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VALIDITY AND PRACTICALITY OF ANIMATED VIDEO - BASED LEARNING MEDIA ON VARIOUS FORCES AND INERTIAL OBJECTS MATERIALS

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ABSTRACT

Contextual learning using observation objects about natural properties and phenomena in learning physics still finds many obstacles. Such as lack of laboratory facilities, demonstration equipment and direct observations in the field. So we need learning media that can show real conditions, namely animated videos. In the concept of force and inertial objects, there are difficulties in describing forces proportionally and free diagrams which have an impact on difficulties answering questions. This study aims to determine characteristics and produce valid and practical animated video-based learning media. This development research uses the Plomp model which is limited to stage one to one evaluation stage. The research instruments used were journal analysis sheets, teacher interviews, self-evaluation sheets, material expert and media expert validation sheets, and one to one evaluation assessment sheets. Data analysis techniques using descriptive analysis techniques and percentage technique. The results of the journal analysis showed that it was difficult to learn the concept of force and the inertia of objects. In teacher interviews, it was shown that learning in the classroom was still saturated due to the lack of variations in graphical learning media. At the development stage, the results of self-evaluation test obtained very good criteria, on the expert review test the validation results were obtained by material experts 81% and 93.8% by media experts. While the practicality stage obtained results by teachers 87.9% and 86.9% by students. So, the animated video media is valid and practical and can be continued at the effectiveness test stage.

Keywords: Learning Media, Animated Video, Force, Inertial objects.

I. INTRODUCTION

Physics is part of the natural sciences (IPA) which is obtained According results of investigations into various natural phenomena arranged in the form of concepts, principles and laws of physics. The main basis of physics is the results of observation and investigation of various natural phenomena found by hands on activity, main activity and daily life which are continued through observation, data collection, data processing to conclude [1]. Physics is a lesson that provides knowledge about the universe to practice thinking and reasoning so that students can increase their thinking power and in line with the increase in their knowledge [2]. Physics is a basic science of technological development so it is important for students to master it.

At this time, the advancement of technology and intellectual knowledge has a significant impact on the field of education, particularly in terms of raising the quality of education. In this day and age of technological advancement, it is essential that teachers can more easily use technology and educational media in order to make it easier for teachers to help students understand lesson material and support learning outcomes [3].

However, the problem that occurs is that school facilities that support learning in using technology-assisted learning media such as LCDs in the classroom have not been utilized optimally, so that most students have difficulty understanding material including physics material resulting in low learning outcomes. Based on observations at one of the Padang city high schools, the problems faced by teachers and students include the difficulty of directing students to understand physics materials and the difficulty of connecting concepts with equations in physics material. The learning resources used by the teacher are less varied and only focus on

textbooks in schools and only use blackboard media in learning so that learning objectives are difficult to achieve. This is due to the teacher's limited knowledge and ability to develop innovative learning media, plus the limited time teachers have to make learning media. Even though schools already have enough facilities and infrastructure to support learning using graphic media in the classroom, such as the availability of projectors and WiFi access. The lack of media in graphic form used by teachers causes students to pay less attention to learning in class and lose concentration while studying which has an impact on student learning outcomes.

One of the low learning outcomes occurred in Newton's laws of motion. The results of daily tests on this material have not reached the minimum completeness criteria with an average of 51.05. This result is far from the value expected to achieve the minimum completeness criteria, which is 80.00. This shows that there is a lack of understanding of the concept by students. If students do not understand Newton's law material, then in the next material students will experience difficulties.

Several studies have revealed that so far students have experienced difficulties and problems in defining and understanding the formula $\sum F=0$ (Newton's First Law), identifies forces using free body diagrams, depicts force vectors as normal forces (**N**), heavyweight (**w**), pulling and pushing forces (***F***), and friction (f), understanding the force of action and reaction [4], difficulties in interpreting the formula [5], unable to describe the forces acting on objects [6]. This is because students only know or memorize Newton's Law formulas without understanding their meaning and application and the lack of variations in practice questions so that students can only work on questions that are similar to sample questions.

In learning Newton's law material related to the concept of force, it requires students to be able to identify the forces acting on an object and describe them in the form of free diagrams. However, this is still an obstacle for the teacher to explain properly, for example, the size in describing the force vector is not proportional.

Accordings problems, it is necessary to strive for the development of graphic learning media that can overcome the limitations in making direct observations, presenting realistic animations, creating independent students so they are not overwhelmed and finally being able to help in understanding the material optimally. One way is by developing learning media.

