Gravity: Jurnal Ilmiah Penelitian dan Pembelajaran Fisika

http://jurnal.untirta.ac.id/index.php/Gravity

ISSN: 244-515x; e-ISSN: 2528-1976

Vol. 08, No. 01, April 2022, Page 12-24

Development of physic learning video properties of light with colaboration teacher and student as learning media in new normal era

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(Received: 15 July 2021; Accepted: 08 April 2022; Published: 10 April 2022)

ABSTRACT

The era of digital technology is very influential on education in the new normal era covid-19 pandemic. The making of physics learning videos can be applied with the collaboration of teachers and students. This research aims to produce the physic learning video properties of light with teacher and student as learning media in new normal era. This Research and Development (R & D) began with preliminary research, research design, developing initial products, limited test trials, revision of limited trials, initial field trials, and revision of initial field trials. The research was applied to 8th grade junior high school students while learning Science Physics Chapter of the Properties of Light. This research used instruments are questionnaires. The product is in a good category so that it is feasible to be used and implemented in the physics science learning process in the new normal era.

Keywords : *learning videos, new normal era, physics education, properties of light*

DOI: 10.30870/gravity.v8i1.11584

INTRODUCTION

Education is one of the means to educate the nation's children. Learning activities are one of the important roles that can be used as a medium to achieve maximum learning. (Teni Nurrita, 2018). The era of digital technology is very influential on education as it is today. In the new normal era, teaching and learning activities are different from before when there was no COVID-19 pandemic. Learning activities are more from home or distance learning than

face-to-face learning in schools. This requires educators to be more technology literate. Some schools that apply face-to-face learning processes are limited. The number of students in the class is limited and is now called a study group with a maximum of 15 students. Learning activities like this occur nationally, some schools apply a session system in the implementation of learning.

Science is a series of concepts and conceptual patterns that are interrelated to produce observations and experiments. Learning media is very important to use during the learning process, especially when carrying out distance learning. One of the learning media used in schools is learning videos. Video media can convey messages clearly with simultaneous sound and display interesting moving objects and images (Pribadi, 2017). Making learning media in the form of videos requires the design, material, and sequence of material described in the video. Science learning videos are said to be valid and effective for learning for junior high school students (Hidayat & Asy'ari, 2016). The learning media applied during learning is not only visual such as props, whiteboards, and pictures, but also requires collaboration between audio and visual in the form of video (Hade & Aswirna, 2019).

Learning video design can be applied to create collaborative learning videos between teachers and students. In the world, educators support teachers to pay attention and understand students' thinking (Luna & Sherin, 2017). Inquiry-based science activities show the entire material in the learning video. The inquiry learning method can be applied through learning videos for students (Gorghiu, Gorghiu, Bizoi, & Suduc, 2010). Educational video games have a positive effect on student motivation leading to improved learning outcomes in schools. Every learning has its drawbacks when applied in the classroom (Sun & Gao, 2016). Demonstration learning videos are appropriate as a learning resource and can be investigated further so that they can be used effectively by teachers (Barton, Whittaker, Kinzie, DeCoster, & Furnari, 2017). Learning using game media can also be regarded as student entertainment and a fun learning activity (Leung, Tripicchio, Agaronov, & Hou, 2014).

The use of streaming video can be effectively used in learning. Various types of videos are also used to support the learning process. These videos can be used effectively and can contribute to useful resources in the learning process (Green, Voegeli, Harrison, Phillips, Knowles, Weaver, & Shephard, 2003). Video-based practicum media can be applied in the learning process and can be used as media and facilities for students (Erniwati, Eso, & Rahmia, 2014). The learning video of the Properties of Light can be said to be valid and suitable for use in the learning process in schools (Isti, Agustiningsih, & Wardoyo, 2020).

The teacher made several science learning videos to be used in science learning in the classroom and outside the classroom. However, not all learning videos are collaborated with students. The material on the properties of light is used by the teacher to invite students to be actively involved in making video learning media. Science practicum videos that are equipped make it easier for students to learn not only at school but can also be carried out at home (Erniwati et al., 2014). Science learning videos make it possible to overcome real-world constraints and explore the possibilities that the digital space can provide (Hafizah, 2020). The properties of light chapther's is one of the abstract materials and needs simulation to find out the nature of light itself.

