills a learner must have to cope with the world of works. (Scardamana and Bereite, 2006) research in cognitive science has established that knowledge and skills are richly interwined, rather than knowledge as content on which skills acts as a process. The frameworks therefore categorizes what student need for the 21st century as understanding and how student actualize those understanding in practice as performance

based on interwoven content knowledge and process skills which is a more accurate depiction of has the mind works.

The development of the Android operating system, starting from gadgets, PC tablets, smartphones and other applications that have other Android operating systems. Of course, it can support students owning and using android in everyday life. The use of smartphones itself is currently popular in the world and is not behind Indonesia. The existence of a smartphone can have a huge impact on human life and provide a lot of convenience in its use. However, the use of smartphones is only used for social media use and only a small proportion use it to help learning activities and human work. Currently, many applications are offered in one hand, making it easier to find the required information.

Learning is a complex thing. The complexity of learning is seen from two subjects, namely from students and from educators. From the student's point of view, learning is experienced as a mental process in dealing with learning materials. Meanwhile, from the point of view of educators, the learning process appears to be learning behavior about something.

According to Panen (2004), learning is a process of change that is relatively fixed in individual behavior as a result of experience. Meanwhile, according to Ruhimat (2011), learning is an activity that is deliberate and carried out by individuals so that there is a change in self-ability, by learning that children who were unable to do something, become capable of doing something, or children who were not skilled, become skilled. Learning is an everyday activity for people. According to Warsita (2008), learning is a complex process that occurs to everyone and lasts a lifetime. Thus, one of the functions of learning theory according to Miarso (2004) in Warsita (2008), learning theory is to reveal the ins and outs of (complex) events that seem simple.

The term learning is an outgrowth of the term teaching, and the term teaching and learning which we can argue about, or we just ignore the important meaning of the three. According to Ruhimat, et al (2011), learning is an effort made by a person or educator to teach students to learn. In the concept of education, learning is defined as an effort to manage the environment on purpose so that someone can form themselves positively in certain environmental conditions (Miarso, 2004).

According to Kustandi (2011), media is an intermediary or messenger for messages from sender to message recipient. More specifically, the notion of media in the teaching and learning process tends to be defined as graphic, photographic, or electronic tools for capturing, processing, and reconstructing visual or verbal information. Meanwhile, according to Susilana (2007), in an effort

to use the media as a tool, media is classified according to its level from the most concrete to the most abstract. Lesle J. Briggs in Rusman (2008) states that learning media as: the physical means of conveying instructional content, books, films, videotapes, etc. Furthermore, Briggs states that media is a tool to stimulate students so that the learning process occurs.

Multimedia can be different from the point of view of different people in general, multimedia is related to the use of more than one kind of media to present information. According to Geyeski (1993) in Munir (2012), multimedia is a collection of computer-based media and communication systems that have roles to build, store, deliver and receive information in the form of text, graphics, audio, video, and so on. Meanwhile, multimedia in a computer context according to Hofstetter in Munir (2012) uses computers to present and combine text, sound, images, animation, and video with tools and connections so that users can navigate, interact, create, and communicate.

Learning in the 21st century requires integration of learning with the daily life processes. One of the alternatives is to integrate several fields into STEM learning (Science, Technology, Engineering, and Mathematics). STEM is a field that requires numeracy, understanding and analyzing empirical data including critical analysis; understanding of scientific and mathematical principles (Ernst, Williams, Clark, Kelly, & Sutton, 2018; Vulperhorst, Wessels, Bakker, & Akkerman, 2018). Not only that, STEM requires students to apply a systematic and critical assessment of complex problems with an emphasis on theoretical knowledge from the subject to practical problems, ingenuity, logical reasoning and practical intelligence (Mutakinati, Anwari, & Yoshisuke, 2018; Sanchis-Segura, Aguirre, Cruz-Gómez, Solozano, & Forn, 2018).

The understanding and scope of STEM skills vary greatly in various countries (Ernst et al., 2018; Vulperhorst et al., 2018). Supply is relatively clearly identified in terms of qualifications achieved in STEM subjects, although the definition of STEM subjects can vary (Fitzakerley, Michlin, Paton, & Dubinsky, 2013). STEM score subjects usually include mathematics; chemistry; computer science; biology; physics; architecture, civil engineering, electricity, electronics, communication, mechanics, and chemical engineering (Stoet & Geary, 2018).

