EDUMASPUL
JURNAL PENDIDIKAN
Vol. 8 – No. 1, year (2024), page 1336-1346
|ISSN 2548-8201(Print)|2580-0469)(On line)|

Development of Practical Guide on Single Slit Diffraction Materials Using He-Ne Lasers and Diode Lasers

Dwi Sartikasari[1], Sri Purwaningsih[2], Hebat Shidow Falah[3]
Physics Education Study Program, Faculty of Teacher Training and Education, Jambi University.
E-mail:dwisartikasari264@gmail.com

Receive: 01/02/2024	*Accepted:02/02/2024*	*Published:01/03/2024*

Abstract: The absence of learning resources in the form of teaching materials to guide modern physics practicum specifically developed for students of the FKIP Jambi University physics education study program is the reason for conducting this research. Based on this, it is necessary to develop teaching materials to support lectures in modern physics courses. One of the materials developed as teaching materials is single-slit diffraction material. The research method used is development research, where the implementation uses a 4D model. One of the stages of developing teaching materials carried out is expert testing. The instrument used is a non-test instrument, namely in the form of a questionnaire. The expert or validator in this research is a physics education lecturer at FKIP Jambi University. The validity of the teaching materials developed was assessed by validators through a questionnaire. The results obtained in this research are teaching materials for modern physics practicums on single slit diffraction material to calculate the wavelength of He-Ne lasers and diode lasers which are quite valid with validation values of 3.33 and very good with a score of 3.83.

Keywords: Practical Guide; He-Ne Laser; Diode Laser.

Abstract:*The absence of learning resources in the form of teaching materials to guide modern physics practicum specifically developed for students of the Jambi University FKIP physics education study program is the reason for conducting this research. Based on this, it is necessary to develop teaching materials to support lectures in modern physics courses. One of the materials developed as teaching materials is single-slit diffraction material. The research method used is development research, where the implementation uses a 4D model. One of the stages of developing teaching materials carried out is expert testing. The instrument used is a non-test instrument, namely in the form of a questionnaire. The expert or validator in this research is a physics education lecturer at FKIP Jambi University. The validity of the teaching materials developed was assessed by validators through a questionnaire. The results obtained in this research are teaching materials for modern physics practice on single slit diffraction materials to calculate the wavelength of He-Ne lasers and diode lasers which are quite valid with validation values of 3.33 and very good with a score of 3.83.*

Keywords*:*Practical Guide; He-Ne Laser; Laser Diodes.

Introduction

Education is a conscious and planned effort to create a pleasant learning and learning atmosphere so that students can actively develop their potential to have religious spiritual strength, self-discipline, personality, intelligence, noble morals, and the skills needed by themselves and society (Pristiwanti et al., 2022). In education, physics learning is a branch of the natural sciences, in essence it is a collection of knowledge, methods of investigation, and ways of thinking. Physics is one of the subjects that can cause difficulties for students, even though students have studied this subject since elementary school (SD) level (Sugiana et al., 2017).

According to Astuti (2015), physics can be viewed as a process or result, so that in learning it must consider several effective and efficient learning strategies or methods, one of which is through practical activities.

Modern physics is one of the courses that underlies several other advanced courses, including quantum physics, solid state physics, statistical physics and core physics (Gunawan, G., Setiawan, A., Widyantoro, DH, 2013).

Modern physics has had a major influence on much of human life. Various discoveries of modern physics have led to a number of changes to physical concepts such as space, time, material objects, atoms, molecules and nuclei within the scope of the world of microscopes (Dra. Hj. Djusmaini Djamas, 2012). Modern physics concepts are abstract concepts, so they need to be visualized. This causes students to experience difficulty in understanding this material. If this continues, student learning outcomes in modern physics courses will be low (Gunawan, G., Setiawan, A., Widyantoro, DH, 2013). Students experience difficulties in studying modern physics material because in general some of the concepts they have are obtained through daily empirical experience, while modern physics concepts seem to conflict with their daily experience. Another factor that causes students to experience difficulties is the nature of modern physics concepts which are dominated by abstract concepts (Hartono, 2011).