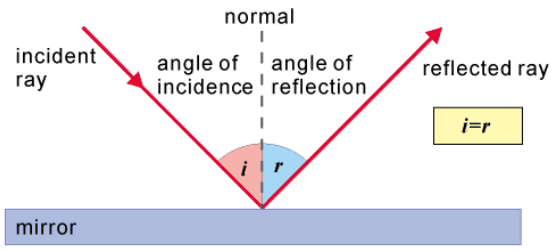
So that researchers want to do research in the form of developing learning media in the form of videos between teacher and student collaboration in the implementation of experiments as demonstrations. Students are invited to experiment independently from home, video is made and the results are collaborated with the teacher.

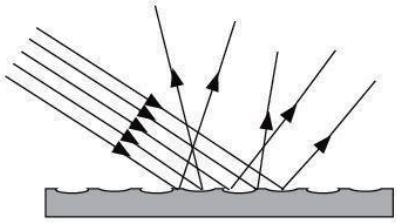
RESEARCH METHODS

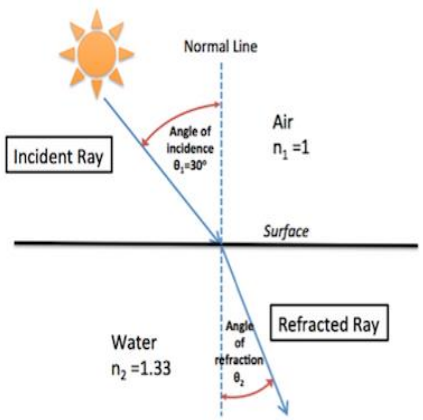
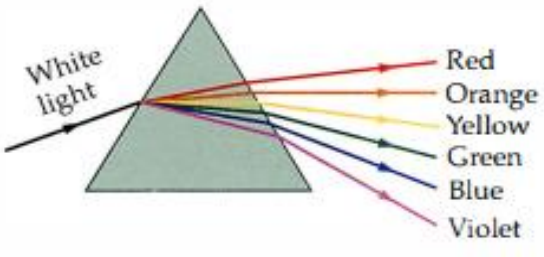
This is Research and Development (R&D) type of study. The development research of Teaching Physics Videos for Teacher and Student Collaboration as Learning Media in the New Normal Era uses the Borg and Gall model. The development of teaching Physics videos for teacher and student collaboration as learning media in the new normal era starts from 1) preliminary research, 2) research design, 3) developing initial products, 4) limited test trials, 5) revision of limited trials, 6) initial field trials, 7) revision of initial field trials (Sugiyono, 2015).

The first stage of product development is material analysis of the properties of light that will be made into a video. Second, teachers and students communicate the material and make videos through video conferences. Third, teachers and students conduct experiments and make videos from their respective homes. Fourth, the video is edited using the KineMaster Diamond application used on mobile phones. Media products are uploaded on google drive, youtube, and WhatsApp.

Table 1. Physics concepts in the light chapter subsection properties of light

Activities	Theory (Properties of Light)
A flashlight experiment is presented in front of a clear and dark glass	1. **The Light can penetrate transparent thing** Objects are divided into two, namely clear thing and dark thing. Clear thing can be penetrated by light. Dark thing cannot be penetrated by light.
The experiment is presented with a flashlight reflected into a mirror	2. **Reflection of light** Reflection of light is divided into two, namely regular reflection and irregular or diffuse reflection. Diffuse reflection is the reflection of light by an uneven surface. Regular reflection occurs in objects that are opaque and have a flat surface, for example a mirror. The speed of light in a transparent medium such as air, water, or glass is less than the speed c = 3 X 10^8 m/s in vacuum. When a beam of light strikes a boundary surface separating two different media, such as an air-glass interface, part of the light energy is reflected and part of the light energy enters the second medium. If the incident light is not perpendicular to the surface, then the transmitted beam is not parallel to the incident beam. The change in direction of the transmitted ray is called refraction. 