STEM education provides opportunities for teachers to show and practice the concepts, principles, and techniques of science, technology, engineering, and mathematics that can be used in an integrated manner (DeCoito, 2016; Irwandani & Rofiah, 2015; Irwansyah, Sukarmin, & Harjana, 2018; Ritz & Fan, 2015). Thus, STEM learning provides real output for age development, including computational thinking with the development of comparative thinking that

facilitates the people to send data quickly (Syukri, Lilia, & Subah, 2013)

The development of science and technology cannot be separated from the contribution to the development of physics. Physics is the study of natural phenomena that occur in matter or energy that occupies space and mass (Chodijah, et al., 2012). Physics studies about the nature, natural laws, and their application in everyday life. Physics has the nature of abstract and concrete concepts. The abstract physics concept is difficult to visualize, so that it makes it difficult for students to study and understand it. This is what makes students think that physics is difficult and unattractive so that it requires educators to develop strategies in learning physics so that they are easily understood by students.

Newton's law is a basic concept of classical physics which has been widely used for its application in the field of technology. Newton's law has an important role in technological development, so it is necessary to learn about technology and engineering techniques in a teaching material. However, references to existing teaching materials are mostly only focused on science and mathematics, while for technology and engineering techniques are still few. According to (Reeve. 2015) STEM learning is a priority learning model in solving global issues and problems facing the world today, for example: global warming, air and water pollution, clean drinking water, and food safety. For this reason, teaching materials are needed whose contents are capable of covering science, technology, engineering and mathematics. Based on this, teaching materials that use the STEM approach are needed.

According to previous research, researchers stated that the habit of increasing knowledge through reading is increasingly being carried out due to the impact of technological developments. Most of the students prefer to play games with laptops or gadgets compared to reading both in class and outside the classroom, even though the role of reading is very large because reading is a source of information.

RESEARCH METHODS

This type of research is Research and Development (R&D). The product developed is Newton's Law Handout Based On Android Integrated STEM (Science, Technology, Engneering, Mathematics). The development model applied is 4-D by Thiagarajan et al. (1974). The stages of the 4D development model include: 1) Define; 2) Design; 3) Develop; and 4) Disseminate (Thiagarajan, 1974).

This research will be conducted online at SMA Negeri 2 Percut Sei Tuan. The research location was chosen because high school level subjects are relevant to

the research title. The time of this research is from February to March 2021.

The population in this study were students of class XI MIPA 1 SMA Negeri 2 Percut Sei Tuan for the 2020/2021 school year. The research sample is part of the population to be observed. In this study, Android-based learning media products will be tested on a large scale against first-class students. The sample in this study were all students of class XI MIPA 1 SMA Negeri 2 Percut Sei Tuan. The sampling technique used was purposive sampling.

RESULT AND DISCUSSION

a. Define

According to previous research, researchers stated that the habit of increasing knowledge through reading is increasingly being carried out due to the impact of technological developments. Most of the students prefer to play games with laptops or gadgets compared to reading both in class and outside the classroom, even though the role of reading is very large because reading is a source of information.

The stage of determining the basic problems of students was carried out by interviewing 1 physics teachers at SMA Negeri 2 Percut Sei Tuan. The results of the analysis from the interviews were used to determine the basic problems experienced by the students of SMA Negeri 2 Percut Sei Tuan. Learning problems experienced by students can be viewed from learning resources, learning media, teaching and learning activities in the classroom, and facilities in the learning process. Based on the analysis of the interview results, it was found that:

1. The physics learning resources used were still lacking, especially during the Covid-19 pandemic. The source of student learning only from elusive handbooks and can’t lead students to learn independently and explore the knowledge
2. Teachers have never made teaching materials in the form of handouts based on Android so that the use of android among students have not been optimized for the learning process
3. Achievement of learning goals still not maximized
4. Teachers in teaching still often use the teacher-centered method has not been many approaches scientific according Curriculum 2013
5. The learning sources do not implement STEM Approaches

b. Design

The selected media is android, this is adjusted to the results of the front and end analysis conducted by researcher by interviewing 1 physics teachers at SMA Negeri 2 Percut Sei Tuan who stated that most students have android but they have not used it optimally to support the learning process in class.

