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MAKING STEM EXPERIMENT VIDEO FOR SCIENCE LESSON: A SIMPLE FAN

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Abstract

This research aims to produce a valid and practical natural science experiment video of a simple fan on energy in living systems. This video contains elements of STEM and critical thinking skill questions. This research uses the Plomp development model, which consists of three phases, namely the Preliminary research, the prototyping and the assessment. This research was carried out until the Prototyping phase. The research instruments used were validity and practicality questionnaires. The validity tests were conducted to three science education lecturers and the practicality tests were conducted on students at SMPN 15 Padang. The results of the validity test obtained an average Moment Kappa (k) value of 0.85 with the very high category. The results of the practicality test at the one to one evaluation obtained an average Moment Kappa (k) value of 0.92 and at the small group evaluation phase obtained an average Moment Kappa (k) value of 0.93 with the very high category. To find out the students' interest in this experimental video, an interview was conducted as additional data stating which stated that the students were very interested and could help the teacher in deliver on energy material in living systems.

Keywords: Experiment Video, STEM, Critical Thinking, Energy Material in Living Systems.

Introduction

Education greatly influences a person's mindset, so that efforts to increase the quality of education must be sought. The success of a person's education will make his mindset better in order to be able to face the demands of the 21st century. In the 21st century, students are required to have high-level thinking skills and a variety of skills, in order to be able to compete in the globalization era. The 21st century skills are at least critical thinking and problem solving, having creativity, working together, interacting well, as well as technology, information and communication skills (Redhana, 2019).

Natural Science subjects involve students actively carrying out activities as long as learning is able to develop critical thinking (Maolidah et al., 2017). Integrated science learning by combining science fields, achieving attitudes, scientific processes and skills. Science learning in the 2013 curriculum in junior high schools (SMP) is carried out in an inseparable manner between physics, chemistry and biology. In the 2013 curriculum, the science learning concept is integrative science or integrated science (Pradani et al., 2018). Science learning enables students to have scientific knowledge and process skills in everyday life as well as the formation of scientific attitudes such as curiosity, critical thinking, problem solving and sensitivity to the environment.

To solve a problem, accurate data is needed so that the right decision is logical, so good critical thinking skills are needed. Critical thinking skills require continuous and deliberate learning and practice to develop to their potential (Redhana, 2012). Critical and creative thinking and being able to solve problems are important skills in the 21st century (Pratiwi et al., 2019).

STEM based learning that uses science, technology, engineering, and mathematics in real-world situations allows students to be competitive in the 21st century because they can simultaneously solve problems (Khairani et al., 2019). STEM combines four main educational disciplines namely Science, Technology, Engineering and Mathematics which are popular ways to implement subject learning effectively (Fatmawati et al., 2018).

Learning by using media can help students understand, present data and conclude (Fadiawati & Tania, 2020). Learning media is media that contains learning messages delivered by the teacher to students (Rosidah, 2016). The choice of the wrong media can affect the learning process, therefore the use of media in learning is given more attention so that students better understand learning and have critical thinking skills. The use of media during learning can provoke new desires and interests in students, motivate them to learn, and even have a psychological impact on them (Rahman et al., 2017).

Audio visual media has more interesting capabilities, because it consists of viewing and hearing media, for example video recordings. Media with audio and visual presentations that contain messages in the form of concepts, principles, procedures, and knowledge application theory to help students understand a material is called learning video media (Riyana, 2007), because with media that has elements of sound and images it can attract the attention of students with an attractive appearance so they are afraid of missing the course of the video.