One of the main functions of learning media is as an intermediary between teachers and students so that a concept can be understood easily. In addition, the function of learning media in the learning process, namely: presenting rare objects and actual objects, making duplicates of actual objects, turning abstract concepts into concrete concepts, providing common perceptions, overcoming barriers of time, place, distance and number, restating information. consistently, and provide a learning atmosphere that is interesting, relaxed and not pressured, so that learning objectives can be achieved [7] According to the form of information used, learning media are divided into five major groups namely visual media, visual media motion, audio media, audio visual media silence, motion audio visual media [8].

Various types of media that can be created in the learning process of students, one of which comes from technology, namely learning videos. Video is very useful for students in the learning process [9]. In addition to making it easier for students to understand the material [9]. Videos can also motivate [10]; improve memory [11], improve learning outcomes [12], train students to use IT and master physics material as a whole [13]. Therefore, learning videos are better for use in learning. Other research reveals that increasing learning outcomes by applying video media is better than applying power point presentation media in learning [14].

Researchers chose the development of learning media in the form of animated videos so that the physics learning process is more meaningful and makes it easier for students to understand abstract physics concepsts.. Animated video is an image object that is made to move as if it were alive with the aim of depicting a predetermined movement, so that an image is created that is made to look real and animation can produce a predetermined object movement [3]. Learning by using animated videos is also more fun because there is real visualization compared to just reading books and listening to the teacher's lecture. The use of animated videos developed by researchers can be used as a valuable stimulus for group discussions. In addition, students are better able to remember and apply practical actions and procedures they have watched in videos [15], can make it easier to convey questions or problems to students [16], and improve students' ability to understand learning material and are suitable for use in learning [17].

To make an animated video, the right software is needed to produce a decent visualization. The existence of technological developments and the abilities possessed by researchers provide opportunities to be able to develop animated videos with software which are available. One of software which can be used to develop learning videos namely Adobe After Effect. Adobe After Effects is a software that is very professional and able to meet the needs of motion graphic design. By using the available features, users can easily create interesting animations. This is very useful for developing and creating dynamic images, creating animations, editing videos, and adding spectacular effects [18]. The research aims to produce animated video-based learning media on materials of various forces and inertial objects that are valid and practical to use.

II. METHOD

This research is included in development research/design research. The development of video animation-based media uses the plomp model which consists of three stages, namely (1) preliminary research stage, (2) development/prototyping stage, (3) assessment stage. The research conducted was limited to the development/prototyping stage (one to one evaluation). The results of the research at the preliminary research stage were analyzed using descriptive analysis techniques.

Preliminary research carried out needs analysis and context analysis. In needs analysis, researchers analyzed the needs of using video-based learning media by conducting interviews with physics teachers. While in the context analysis, the researcher analyzed the depth and difficulty of the material for learning Newton's laws of motion with related journals. Preliminary research aims to find out the problems in the field that must be solved and conduct a literature studies to find the right solution.

At the development/prototyping stage, learning media based on video animation were designed on the material of various force and inertial objects. Furthermore, a formative evaluation is carried out, which consists of self evaluation, expert review and one to one evaluation. Improvements to the designed media were carried out according to the suggestions given at the stage expert review. Self-evaluation was carried out by the researcher himself to check for completeness and see any obvious errors in the prototype. The instrument used for self-evaluation is a self-assessment questionnaire with an assessment score using a Likert scale. The data analysis technique used is the percentage technique with the following equation:

$$Percentace = \frac{Score\ Obtained}{Maximum\ Score}\ x\ 100\% \qquad (1)$$

The interpretation of the results of the self-evaluation can be seen in Table 1.

Table 1. Interpretation Results

Interval	Category
81-100	Very High
61-80	High
41-60	Enough
21-40	Low
0-20	Very Low

(Source: Ref [19])

After stage self evaluation, then the prototype is validated at stage expert review by two material expert validators and one media expert validator. The validation instrument used in validation by material experts is a validity questionnaire with five aspects namely (1) aspects of learning objectives, (2) aspects of learning materials, (3) aspects of learning methods, (4) aspects of learning resources and (5) aspects of learning activities. While the instrument used in validation by media experts is a validity questionnaire with three aspects, namely (1) aspects of software engineering, (2) aspects of learning design and (3) aspects of visual communication. The data analysis technique used is the percentage technique with Equation (1). Interpretation of validity results can be found in Table 1.