Activities	Theory (Properties of Light)
	Figure 1. Reflection from a smooth surface  Figure 2. Reflection from a rough surface Reflection Law of light: a) The incident ray, the reflected ray, and the normal line lie in the same plane. b) The angle of incidence (i) is equal to the angle of reflection (r).
An experiment is presented using cardboard and candles arranged like the picture.  **Figure 3.** Experiment on Light Creeping in a Straight	3. **The Light Creep Straight** The light will come out of the last box, when the third hole is in a straight line. This experiment proves that light travels in a straight line.
An experiment is presented using a pencil or spoon placed in a glass.  **Figure 4.** Experiment on Refraction Light	4. **Refraction of Light** When a beam of light strikes a boundary surface separating two different media, such as an air-glass interface, part of the light energy is reflected and part of the light energy enters the second medium. If the incident light is not perpendicular to the surface, then the transmitted beam is not parallel to the incident beam. The change in direction of the transmitted ray is called refraction.

Activities	Theory (Properties of Light)
	 $n_1 \sin\theta_1 = n_2 \sin\theta_2$ **Step1:** $(1)\sin(30) = 1.33\sin\theta_2$ **Step2:** $(1) \times 0.5 = 1.33\sin\theta_2$ **Step 3:** $\frac{0.5}{1.33} = \frac{1.33\sin\theta_2}{1.33}$ **Step 4:** $0.376 = \sin\theta_2$ **Step 5:** $\sin^{-1} 0.376 = \theta_2$ $\theta_2 = 22.09$ *degrees* **Figure 5.** Snell's Law (Li, 2014) Snell's Law states : a) The incident ray, normal and refracted rays lie in the same plane. b) Rays coming from a denser to a less dense medium are refracted away from the normal and rays coming from a less dense to a denser medium are refracted closer to the normal.
	5. **Dispersion of Light** Sunlight that looks white, is actually composed of many colored lights. Sunlight is broken down by water droplets in the clouds to form a rainbow. After the rain then there is the heat of the sun, so a rainbow is formed. Rainbow colors are formed from red, orange, yellow, green, blue, indigo, and purple. The rainbow is a familiar example of dispersion, in this case the dispersion of sunlight. A beam of white light incident on a glass prism is dispersed into its component colors. The index of refraction decreases as the wavelength increases so that the longer wavelengths (red) are bent less than the shorter wavelengths (violet).  **Figure 6.** Prism of Light

(Li, 2014; Tipler & Mosca, 2004)

The validation process and product quality are carried out by looking at the score on the assessment sheet. Each item of the assessment sheet statement uses a score in the range of 1-5. Score analysis is carried out through the following process:

1) Calculate the average score ($\bar{X}$) of product assessment by dividing the total score ($\sum X$) divided by the number of raters (n).

$$\bar{X} = \frac{\sum X}{n} \quad (1)$$

2) Comparing the average score ($\bar{X}$) against the quality category is shown in Table 2.

Table 2. Quality Category

No	Range	Category
1.	$\bar{X} \geq Xi + 1{,}8\,SBi$	Very good
2.	$Xi + 0{,}6\,SBi < \bar{X} \leq Xi + 1{,}8\,SBi$	Good
3.	$Xi - 0{,}6\,SBi < \bar{X} \leq Xi + 0{,}6\,SBi$	Enough
4.	$Xi - 1{,}8\,SBi < \bar{X} \leq Xi - 0{,}6\,SBi$	Not enough
5.	$\bar{X} \geq Xi - 1{,}8\,SBi$	Very less

description: $\bar{X}i$ is mean score, Xi is mean ideal score, Xi is (1/2) x (max score + min score), *Sbi* is ideal standard deviation where, *SBi* is (1/6) x (max score – min score), and ideal max score is $\sum$item criteria x max score, ideal min score is $\sum$item criteria x min score (Widoyoko, 2011).

Indicators of media, material, and perceived ease of audio-visual animation videos in the instruments used are written in the table 3.