Modern physics courses discuss phenomena that occur in matter at the atomic/subatomic scale or particles that move at speeds close to the speed of light (relativity). One of the phenomena that is popular and forms the background to the development of modern physics is diffraction (Nitriani et al., 2018)

Diffraction is a bending event of light because light passes through several narrow slits (Rokhaniyah, 2019). The diffraction phenomenon that can be observed is that a bright dark pattern is formed because the light from the laser beam is deflected by the diffraction grating (Mutiarani et al., 2021). Diffraction is a monochromatic light event that can pass through a narrow barrier to form a light-dark pattern. According to the opinion of Sariyanto et al. (2014). Diffraction patterns can be formed in the presence of single slit, two slit and multiple slit barriers. This diffraction pattern can be formed with two slit barriers, multiple slits and single slits (Datangeji et al., 2019).

Single slit diffraction is a bending event of light that occurs in a slit. One of the basic and classic concepts regarding single slit diffraction experiments is that when light waves with a certain wavelength move through a slit, the result of bending or

diffraction depends on the physical size of the slit by taking into account the wavelength of the light beam being bent (Fauzi & Trisniarti, 2016). Diffraction can occur in a single slit where the pattern that occurs is a bright pattern in the center with a slight dark-light pattern at the edges. This occurs due to the different trajectories of the rays that bend after passing through a very narrow gap (Anggur et al., 2019).

Laser diffraction is often seen by students as material that is difficult to understand because the material is abstract, so there is a need for a learning method, namely by carrying out a practicum so that students can study the material in real life (Hikmah Syiarah et al., 2022). Laser light is an electromagnetic wave which has properties that can experience reflection, refraction, interference, deviation, dispersion, diffraction and polarization (Kholifudin, 2017).

Wavelength is the most important quantity for a laser when used for various applications, especially in the fields of spectroscopy and interferometers where information about the actual wavelength is needed (Minarni et al., 2013). Wavelength is the distance that a wave can travel in one period. Wavelength can be denoted by λ. In the International System (SI), the unit of wavelength is the meter (m). Each wavelength spectrum has a different attenuation value (Prisdiansyah et al., 2017).

This is in accordance with research Sartika & Humairah, (2017), the majority of students experience difficulty in solving problems in the Modern Physics course with percentage scores: 78% of students experience difficulty in the problem understanding stage, 67% of students experience difficulty in the solution planning stage, 67% of students experience difficulty in the solution stage, and 100% Students experience difficulties in the review/evaluation stage.

Based on the article Tindangen & Theodora Maasawet (2016), the scientific process in question is a practical activity that can be carried out both inside and outside the classroom. The fact that occurs in the learning process today is that it still uses conventional teacher-centered learning without giving access to students to be able to develop their thinking patterns independently. This is certainly not in line with the goals of education in Indonesia which can develop students' potential to become capable, creative, independent and responsible human beings. The learning practices that have occurred so far should use the inquiry model because it can refer to the verification process. The Inquiry model can emphasize maximum student activity to search and discover, where this model can place students in the learning subject.

Practicum is one of the learning strategies that can attract students' interest in developing concepts, because practicum can provide direct experience for students to observe a phenomenon that occurs so that students can better understand the concepts being taught (Hamidah et al., 2014). Based on the terminology, practicum can be defined as a series of activities that allow a student to apply skills or practice something. The practicum-based learning method is a way of presenting lessons, where students carry out experiments by experiencing and proving for themselves what they have learned (Kurniawati, 2018). According to Mahmudatun Nisa (2017),

practicum is an activity that aims to equip students to better understand theory and practice.

Through practicum, researchers hope that the methods used will be able to support the success of the learning process, especially in modern physics learning. The advantages of practicum in the laboratory help students more in terms of scientific skills than anything else, such as increasing achievement, and something that can be seen from the response to the previous question. The weaknesses in practicum are limited time, lack of tools and materials and limited space, because not all laboratories have complete facilities (Bambang Sumintono, 2010). To support the physics learning process, it is necessary to carry out practical activities, one of which is a modern physics course (Yuanita et al., 2015).

Lasers are light sources that are monochromatic and coherent. Monochromatic and coherent light sources are very important in various fields of science, especially in atomic physics and optics. Currently, lasers with tunable wavelengths are also available, such as dye lasers and diode lasers (Yayuk et al, 2014)

Diode lasers are a type of semiconductor laser that Is commercially available with various wavelengths from near Ultra Violet (Near UV) to Far Infrared (Far IR). Diode lasers can be subject to variations in injection current, temperature and other factors so their output wavelength needs to be measured before use. The diode laser wavelength is measured using a wavemeter (Minarni et al., 2013). Diode lasers have a characteristic phase of Volt-Ampere change called the laser phase. There are 3 stages that have been successfully tested and proven, namely the spontaneous emission phase, the transition phase, the stimulated emission phase and one characteristic that was discovered, namely the characteristic of light divergence (Natasaputra et al., 2023).