After the prototype is declared valid, then an evaluation is carried out one to one to see the practicality of the prototype that has been made. The instrument used is an assessment sheet by the teacher and students which consists of material aspects and media aspects. Assessment on the practicality assessment sheet using a Likert scale. Furthermore, the data were analyzed using percentage techniques as in Equation (1). The practicality interpretation of the prototype is shown in Table 1.

III. RESULTS AND DISCUSSION

A. Result

In the preliminary stage, a preliminary study was carried out through interviews with the physics learning process to physics teachers and journal analysis. The results of the learning process interviews obtained from two physics teachers at one of the Padang city senior high schools that in the learning process, the learning resources used were still fixated on textbooks and the teaching and learning process was carried out manually using blackboard media so that students paid less attention and concentration in learning, it is difficult to understand the concept of physics properly which causes low student learning outcomes.

Data on learning difficulties analysis on Newton's Law material by students was obtained through an analysis of three journals. The results of the analysis show that on average students still experience difficulties in Newton's law material. Journal analysis can be seen in Table 2.

Table 2. Journal Analysis Results

No	Author	Analysis Result Article
1	Ayu at al (2018)	The average value of students' understanding of concepts is in the low category, which is equal to 24.3 out of a maximum value of 100. This shows that students having difficulty in Newton's law material. In general, students experience difficulty defining and understanding the formula $\sum F = 0$, identify forces use free body diagrams, and understand the forces of action and reaction.
2	Nuriyah at al (2017)	The students' mastery of concepts is still low. students find it difficult to understand the forces that work, the direction of the force vector, and students only know Newton's Law formula without understanding its meaning and application.
3	Januarifin at al (2018)	Many students experience mistakes in solving Newton's first, second, third law and frictional problems. The mistake is a mistake in understanding concepts, strategy errors and can't decipher the forces that work on object. The reason is because students only memorize mathematical equations without understand the physical meaning and the lack of variations in the practice questions so that students only can work on questions that are similar to the example questions.

The results of the journal analysis in Table 2 show that many students experience difficulties in Newton's law material. The greatest difficulty lies in understanding the forces acting and the difficulty in drawing a free-body diagram. This indicates the need for a solution to overcome it.

After knowing the problems in the preliminary research, literature study ware carried to find a suitable solution. The suggested solution is media for learning that is based on animated that can help students understand concepts, improve learning outcomes, interest and motivation to learn [20].

Results at the development or prototyping stage, starting with designing storyboard animation video media on the material of various force and inertial objects. The first evaluation carried out on the media prototype design is self-evaluation. Results of the self-evaluation are presented in Table 3.

Table 3. Analysis Results Self Evaluation

No	Assessed Aspects	Average (%)	Category
1.	Material Aspect	96,67	Very High
2.	Media Aspect	98,00	Very High
	Overall Average	97,27	Very High

In Table 3 there are two aspects that are assessed, namely the material aspect and the media aspect. In the material aspect, the average percentage is 96.67%, while the media aspect is 98.00%. The overall average self-assessment is 97.27% with a very high rating category. Next is done expert review by material experts and media experts on animated video-based learning media. Results expert review by material experts are presented in Table 4.

Table 4. Result of Expert Review Analysis by Material Experts

No	Assessed Aspects	Average (%)	Category
1.	Aspects of learning objectives	80,0	High
2.	Aspects of learning Materials	81,1	Very High
3.	Aspects of learning objectives	90,0	Very High
4,	Aspects of Learning Resources	80,0	High
5.	Aspects of Learning Activities	80,4	High
	Average Validity	81,0	Very High

In Table 4, the average validity by material experts ranges from 80.00% to 90.00% with an average overall aspect of 81.00%. According results of the assessment analysis by material experts, video-animation-based learning media on material of various forces and inertial objects is valid in terms of the aspects of objectives, materials, methods, sources and learning activities with very high validity categories. Furthermore, results expert review by media experts are presented in Table 5.