Table 3. indicator of the media, material, and practical aspects

No	Rated indicators		
	Media Aspect	Material Aspect	Practical Aspect
1	Video Design	Presentation	Perception of Ease of Use
2	Visual Quality	Material Coverage	Usability Felt
3	Audio Quality	Content Suitability	Use of the actual product
4	Content		
5	Organization and Language		

The product is validated using Aiken's V. analysis using the Aiken's V equation or using the Quest application. Limited test is the stage of product validation by experts. Media were assessed by media expert lecturers, theorists, and science teachers. The task of expert lecturers and science teachers is to assess the media from the feasibility of theory and media presentation. The media that has been assessed get input and values to be used as material for improving science videos before the initial field trial is carried out. Initial field trials using assessment tests and non-tests. The assessment is carried out using an assessment sheet that has been assessed by expert lecturers.

RESULTS AND DISCUSSION

The trial of the learning video product in this study consisted of 2 stages, namely: a limited trial (validation of experts and practitioners) and an initial field trial. This stage aims to produce aviable product. The data results include data from the validation assessment results and data from the results of student trials. Limited trials were carried out by material expert lecturers, media experts, and science teachers.

Table 4. Product assessment results from material aspects

Material Aspect	Aiken V	Category
Presentation	0.85	Very Good
Material Coverage	0.91	Very Good
Content Suitability	0.89	Very Good

Table 5. Product assessment results from practical aspects

Practical Aspect	Aiken V	Category
Perception of Ease of Use	0.92	Very Good
Usability Felt	0.91	Very Good
Use of the actual product	0.89	Very Good

Table 6. Product assessment results from the media aspects

Media Aspect	Aiken V	Category
Video Design	0.90	Very Good
Visual Quality	0,86	Very Good
Audio Quality	0.93	Very Good
Content	0.80	Very Good
Organization and Language	0.83	Very Good

The results of data analysis are based on assessments by media experts, material experts, and science teachers. Table 4, Table 5, Table 6 shows the results of the assessment of the video media on the characteristics of teacher and student collaboration based on aspects of media, learning materials, and practicality so that it is stated in the very good category. The initial field test was applied to determine and measure the implementation of the science video media on the characteristics of Light, a collaboration between teachers and students which was developed to implement the learning process and student creativity in the implementation of distance learning. Media can be applied to provide aspects such as clarity, legibility, effectiveness and usefulness in the material properties of light.

Table 7. Product assessment results in initial field trials

Theory		Media	Mean
Creativity	Critical Thinking		
2.65	2.55	4.61	3.27
Good	Good	Very Good	Good

Assessment of the feasibility of developing collaborative learning video media of teachers and students on the nature of light science material, obtained an average assessment of 3.27 with good categories. The development of science video media on the properties of light in collaboration between teachers and students was concluded to be suitable for use in the main field trial. The description of the science video media on the characteristics of the light produced by the teacher and student collaboration can be seen in Figure 7, Figure 8, Figure 9, and Figure 10.

Figure 7. Student experiment video clip

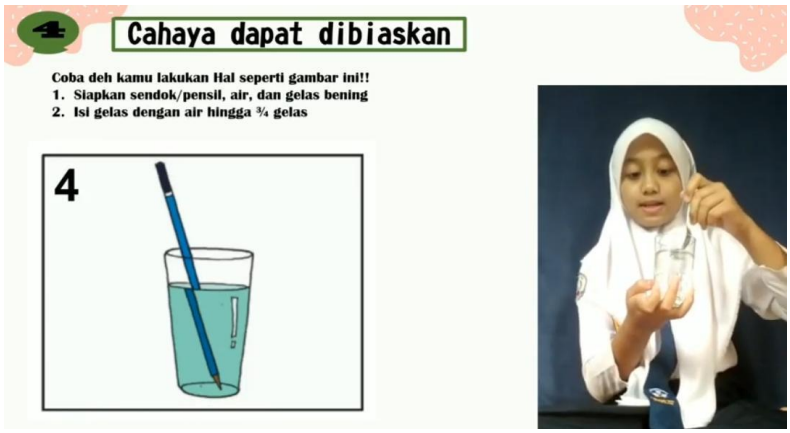


Figure 8. Excerpts of material and student experiments

Figure 9. Behind the Scene

Figure 9. Science Learning Video Cover

Item validation is done by reading the Aiken V table with valid and invalid categories. Table Aiken V refers to research from (Lewis. R. Aiken, 1985). The value of item validity can be seen based on Table 7.