Based on interviews and observations conducted at SMPN 15 Padang to science teachers and students by spreading questionnaires. In the Covid-19 pandemic situation, the learning method used in schools is hybrid learning and uses the 2013 Curriculum and carries out learning that is divided into two shifts alternately every week with a limited time allocation, it is found that it is difficult for students to understand concepts so they low Critical thinking. Practicums that are carried out in schools are rarely carried out because the learning time is short which results in students not understanding the concept of the material being taught, but by doing practicum students prove theories that can clarify the concepts and principles of learning science (Suryaningsih, 2017). The researcher obtained Daily Assessment data on the material Energy in the Life System for Classes VII.1 to VII.3 SMPN 15 Padang for the 2021-2022 academic year as follows:

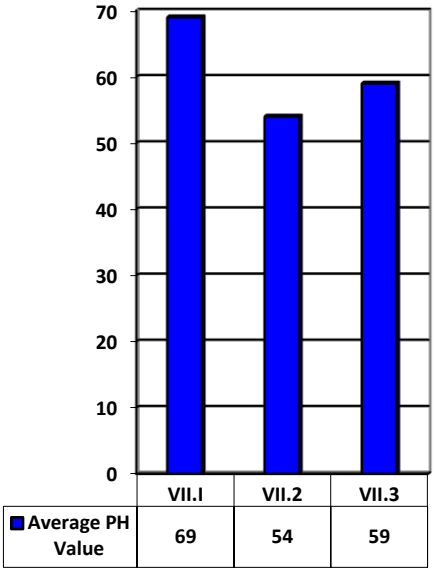


Figure 1. Average PH Value of Students

Based on Figure 1, it is known that not all students have completed the material on Energy in Living Systems. SMPN 15 Padang sets the (minimun completeness criteria/ KKM) for science subjects: 75. During the learning process, teachers use literacy books, as well as Kemendikbud print books that have been provided by the school. The teacher has used instructional media such as material explanation videos but has never used learning media such as science experiment videos which can train students' critical thinking skills and can assist in the implementation of practicums that are still not optimal. Before the Covid 19 pandemic, the teacher had asked students to answer the questions given, but had not gotten maximum results because they still did not understand the concept of the material. Therefore, critical thinking skills need to be trained because they are one of the demands of the 21st century.

To overcome the things described above, a learning media in the form of a valid and practical video is provided, in which there are several critical thinking questions with the STEM approach and can be accessed by students anywhere and can be played back and can train critical thinking skills in science learning.

Research Method

The research that has been carried out uses the Plomp development model which has three phases, namely the preliminary research, the prototyping, the assessment (Plomp & Nieveen, 2013). The Plomp development model for each step of its activities matches the characteristics of research that are flexible and adaptable (Rochmad, 2012).

The preliminary research was carried out by analyzing the problems that occurred during the lesson, namely analyzing needs, analyzing students, analyzing curriculum and analyzing concepts. Needs analysis uses an instrument in the form of a questionnaire given to teachers and analyzes the components of the science experiment video on YouTube. Analysis of students using instruments in the form of questionnaires given to students. Curriculum analysis is in the form of curriculum analysis sheets which contain core competencies, basic competencies and indicators. Concept analysis is in the form of a concept analysis sheet which contains the material concepts being studied.

The Prototyping to develop a product as a solution to the problems obtained at the preliminary research using formative evaluation, namely self evaluation, expert review, one to one evaluation, and small group evaluation as basically consisting of four prototypes to produce the final prototype or product the resulting end. At the self evaluation stage, the data collection instrument was questionnaires filled in by the researcher themselves. The expert review stage uses an instrument in the form of questionnaires by the lecturer as the validator. The one to one evaluation phase used an instrument in the form of questionnaires which was given to 3 students with different abilities. The small group evaluation stage used an instrument in the form of questionnaires which was given to 27 students.

The scores obtained were processed to determine the validity and practicality of the science experiment video, then using the Kappa Cohen formula as follows.

$$Moment\ Kappa\ (k) = \frac{P_O - P_e}{1 - P_e}$$

Explanation:
k = The kappa moment shows the validity of the product.
P*o* = Realized proportion
P*e* = Unrealized proportion

Interpret the value of the kappa moment in the validity and practicality categories based on the kappa moment (*k)* (Boslaugh & Paul, 2008) sebagi berikut.