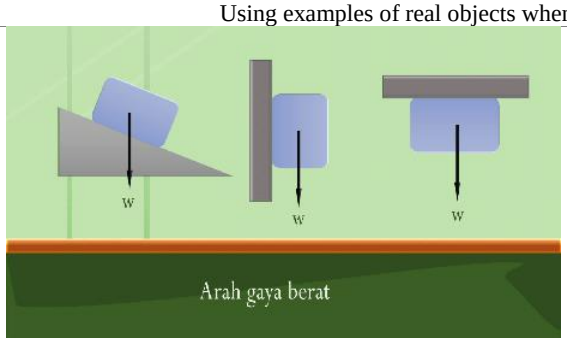
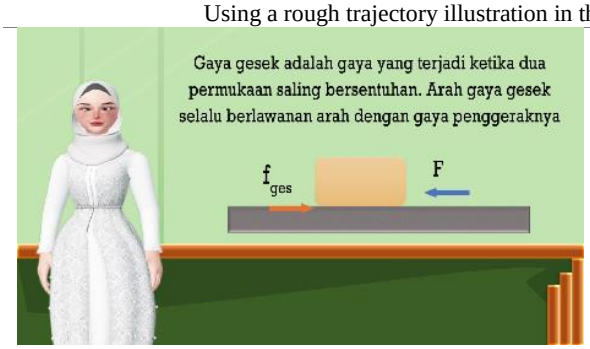
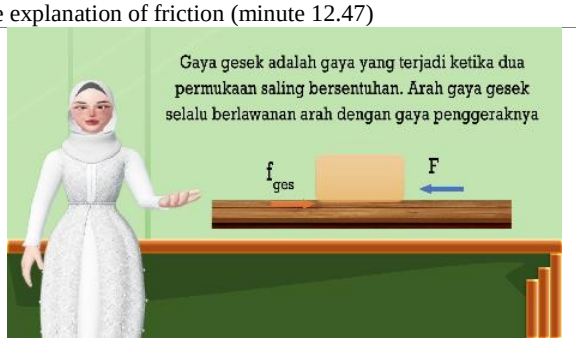
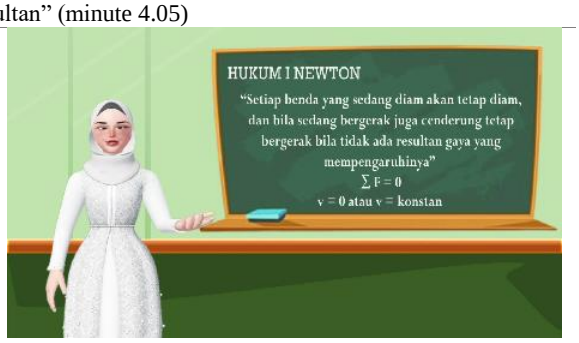
Tabel 5. Result of Expert Review Analysis by Madia Experts

No	Assessed Aspects	Average (%)	Category
1.	Software Engineering Aspects	100	Very High
2.	Aspects of Learning Design	85,7	Very High
3.	Aspects of Visual Communication	94.5	Very High
	Average Validity	93,8	Very High

In Table 5, the average validity by media experts ranges from 85.7% to 100% with an average overall aspect of 93.8%. According results of the assessment analysis by media experts, video animation-based learning media on the material of various forces and inertial objects is valid in terms of the three aspects assessed, namely

aspects of software engineering, aspects of learning design and aspects of visual communication with very high validity categories. In the expert review process, several suggestions were obtained from experts to improve the prototype and revised the animated video-based learning media. According suggestions from material expert validators and media experts, the revisions made to improve the prototype of video-animated learning media are presented in Table 6.

Table 6. Revision of Animated Video Media Prototype According to Expert Advice

No	Part Before and After Revision
1	Using examples of real objects when demonstrating gravity (minute 1.01)
	 Before Revision  After Revision
2	Using a rough trajectory illustration in the explanation of friction (minute 12.47)
	 Before Revision  After Revision
3	Adding the word "resultan" (minute 4.05)
	 Before Revision  After Revision
4	Add duration to learning objectives
	 Before Revision (durasi 3 detik)  After Revision (durasi 8 detik)

After prototype revision, then in the one to one evaluation stage an assessment is carried out with a practicality test by the teacher and 12 students. The aspects assessed are the material aspects and the media

aspects. The results practicality test analysis by teachers and students are presented in Table 7 and Table 8.

Table 7. Results of Practicality Test by teachers

No	Assessed Aspects	Average (%)	Category
1.	Material Aspect	83,9	Very High
2.	Media Aspect	92,7	Very High
	Average Practicality	87,9	Very High

Table 8. Results of Practicality Test by Students

No	Assessed Aspects	Average (%)	Category
1.	Material Aspect	83,5	Very High
2.	Media Aspect	91,0	Very High
	Average Practicality	86,9	Very High

Based on Table 7, the average practicality by teachers is 87.9%. Whereas in Table 8 the average practicality by students is 86.9%. This shows that animated video-based learning media on the material of various forces and inertial objects assessed from the material and media aspects is practical to use with a very high practicality category.