Table 7. Question Item Validity Category

No. of Items (*m*) or Raters (*n*)	Number of Rating Categories (c)											
	2		3		4		5		6		7	
	V	p	V	p	V	p	V	p	V	p	V	p
2							1.00	.040	1.00	.028	1.00	.020
3							1.00	.008	1.00	.005	1.00	.003
3			1.00	.037	1.00	.016	.92	.032	.87	.046	.89	.029
4					1.00	.004	.94	.008	.95	.004	.92	.006
4			1.00	.012	.92	.020	.88	.024	.85	.027	.83	.029
5			1.00	.004	.93	.006	.90	.007	.88	.007	.87	.007
5	1.00	.031	.90	.025	.87	.021	.80	.040	.80	.032	.77	.047
6			.92	.010	.89	.007	.88	.005	.83	.010	.83	.008
6	1.00	.016	.83	.038	.78	.050	.79	.029	.77	.036	.75	.041
7			.93	.004	.86	.007	.82	.010	.83	.006	.81	.008
7	1.00	.008	.86	.016	.76	.045	.75	.041	.74	.038	.74	.036
8	1.00	.004	.88	.007	.83	.007	.81	.008	.80	.007	.79	.007
8	.88	.035	.81	.024	.75	.040	.75	.030	.72	.039	.71	.047
9	1.00	.002	.89	.003	.81	.007	.81	.006	.78	.009	.78	.007
9	.89	.020	.78	.032	.74	.036	.72	.038	.71	.039	.70	.040
10	1.00	.001	.85	.005	.80	.007	.78	.008	.76	.009	.75	.010
10	.90	.001	.75	.040	.73	.032	.70	.047	.70	.039	.68	.048

Media Video Science The Nature of Light collaboration between teachers and students has been said to be valid after going through a limited trial process with a validation process

from media and material expert lecturers, and science teachers. Aiken V's value from the media aspect includes video design 0.90; visual quality 0.86; audio quality 0.93; content 0.80; organization and language 0.83. Aiken V's assessment results from the material aspect include presentation, material coverage, and material suitability of 0.85; 0.91; and 0.89. While the results of the product assessment from the practical aspect include perceived ease, perceived usefulness, and product use of 0.92; 0.91; and 0.89. So the rating category is very good. If the media sent has been downloaded, then the media product can be accessed without an internet network.

The product is said to be feasible after going through the initial field trial process to junior high school students. The result of the product assessment in the initial field trial was 3.27 in terms of material and media. Video media is said to be suitable for use in accordance with the results of research that physics learning videos can be an educational tool that is suitable for use in the field of education (Kurniawan, Kuswandi, & Husna, 2018). Videos containing demonstrations or experiments are feasible as learning resources and are used effectively by teachers (Barton, Whittaker, Kinzie, DeCoster, & Furnari, 2017). Science video media on the properties of light, collaboration between teachers and students, can be used on smartphones or computers with video player applications and can be viewed online via YouTube.

The design of learning media in the form of Physics videos is said to be valid and suitable for use in the learning process (Dwipangestu, Mayub, & Rohadi, 2018). Students who cannot carry out learning activities at school, because learning from home usually cannot carry out practicum. Practicum in schools can be overcome by making videos in an interesting, coherent, and systematic way, such as research from (Rante, Sudarto, & Ihsan, 2013). The learning method using video is suitable for use during the learning process during the COVID-19 pandemic. Physics or science experiments can still be carried out even if you study from home using interesting student-made videos. Now, the learning process is more often carried out from home, or carrying out face-to-face learning on a limited basis. Students and teachers are restricted from interacting closely with each other or keeping a distance. Teachers are required to be creative and innovative in carrying out the learning process. Students are more interested and enthusiastic about watching Physics learning videos than just reading textbooks (Nuzuliana, Bakri, & Budi, 2015).