The He-Ne laser is the type of laser that is most widely used. This means that the light beam produced is red (visible light) so it is easier to direct at the targeted acupuncture point. The use of infrared beams that are invisible to our eyes is very difficult, unless there is a detector as an auxiliary means so that the light beam can be directed precisely at the desired acupuncture point (Susilayati, 2016).

Method

The research carried out is research and development of practicum guides using the 4D development model which consists of definition, design, development and distribution. The research subjects taken were physics education students class of 2021, FKIP, Jambi University. In this article, we will explain the stage of developing teaching materials, namely expert testing.

Definition Stage

At this stage, an analysis of the needs for teaching materials for modern physics courses is carried out. The data analyzed was obtained from a questionnaire given to semester 6 students class of 2021 who were taking modern physics courses.

From the data collected, 35 respondents were obtained. Data collection was carried out via a link from Google form digitally and shared in the Whatsapp group. The questionnaire is filled with information, the higher the number, the

better the assessment. The data processing used is making percentages from the scale given in the distributed form. The results of the research carried out will be used as material for evaluating the development of the next learning media creation.

Design Stage

At this stage the researcher began to design the practicum guide that was developed. The activities carried out by researchers at this stage consist of three steps, namely preparation of test standards, media selection, format selection, and initial design which are described as follows: 1.) Test standard preparation stage: This stage is carried out by compiling a questionnaire grid for developing guidelines. Modern Physics on single slit diffraction material to calculate the wavelength of He-Ne lasers and diode lasers given to experts and students. The preparation of a material and media expert questionnaire grid is used to determine whether the materials and media in the guide are suitable for use or not. Then a perception questionnaire was used to determine students' perceptions of the modern physics guide that was developed. 2.) media selection stage: This media selection can be done by identifying the right media according to the characteristics of the learning material. In this research, the material developed in this print-based practical guide is single-slit diffraction material. 3.) format selection stage: Format selection can be done to design the content of the learning material.

Development Stage

At this stage the product being developed will be validated. The validity of the teaching materials developed is assessed through a questionnaire in the form of a validation sheet. Evaluation of teaching materials on the validation sheet for each component uses a score of 1 to 4, with 1 meaning disagree, 2 disagree, 3 agree, 4 strongly agree. Data from the validation sheet were analyzed descriptively. For quantitative data, namely the score from the validator, the percentage obtained will be calculated between the final score and the maximum score given by the validator.

No	Category	Score
1	Don't agree	1
2	Don't agree	2
3	Agree	3
4	Strongly agree	4

Based on the score above, it can be determined using the following formula: From the N value, the distance between gaps d can be determined as follows:

$$d \sin \theta = n\lambda \qquad (2.1)$$

To find Wavelength:

$$\lambda = \frac{d \sin \theta}{n} \qquad (2.2)$$

$$\lambda = \frac{d}{n} . \frac{y}{L} \qquad (2.3)$$

Where :
λ = is the wavelength of light
n = (order)
L = (Grid to screen distance)
y = (Distance between diffraction patterns)
d = (Distance between gaps)

The data obtained from validation by material experts and media experts is then averaged and the score percentage is

determined. The following is the validity score scale for teaching materials.

No	Score	Category
1	90% - 100%	Very Valid
2	70% - 89%	Valid
3	50% - 69%	Fairly Valid
4	30% - 49%	Less Valid

The product revision stage is carried out by improving teaching materials according to suggestions given by material experts and media experts. The aim of product improvement is to correct the shortcomings of the product that has been developed and become the final product, namely, the development of a modern physics practical guide on single slit diffraction material to calculate the wavelength of He-Ne lasers and diode lasers.

Results and Discussion (70%)

In this development research, a modern physics practical guide for single-slit diffraction experiments was produced to measure the wavelength of He-Ne lasers and diode lasers. This guide is designed based on a 4D model with steps, namely definition, design, development and deployment.