B. Discussion

The preliminary research phase was carried out to determine the fundamental problems that occurred in the field and find solutions to these problems. The results of preliminary research through the analysis of interviews conducted with two physics teachers. The problems obtained are (1) the limited use of media in teaching and learning process, (2) there is no learning media in graphic form that can attract the attention of students, (3) the lack of concentration and attention students in learning process in physics subjects and (4) low understanding of Newton's law concepts which causes low student learning outcomes. In the analysis conducted on the three journals, it showed that students still had difficulty understanding and defining the formula $\sum F=0$ (Newton's First Law which discusses the inertness of objects) and cannot describe the forces acting on objects [5], [6], [4].

The solution to the problem above is to develop learning media based on animated videos on the material of various forces and inertial objects. The using media in form of videos can improve student learning outcomes, can improve cognitive aspects and psychomotor aspects of students [20].

At the development/prototyping stage, an animation video has been designed on the material of various forces and inertial objects according to storyboard which has been made. then self-evaluation of the media is carried out videos by researchers. Results self evaluation in the very high category. It is because the video media developed has fulfilled the material and media aspects.

In validation stage of animated video-based learning media, two material experts and one media expert who is a physics lecturer at Faculty of Mathematics and Natural Sciences, Padang State University. conduct it. The assessment given by the material expert validator on animated video-based learning media on material of various forces and characteristics The inertia of objects uses a validity instrument which consists of five assessment aspects, namely (1) aspects of learning objectives, (2) aspects of learning materials, (3) aspects of learning methods, (4) aspects of learning resources and (5) aspects of learning activities [21]. While the assessment given by the media expert validator uses a validity instrumentwhich consists of three aspects, namely aspects of software engineering, aspects of learning design and aspects of visual communication [22]. The data obtained was processed using the percentage technique and its validity was assessed by the material expert validator and media expert with a very high validity category.

At the validation stage by material experts, the average percentage was 81% with a very high validity category. This is because the video learning media is designed according to the learning component [21]. Viewed from the aspect of learning objectives has an average percentage of 80%. According results of data analysis in Table 4, it shows from the aspect of learning objectives that animated video-based learning media has high validity. This data shows that the learning objectives in video-animation-based learning media in the material of various forces and inertial objects have been displayed clearly and in accordance with the material presented in the animated video.

From the aspect of learning materials, it has an average percentage of 81.1%. Based on analysis in Table 4, it shows from the aspect of learning material that animated video-based learning media has very high validity. This data shows that learning material in video-animation-based learning media has been displayed clearly and sequentially with the right choice of words. The learning material delivered is also considered important for students with interesting delivery and presentation so that students can listen well and can increase students' activeness in learning.

From the aspect of learning methods, it has an average percentage of 90%. Based on analysis in Table 4, it

shows that from the aspect of the learning method, animated video media is categorized with very high validity. This shows that animated video-based learning media can be used with several learning methods and students can really practice animated learning material.

From the aspect of learning resources, it has an average percentage of 80%. Based on analysis in Table 4, it shows that from the aspect of learning resources, animated video media is categorized as having high validity. This shows that animated video-based learning media can make it easier for students to learn material about various forces and inertial objects. Animated video media can also be used as a reference in solving relevant questions or problems.

From the aspect of learning activities contained in video animation-based learning media, it has an average percentage of 80.4% with a high validity category. This animated video media contains exploration, elaboration, confirmation and exercises on gravity, normal force, frictional force and inertial objects. Training activities regarding various forces and inertial objects can greatly assist students in understanding the material. This is in accordance with the learning activities suggested in the 2013 curriculum.

Evaluation of video animation-based learning media at the material of various forces and inertia properties was also carried out by media experts. The assessment was carried out by a media expert validator using an instrument consisting of three aspects, namely aspects of software engineering, aspects of learning media design and aspects of visual communication [22].

At validation stage by media experts, the average percentage was 93.8% with a very high validity category. Viewed from the aspect of software engineering, it has average percentage of 100% with a very high validity category. This animation-based learning media is considered effective, efficient and reliable in independent learning which can facilitate students in learning. Animated video-based learning media can be used repeatedly with easy maintenance. This media can be run on smartphone/computer with various existing software. The main software used to develop this video media is Adobe After Effect CC 2020 which has tools which is complete so as to be able to develop videos worthy of use in learning.