Table 1 Validity and Practicality Categories Based on Kappa Moments (*k*)

No	Intervals	Category
1.	0,81-1,00	Very high
2.	0,61-0,80	High
3.	0,40-0,60	Moderate
4.	0,21-0,40	Low
5.	0,01-0,20	Very low
6.	0,00	Invalid/ impractical

Result and Discussion

This research is a type of development research to produce simple fan experiment video with STEM approach and there are several critical thinking questions (hereinafter referred to as VKAS). This research uses the Plomp development model consists of three phases, namely the Preliminary research, the prototyping and the assessment, but it is only carried out until the prototyping phase due to time constraints. The results and discussion of this research are as follows:

Preliminary research phase

The Preliminary research phase researcher investigated the problems that occurred during the lesson, namely by means of needs analysis, student analysis, curriculum analysis, and concept analysis. Analysis of needs by conducting observations and interviews to find out the difficulties faced by teachers and students in the learning process. Observations that have been made to teachers and students found problems, namely limited time allocation so that the material delivered was shortened and practicum was rarely carried out so that students had difficulty understanding the concept. Practicum activities are very important in science lessons, because by doing practicum students will be more motivated to learn so that students can understand the concept of a material being studied (Widodo & Ramdaningsih, 2006).

Interviews that have been conducted with science teachers show that the learning media used are printed books, literacy books and videos. Video learning media that teachers have used during learning activities such as material explanation videos, but have never used science experiment videos that can train student's critical thinking skills and can help in the implementation of practicums that are still not optimal. Critical thinking skills need to be developed so that students can learn to analyze and find solutions to solve a problem (Nasihah et al., 2020).

In the needs analysis, a comparison of the videos available on YouTube was also carried out that there was no material, critical thinking questions, STEM approaches, explanatory writing and displays that were still monotonous and the quality of the video resolution was still low. Monotonous video displays will make students feel bored and unmotivated to learn, while those that are not monotonous will make students better understand the material presented (Khairani et al., 2019).

The analysis of students who had been carried out on 15 people using an assessment questionnaire, it was found that not all students liked science subjects so they found it difficult to understand the lesson. The use of learning media makes students more easily understand the material presented (Asyhari & Silvia, 2016). The learning media that are commonly used are printed books and literacy books so students who don't like science lessons need innovative learning media such as learning videos that can attract attention so that students are enthusiastic in the learning process. (Kurniawati et al., 2013).

In the curriculum analysis, a review curriculum was implemented at SMPN 15 Padang based on character education, cultural

and culture-based approaches (Ghufron, 2017) by observing core competencies, basic competencies, competency achievement indicators as guidelines for developing VKAS on the material Energy in Living Systems.

In the Concept analysis is carried out by taking a basic competency in energy material in living systems, namely the concept of energy, energy sources, and changes in energy forms. Compiling a script on the concept of material can make it easier to explain and present material so that the video recording time is shorter (Dipuja, 2020).

The Prototyping Phase

The researcher carried out the prototyping phase based on Tessmer's formative evaluation to develop a product as a solution to the problems found in the preliminary research. The results of the Preliminary research analysis serve as a guideline for making plans to develop VKAS. The results of each prototype can be described as follows:

Prototyping Phase I

Prototype I is the result after conducting an the Preliminary research. Prototype I produces VKAS by using the Adobe Premiere Pro application. This science experiment video contains twelve components, namely the opening video, STEM elements can be seen in Figure 5, basic competencies and indicators, the purpose of the experiment, introductory material can be seen in Figure 2, experimental tools and materials, experimental work procedures can be seen in Figure 4, Experimental activities can be seen in Figure 3, table of observations, answers to critical thinking questions, conclusions and closing. Here's a view of the components.