The format chosen in this development is in the form of a newton's law handout handout which is integrated into the STEM learning approach. The selection of this format was adjusted to several problems found at the define stage, namely:

1. The physics learning resources used were still lacking, especially during the covid-19 pandemic. The source of student learning is only from handbooks that are difficult to understand and cannot guide students to learn independently and explore knowledge so that the integrated handout of the STEM approach should be chosen.
2. Learning resources are not interesting
3. Existing learning resources have not been integrated into STEM learning even though as many as 80% of students like STEM based learning
4. Teachers still often use the lecture method but have not applied a lot of scientific approaches according to the 2013 Curriculum so that STEM learning is suitable for choosing existing learning
5. Learning source does not implement STEM approach problems even though as many as 97.5% of students stated that they really needed to get used to practicing with STEM approach because Considering STEM is a learning innovation that can encourage a globally competitive and quality learning in the 21st century today.

Figure 1. Diagram of Student Responses to STEM learning

The initial design in this development was in the form of newton's law handout draft which is integrated to STEM approach using Microsoft Power Point 2016. The parts of this draft handout include profiles compilers, competencies, materials, checkpoint part, and objective test.

c. Development Stage

Newton's Law Handout Based On Android Integrated STEM (Science, Technology, Engineering, Mathematics) was made using "*power point*" application. This application was chosen because the purchase price is not too

expensive, it can be used on Android, and tutorial videos for making applications using power point are easy to find on YouTube. The product is named Newton's law Handout with a file size of 5 MB.

Validation was carried out to determine the feasibility of the product being developed and to get suggestions for improvement. The validation was carried out on 3 validators of which 2 lecturers and 1 teacher.

Table 1. Feasibilty Validation Results

Aspects Assessed	**Feasibility Percentage**			**Average**	**Category**
	Validator 1	**Validator 2**	**Validator 3**		
Feasibility of Content	83.65%	94.23%	73%	83.62%	Very Feasible
Language Feasibility	83.92%	100%	98.21%	94.04%	Very Feasible
Presentation Feasibility	86.67%	98.34%	96.67%	93.89%	Very Feasible
Graphics Feasibility	96.67%	100%	100%	98.89%	Very Feasible
Total Average	**87.73%**	**98.14%**	**91.97%**	**92,61 %**	**Very Feasible**

The assessment of Newton's law Handout Based on Android Integrated STEM (Science, Technology, Engineering, Mathematics) based on the BSNP (2014) has four aspects, namely content feasibility, language feasibility, presentation feasibility and graphic feasibility. The percentage of feasibility for each aspect based on the overall validators' assessment is above 90% where the average percentage of eligibility by validator 1 is 87.73%, validator 2 is 98.14%, and validator 3 is 91.97%, meaning that the quality of the product developed is categorized as "Very Feasible" used in the teaching and learning process.