From the assessment on the learning design aspect, it has average percentage of 85.7% with a very high validity category. The presentation of learning objectives in learning media is appropriate and relevant to the curriculum, the scope of media content animated video-based learning media is also at accordance with learning objectives. This learning media can be used in several learning strategies that will be help increase the attractiveness of students towards learning. The stimulus given in the animated video media corresponds to the actual situation by describing the actual situation.

From the aspect of visual communication, it has an average percentage of 94.5% with a very high validity category. This shows that animated video media can convey material well in accordance with the ability of the level of development of students and be creative in conveying the contents of the material with pictures. Images and animations are displayed in a clear and attractive manner. compatibility between dubbing and the visualization that is displayed is properly supported by intonation dubbing that sounds clear as well background appropriate and does not interfere with the audio dubbing. Visual learning media is well visible from the type of letters (font) that are used are easy to read, a combination of text colors with background is appropriate and the quality of movement in good animated video-based learning media.

Animated video-based learning media on the material of various forces and inertial objects has a very high level of validity in both the assessment by material experts and media experts. According validation carried out by three validators, suggestions were obtained that could support the perfection and feasibility of animated video-based learning media on the material of various forces and inertial objects for senior high school physics learning.

The practicality animated video-based learning media is determined from the assessment of the product using instrument in the form an appropriate assessment sheet given to teachers and students. The practicality assessed consists of two basic aspects, namely material aspects and media aspects. Data on the practicality of animated video-based learning media obtained from calculations using the percentage formula. This practicality is carried out in stages one to one evaluation to three physics teachers and 12 students high schools.

From Table 7 and Table 8 are obtained in the very high practicality category. These data indicate that video animation-based learning media on materials of various forces and inertial objects is already practical to use both from material and media aspects.

From the material aspect, video animation-based learning media has a very high category. According assessment given by teachers and students. This illustrates that animation-based learning media is already practical to use in senior high schools physics learning on the material of various forces and inertial objects. Learning objectives in the media are conveyed clearly using words and sentences as well as a clear flow in describing the material. The material presented in animated video media can be practiced directly by students so that it can be used as an independent learning media by students. The concepts of gravity, normal force, frictional force and the inertness of objects can be understood well by assisted students because they are supported by questions and practice questions that involve these concepts.

The aspect of animated video media has a very high category. According results of the assessment carried out by teachers and students. Animated video media is effectively used make it easier for students to understand the material in a short time. Even so, this animated video media can also be used repeatedly without requiring

special care for the management of learning media and is able to increase student learning motivation. Supported by a consistent image layout, intonation dubbing that sounds clear, background which does not interfere with the delivery of material, and writing that can be read clearly makes this animated video-based learning media practical to use in terms of media.

The practicality test results from three physics teachers and 12 students showed that the average percentage of practicality was very high for both teachers and students, namely 87.9% and 86.9%. So, animated video-based learning media on the material of various forces and inertial objects for senior high school physics learning are stated to be practical and can be used easily for teachers and students. Animated videos have a higher influence on the independence of students in learning physics [23]. Another study conducted by Rahmana who developed a learning video-assisted learning tool on elasticity material showed that learning videos were able to improve problem solving skills by learners [24]. Animated video-based learning media can be used as an alternative media that can be chosen by teachers and students inside and outside the classroom. Using learning videos can help students learn abstract things to be real as in global warming material [25].

IV. CONCLUSION

This research produces animated video-based learning media on the material of various forces and inertial objects containing the concept of understanding the material, examples of questions and practice questions as well as discussion of practice questions. The content of the material concerns determining the direction of gravity, normal force and frictional force on a flat and inclined plane as well as the magnitude of the force acting by connecting the concept of the inertial nature of objects. Animated videos are created using the application Adobe After Effect CC 2020 with an output MP4 file that lasts 21 minutes 50 seconds.

Animated video-based learning media on the material of various forces and inertial objects was declared valid by material experts and media experts with a very high validity category with an average percentage average 81.0% and 93.8%. Furthermore, learning media based on animated videos on the material of various forces and inertial objects were also declared practical by physics teachers and students in schools with very high practicality categories, namely with a percentage of 87.9% and 86.9%. Therefore, it is hope that further study can be carried out regarding the effectiveness of this animated video-based learning media. This animated video can also be developed on other physics material.

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