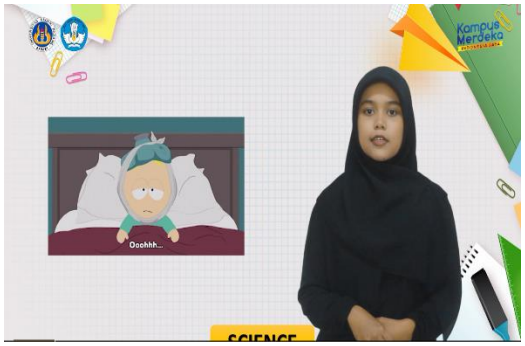


Figure 2. Introductory material

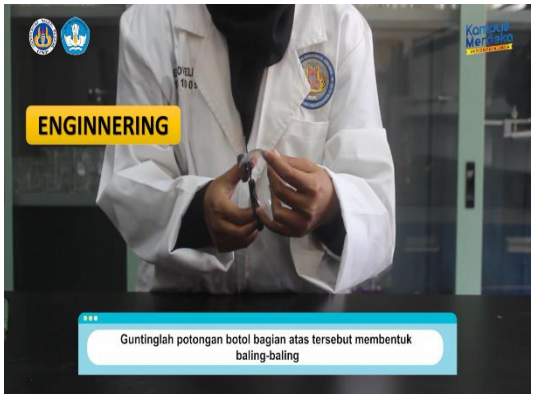
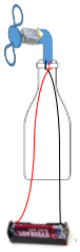


Figure 3. Experimental activies

Prototyping Phase II

Prototype 1 that has been carried out is then carried out by self evaluation by rechecking the main components that must be in the VKAS using a checklist. If there is a revision on prototype I, it produces prototype II. The results of the formation of prototype II, it was found that prototype I had completed all components and aspects of the assessment and indicators that were assessed, namely clarity of message, stand alone, user friendly, contents representation, visualization with media, can be used classically or individually, questions critical thinking, and STEM aspects. In the self evaluation, there was a minor revision, namely in the form of correcting writing errors and synchronizing dubbing with video contents.

Simple Fan



Ingredients

Ingredients	Quantity
1. Plastic bottles	2 pieces
2. Pipe connection	1 pieces
3. Battery	3 pieces
4. Glue wax	sufficiently
5. Battery holder	3 pieces
6. Dynamo	1 pieces
7. Isolation	1 pieces
8. Bottle cap	2 pieces
9. Candles	1 pieces
10. Matches	1 pieces
11. Plywood board	sufficiently

Tools

Tools	Quantity
1. Cutter	1 pieces
2. Scissors	1 pieces
3. Nail	1 pieces
4. Anemometer	1 pieces