Advanced technology requires teachers to be active in making learning media. Learning to use smartphones has begun to be applied before the covid-19 pandemic. However, its implementation is still not optimal. Currently, the use of smartphones is an item that must be used in the learning process. Learning media using smartphones is said to be feasible and interesting to use in learning physics both in the classroom and outside the classroom (Sari, Prasetyo, & Kuswanto, 2020). The use of smartphones in the development of learning media can be used and applied to students in the learning process (Sari, Nikmah, Kuswanto, & Wardani, 2019). Students are invited to be actively involved in various learning activities including online, in class, practice and others (Czaplinski & Fielding, 2020). Now, students are required to be active and independent in carrying out online or offline learning. Physics

Science learning video chapter on the properties of light is feasible and can be implemented in science learning in the new normal era.

CONCLUSION

The results showed that Physic Learning Video Properties of Light with Collaboration Teacher and Student as Learning Media in New Normal Era chapter is a media that is operated using a smartphone or computer with youtube, WhatsApp, or google drive. Products included in the feasible category are used in the learning process of physics and science for students based on good categories. This media can be implemented in the learning process in the new normal era, when learning online or offline or also blended learning.

ACKNOWLEDGEMENT

We thank our colleagues from Junior High School 4 Majenang (SMP Negeri 4 Majenang), Central Java, Indonesia that greatly assisted the research.

REFERENCES

Barton, E. A., Whittaker, J. V., Kinzie, M. B., DeCoster, J., & Furnari, E. (2017). Understanding the relationship between teachers' use of online demonstration videos and fidelity of implementation in MyTeachingPartner-Math/Science. *Teaching and Teacher Education*, *67*, 189–201. https://doi.org/10.1016/j.tate.2017.06.011

Czaplinski, I., & Fielding, A. L. (2020). Developing a contextualised blended learning framework to enhance medical physics student learning and engagement. *Physica Medica*, *72*(March), 22–29. https://doi.org/10.1016/j.ejmp.2020.03.010

Dwipangestu, R., Mayub, A., & Rohadi, N. (2018). Pengembangan Desain Media Pembelajaran Fisika SMA Berbasis Video pada Materi Gelombang Bunyi. *Jurnal Kumparan Fisika*, *1*(1), 48–55. https://doi.org/10.33369/jkf.1.1.48-55

Erniwati, Eso, R., & Rahmia, S. (2014). Penggunaan Media Praktikum Berbasis Video dalam Pembelajaran IPA-Fisika untuk Meningkatkan Hasil Belajar Siswa pada Materi Pokok Suhu dan Perubahannya. *Jurnal Sains Dan Pendidikan Fisika*, *10*(3), 269–273. http://ojs.unm.ac.id/JSdPF/article/view/964

Gorghiu, G., Gorghiu, L. M., Bîzoi, M., & Suduc, A. M. (2010). Setting up of a web educational video-clips exhibition related to the implementation of virtual experiments in Sciences education. *Procedia - Social and Behavioral Sciences*, *2*(2), 2906–2910. https://doi.org/10.1016/j.sbspro.2010.03.438

Green, S. M., Voegeli, D., Harrison, M., Phillips, J., Knowles, J., Weaver, M., & Shephard, K. (2003). Evaluating the use of streaming video to support student learning in a first-year life sciences course for student nurses. *Nurse Education Today*, *23*(4), 255–261. https://doi.org/10.1016/S0260-6917(03)00014-5

Hade, L., & Aswirna, P. (2019). Pengembangan Media Pembelajaran Fisika Menggunakan Corel Video Studio Pro X 7 Pada Materi Teori Kinetik Gas. *Natural Science Journal*, *5*(1), 740–753.

Hafizah, S. (2020). Penggunaan Dan Pengembangan Video Dalam Pembelajaran Fisika. *Jurnal Pendidikan Fisika*, *8*(2), 225. https://doi.org/10.24127/jpf.v8i2.2656

Hidayat, S., & Asy'ari, M. (2016). Pengembangan Video Time Lapse Caricature (VTLK) sebagai Media Pembelajaran IPA untuk Melatih Scientificcuriosity Siswa. *Jurnal Ilmiah Pendidikan Fisika "Lensa," 3*(2), 307–309.