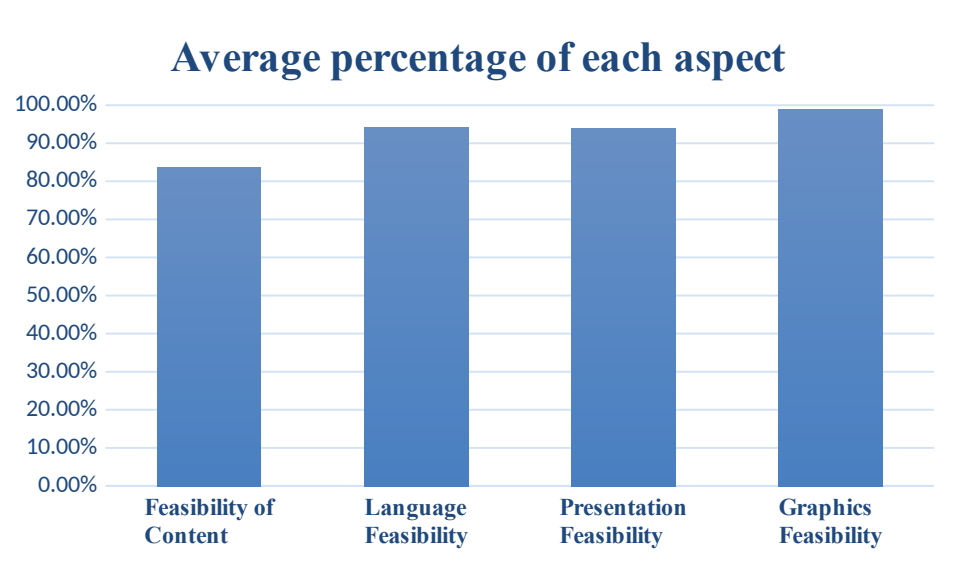

Figure 2. Diagram of the Average Percentage of each aspect

Table 2. Feasibilty STEM Aspects Results

STEM Aspects	**Score**			**Average (percentage**	**Category**
	Validator 1	**Validator 2**	**Validator 3**		
Science	3	4	4	91.67%	Very Feasible
Technology	4	4	4	100%	Very Feasible
Engineering	3	3	4	83.34%	Feasible
Mathematics	4	3	4	98.89%	Very Feasible
Total Average (percentage)	**87.5%**	**87.5%**	**100%**	**91,67%**	**Very Feasible**

The improvement of student learning outcomes after using android-based handout can be analyzed using the N-gain test. In research, it is necessary to test N-gain before testing the hypothesis. Based on the calculations, the data obtained from the gain test results are as in table 3 below.

Table 3. N-gain test result

Mean pretest score	**Mean posttest score**	**Average N-Gain**	**Category**
42.5	78.13	0.60	Medium

The field trial is carried out after the validation stage. The development test was carried out by asking for responses from students and teachers to the Newton's Law Handout Based On Android Integrated STEM (Science, Technology, Engineering, Mathematics). The instrument used to obtain responses is in the form of a questionnaire that applies the *Guttman Scale*. By using the *Guttman scale,* the researcher got a brave answer of "Yes" and "No". The instrument used consists of several aspects including Ease of Understanding, Learning Independence, Learning Activeness, Interest In Handout, Presentation of Handout, The Use of Handout, and also the whole response to the handout developed. Before asking for student responses, the researcher first put on the product that was developed. Product introduction is done online using Zoom Meeting. After the product introduction, the researcher sent a google form link containing a questionnaire to obtain student responses. As for the teacher, the introduction of the application is carried out during the validation stage and the response is obtained offline. The results of student and teacher responses are as follows:

Table 4. Students and Teacher Result response

Aspects	**Percentage (%)**		**Average (%)**
	Students	**Teacher**	
Ease of Understanding	78	100	89
Learning Independences	83.75	100	91.88
Learning Activeness	92.50	100	96.25
Interest In Handout	86.25	100	93.13
Presentation of Handout	93.30	100	96.65
Use of android based handouts	81	100	90.5

Integrated Newton's Law Handout Based On Android Integrated Stem (Science, Technology, Engneering, Mathematics)	86.43	100	93.22

Based on the table 4.5 it can be seen that students and teacher give a positive response to the product being developed. This is evidenced by the high percentage of their responses. Aspects of Ease of Understanding obtained a percentage of 89% (Very Good), Aspects of Learning Independence 91.88% (Good), Aspects of Learning Activeness 96.25% (Very Good), Aspects of Interest In Handout 93.13% (Very Good), Aspects of Presentation of Handout 96.65% (Very Good), Aspect The Use of Handout 90.5% (Good), and also the whole response to the handout developed as much 93.22% (Very Good), which categories- the categories as **very good**

CONCLUSION

Based on research and development conducted by researchers, it can b**e**concluded that Newton's handout feasibility which has been developed based on an assessment by experts as a whole gets an overall average score of 83.62% for content feasibility, 94.04% for language eligibility, 93.89% for presentation feasibility, and 98.89% for graphic feasibility with the overall average is 92.61% which is "very feasible" category. Students give a positive response to the product being developed. This is evidenced by the high percentage of their responses. Aspects of Ease of Understanding obtained a percentage of 78% (Good), Aspects of Learning Independence 83.75% (Good), Aspects of Learning Activeness 92.50% (Very Good), Aspects of Interest in Handout 86.25% (Very Good), Aspects of Presentation of Handout 93.30% (Very Good), Aspect The Use of Handout 81% (Good), and also the whole response to the handout developed as much 86.43% (Very Good). Based on these data, the results of the calculation of n-gain obtained 0.60. This means that this experimental class has increased learning outcomes in the medium category $0,3 \leq g \leq 0,7$ (medium category).

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