Experiment Working Procedure

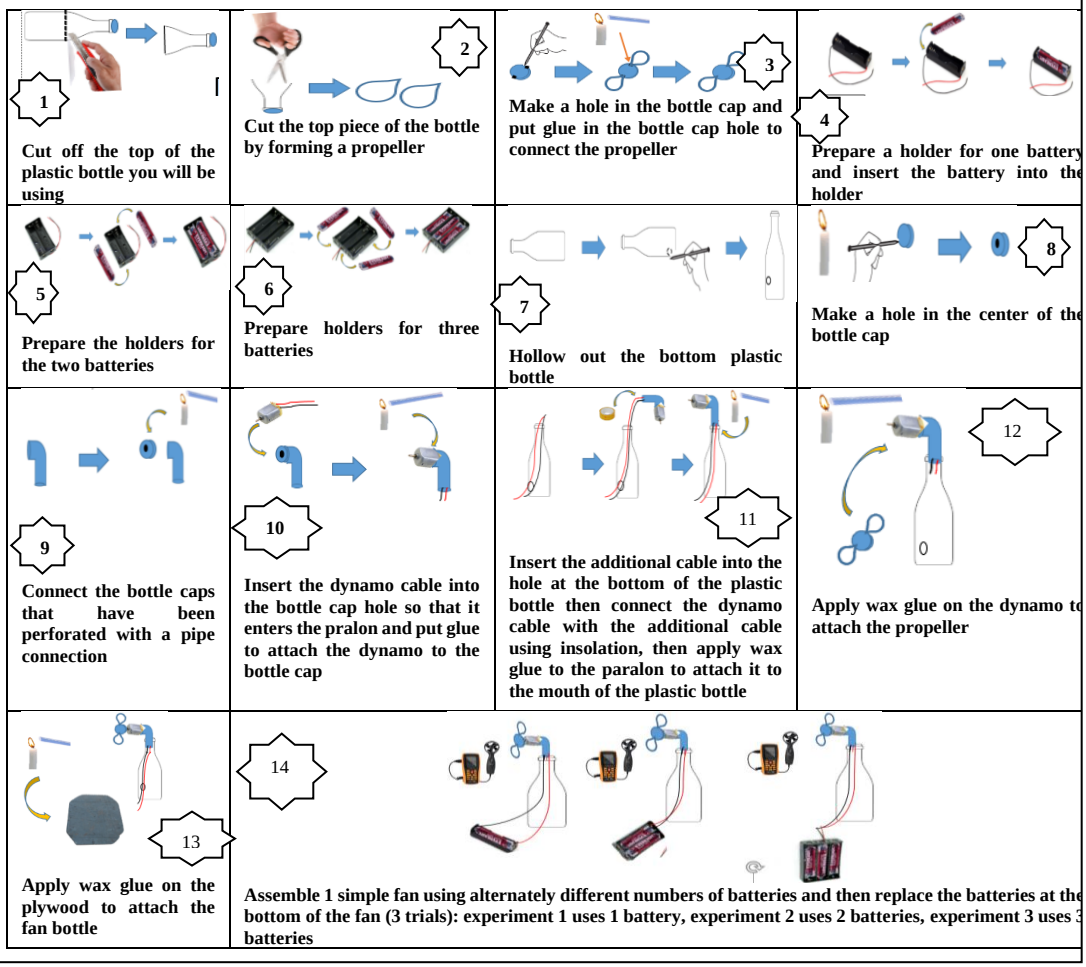


Figure 4. Simple Fan Experiment Working Procedure

• Science material for Class VII Middle School Semester I, Energy in Living Systems material • The simple fan experiment applies the concept of changing the form of electrical energy to motion energy	• Searching for literature using the internet and HP • The use of an anemometer when conducting experiments • The use the camera for video production • Watch videos from YouTube using HP
Enginering	***Mathematics***
• Designing the process of making a simple fan. • Designing a simple fan testing process	• Calculates the speed generated by the fan based on the amount of battery voltage • Calculates wind temperature based on the amount of battery voltage

Figure 5. STEM Elements

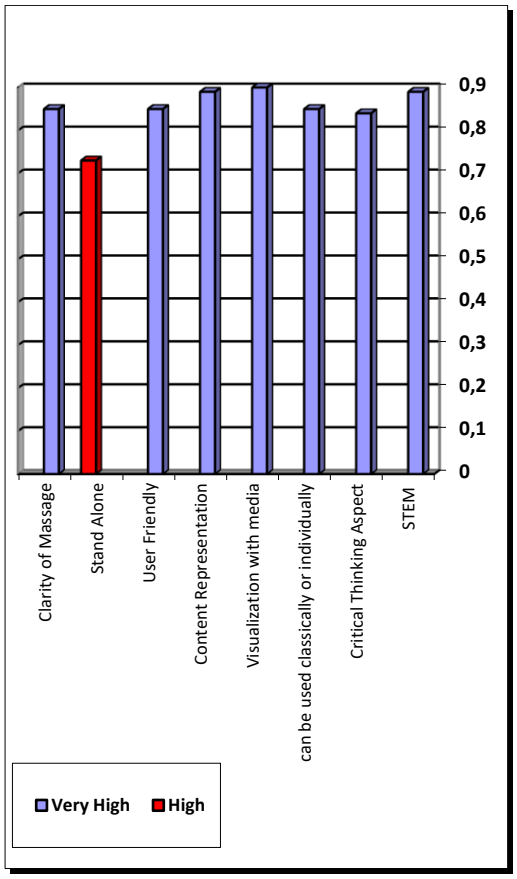


Figure 6. Accumulation of Validity Test Values at the Expert Review Stage

The validator's assessment of the Clarity of Messages aspect has an average kappa moment of 0.85 with a very high category. The results that have been obtained are that the science experiment videos developed have clear message delivery in every aspect, both in terms of character voices, character articulations, explanatory writing and instructions for carrying out the experiment. This aspect of video media can help clarify material so that it can arouse students' learning interest and achieve learning objectives (Zahwa & Syafi'i, 2022).