Isti, L. A., Agustiningsih, & Wardoyo, A. A. (2020). Pengembangan Media Bideo Animasi Materi Sifat-sifat Cahaya untuk Siswa Kelas IV Sekolah Dasar. *Edustream: Jurnal Pendidikan Dasar*, *IV*(1), 21–28.

Kurniawan, D. C., Kuswandi, D., & Husna, A. (2018). Pengembangan Media Video Pembelajaran Pada Mata Pelajaran IPA Tentang Sifat dan Perubahan Wujud Benda Kelas IV SDN Merjosari 5 Malang. *JINOTEP (Jurnal Inovasi Dan Teknologi Pembelajaran)*, *4*(2), 119–125. https://doi.org/10.17977/um031v4i22018p119

Leung, M. M., Tripicchio, G., Agaronov, A., & Hou, N. (2014). Manga comic influences snack selection in black and hispanic New York City youth. *Journal of Nutrition Education and Behavior*, *46*(2), 142–147. https://doi.org/10.1016/j.jneb.2013.11.004

Lewis. R. Aiken. (1985). Three Coefficients For Analyzing The Reliability And Validity Of Ratings. *Educational and Psychological Measurement*, *45*, 131–141. https://doi.org/https://doi.org/10.1177/0013164485451012

Li, B. (2014). Classical Geometric Optics. In *Experimental Physics*. UIA Curriculum, Department of Physics.

Luna, M. J., & Sherin, M. G. (2017). Using a video club design to promote teacher attention to students' ideas in science. *Teaching and Teacher Education*, *66*, 282–294. https://doi.org/10.1016/j.tate.2017.04.019

Nuzuliana, A. H., Bakri, F., & Budi, E. (2015). Pengembangan Video Pembelajaran Fisika pada Materi Fluida Statis di SMA. *Prosiding Seminar Nasional Fisika (E-Journal) SNF 2015, IV*, 27–32. https://doi.org/http://snf-unj.ac.id/kumpulan-prosiding/snf2015/

Pribadi, B. A. (2017). *Teknologi dalam Pembelajaran*. Kencana.

Rante, P., Sudarto, & Ihsan, N. (2013). Pengembangan multimedia pembelajaran fisika berbasis audio-video eksperimen listrik dinamis di SMP. *Jurnal Pendidikan IPA Indonesia*, *2*(2), 203–208. https://doi.org/10.15294/jpii.v2i2.2724

Sari, F. P., Nikmah, S., Kuswanto, H., & Wardani, R. (2019). Developing Physics Comic Media a Local Wisdom: Sulamanda (Engklek) Traditional Game Chapter of Impulse and Momentum. *Journal of Physics: Conference Series*, *1397*(1). https://doi.org/10.1088/1742-6596/1397/1/012013

Sari, F. P., Prasetyo, H., & Kuswanto, H. (2020). Physics comics learning media based on Engklek traditional games on parabolic motion topics to improve creativity. *Journal of Gifted Education and Creativity*, *7*(August), 83–92.

Sugiyono. (2015). *Metode Penelitian Kuantitatif, Kualitatif, dan R&D*. Alfabeta.

Sun, H., & Gao, Y. (2016). Impact of an active educational video game on children's motivation, science knowledge, and physical activity. *Journal of Sport and Health Science*, *5*(2), 239–245. https://doi.org/10.1016/j.jshs.2014.12.004

Teni Nurrita. (2018). Pengembangan media pembelajaran untuk meningkatkan hasil belajar siswa. *Jurnal Misykat*, *03*(01), 171. https://media.neliti.com/media/publications/271164-pengembangan-media-pembelajaran-untuk-me-b2104bd7.pdf

Tipler, P. A., & Mosca, G. (2004). *Physics for Scientists and Engineers fifth edition*. W. H. Freeman and Company.

Widoyoko, E. P. (2011). *Teknik Penyusunan Instrumen Penelitian*. Pustaka Belajar.