The validator's assessment of the stand alone aspect has an average kappa moment of 0.73 with a high category. The results that have been obtained are that the developed VKAS can be used without the help of other sources because this video already contains material, experimental objectives, experimental procedures and critical thinking questions. Learning videos do not have to be done together with other teaching materials (Magdalena et al., 2020).

The validator's assessment of the user friendly aspect has an average Kappa moment of 0.85 with a very high category. The results that have been obtained are that the developed VKAS is easily understood by students because they have used words that are appropriate to the level of understanding of students. The use of media in learning in the form of videos can increase the interest and motivation of students in learning (Hanani, 2021).

The validator's assessment of the content representation aspect has an average kappa moment of 0.89 with a very high category. The results that have been obtained are that the developed VKAS material is in accordance with the experiment. Making learning videos must pay attention to synchronization between images, sound and text so that they can increase students' motivation and interest in learning (Robet, 2013).

The validator's assessment of the visualization aspect with media has an average kappa moment of 0.90 with a very high category. The results that have been obtained are that the developed VKAS has an attractive appearance and high resolution video quality. Display that is not monotonous starting from the presentation of the material content, clear video resolution so that it helps students understand the learning material presented (Khairani et al., 2019).

The validator's assessment of that can be used classically or individually aspects has an average kappa moment of 0.85 with a very high category. The results that have been obtained are that the developed VKAS can be used anywhere and anytime repeatedly during learning so that students easily understand the material (Ardiman et al., 2021).

The validator's assessment of the critical thinking aspect has an average Kappa moment of 0.84 with a very high category. The results that have been obtained are that the developed VKAS already contains critical thinking questions based on aspects of critical thinking according to Ennis consisting of building simple skills, building basic skills, concluding, providing further explanations, setting strategies and tactics. can be seen in Table 2. Critical thinking skills require regular practice in order to develop (Redhana, 2012) so that students are able to think independently in solving problems that occur.

Table 2 Critical Thinking Skill Questions Ennis (2011)

No	Critical Thinking Ascpect	Critical Thinking Questions
1.	Simple skill building	After conducting the experiment, what energy changes occur in this simple fan experiment?
2.	Set strategy and tactics	How is the relationship between the number of batteries and the wind speed?
3.	Conclude	How is the relationship between the number of batteries and the temperature generated by the fan?
4.	Provide further explanation	If there is a problem in the operation of a simple fan, what kind of fault might occur?
5.	Build basic skills	If the battery is replaced with another source of energy such as lime, can it spin?

The validator's assessment of the STEM aspect has an average Kappa Moment of 0.89 with a very high category. The results that have been obtained are that the developed VKAS has been equipped with a STEM approach consisting of science, technology, engineering and mathematics components. The STEM approach is expected to produce meaningful learning through a combination of knowledge and skills, so as to increase knowledge and apply it to solve problems (Wibowo, 2018).

Based on Figure 6, the results of the validity test from the three validators obtained an average Kappa Moment of 0.85 with a very high category. The results that have been obtained are that the developed VKAS is declared valid and continues to the practicality test stage.

Prototyping Phase IV

Prototype III that was produced was then carried out one to one evaluation of three students who had high, medium and low knowledge based on suggestions from the science teacher. The results of the practicality test at the one to one evaluation stage of the VKAS are as follows.

Based on Figure 7 it is known that at the One to one evaluation stage the results of the practicality test were obtained from three students, having an average Kappa Moment in all aspects of 0.92 with a very high category. The average kappa moment value in the aspect of ease of use is 0.90 in the very high category. The average kappa moment value in the interesting aspect is 0.95 with a very high category. The average kappa moment value on the benefit aspect is 0.90 with a very high category. There was no

suggestion from the students, resulting in the prototype IV.

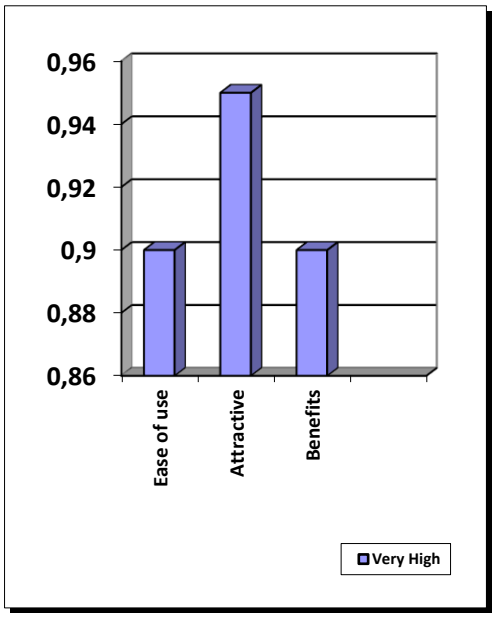


Figure 7. Accumulated Practicality Test Scores in the One to One Evaluation Stage

Prototyping Phase V

Prototype IV that has been produced is then carried out by a small group evaluation of 27 students. If there is a revision, it will result in a V prototype.

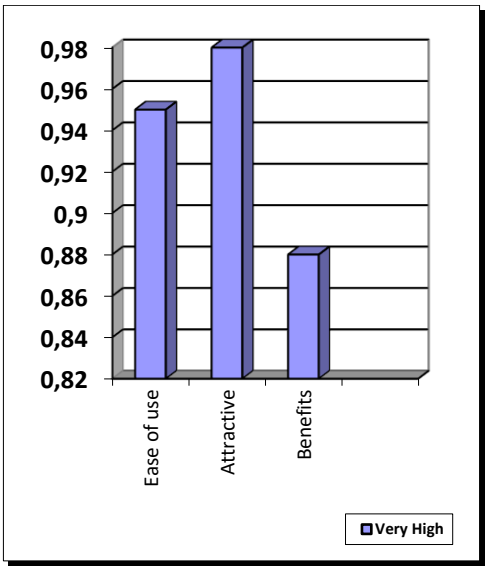


Figure 8. Accumulated Practicality Test Values in the small group evaluation stage

Based on Figure 8 it is known that at the small group evaluation stage the results of the practicality test were obtained on 27 students, the average Kappa Moment for all aspects was 0.93 with a very high category. The average kappa moment value in the aspect of ease of use is 0.95 in the very high category. The average kappa moment value for interesting aspects is 0.98 with a very high category. The average kappa moment value on the benefit aspect is 0.88 with a very high category. At this stage there are no revisions, resulting in the final product in the form of VKAS.

In the practicality test of the 0ne to one evaluation and the small group evaluation phase, the aspects assessed in the practicality stage were ease of use aspects, attractive aspects and benefits. Ease of use aspects of VKAS has very high practicality. The results obtained are that the developed VKAS has good video content preparation because the presentation of the material in this video as a whole is easy to understand, equipped with text to clarify delivery, there are experimental activities assisted by presenting instructions from experiments and the video can be played repeatedly while studying. The use of experimental videos can make it easier for teachers to explain concepts and help students to understand material concepts by observing experiments anywhere without doing it in the laboratory (Yulianti et al., 2019). The difficulty of understanding material for students results in decreased learning outcomes. The use of audio visual media can foster interest and motivation of students in learning (Wulandari et al., 2021).

Attractive Aspects VKAS has very high practicality. The results obtained are that the developed VKAS has moving animated images accompanied by soft music in the material explanation section so that when learning students do not feel tense and are more interested, innovative learning media are needed such as learning videos that can focus students' attention in order to be enthusiastic during the learning process (Kristiawan et al., 2014).

Aspect Benefits VKAS has a very high practicality. VKAS is useful in generating curiosity and creating a sense of satisfaction in students after observing a science experiment video related to the material studied during the learning process (Amanda et al., 2020).

Conclusion

Based on the results of the research that has been done, it can be concluded that the VKAS which is completed by STEM Approach and critical thinking questions has a very high category of validity test. Practicality in one to one trials with very high category and in small group trials with very high category. This shows that VKAS is valid and practical. VKAS learning media can make students more interested in learning science and make it easier for teachers to convey material when carrying out practicums and can train students' critical thinking skills

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