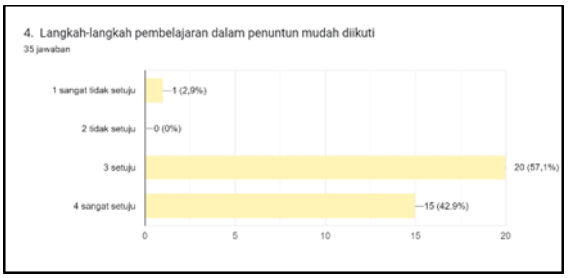

Figure 1. Questionnaire graph regarding the level of ease of guidance in classroom learning

The results of the questionnaire distributed to respondents for the first aspect regarding the level of ease of guidance in learning in class showed that 60% of respondents answered agree on a scale of 3; As many as 40% of respondents answered that they strongly agreed with scale 4. Thus, according to students, the ease of use of the guide in learning chose scale 3 with a good description. This confirms that the use of teaching materials can properly help students in using guides.

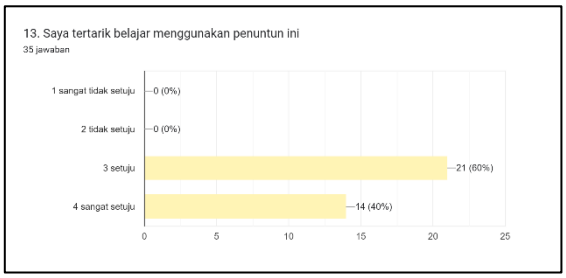

Figure 2. Questionnaire graph regarding students' perceptions of interest in using guides

In the second aspect of the question, namely students' interest in using the guide, data was obtained that 60% of respondents answered agree on a scale of 3; As many as 40% of respondents answered that they strongly agreed with scale 4. Thus, students' interest in guiding them chose scale 3 with a good description. This confirms that the use of teaching materials can properly attract students' attention in using the guide.

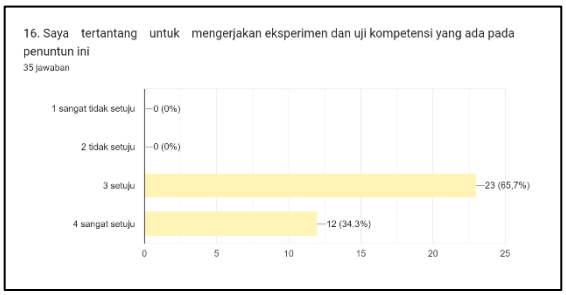

Figure 3. The perception questionnaire graph is challenged to carry out experiments and competency tests in the guide

For questions on the third aspect, namely being challenged to carry out experiments and competency tests in the guide, data was obtained as much as 65.7%

of respondents answered agreeing on a scale of 3; As many as 34.3% of respondents answered that they strongly agreed with scale 4. Thus, students felt challenged by the guide to choosing scale 3 with a good description. This confirms that the use of teaching materials can properly make students feel challenged by experiments and competency tests in guidance

From the three aspects of questions asked to students, it can be seen that the most dominant category in all three is good description. The graph of the average value of respondents shows that the highest increase was 65.7%, while the category with sufficient description reached 40% of respondents. By looking at the average percentage of the three aspects, it can be concluded that teaching materials have a significant influence on learning activities.

At the definition stage, the researcher carried out an initial analysis whose aim was to identify and determine the fundamental problems faced in learning, so that a development guide for modern physics practicum was needed. In the initial study, it was carried out using a needs questionnaire consisting of 10 questions to 48 students who had taken modern physics courses in the physics education study program at Jambi University. It is known that there are problems such as difficulty understanding the material in modern physics lectures, and there has never been a practicum in modern physics lectures, and there are no learning resources such as practicum guides to maximize the practicum process while making students interested in the material being taught. Based on these problems, researchers provide a solution in the form of a modern physics practicum guide product which presents the material in a more attractive appearance so that it can be used as a learning resource and guide for students when carrying out practicums. The solution provided is possible to be implemented in the physics education study program at FKIP Jambi University.

At the design stage, teaching materials can be developed. Researchers chose a modern physics practical guide as a learning resource to be developed. The next step is initial design, including determining the structure of the material in accordance with the Core Competencies (KI) which is adapted to the independent curriculum and material that follows the syllabus. In this phase, flowcharts and storyboards are created as a guide for product development.

In the development process, researchers produce products based on previous storyboard designs which serve as guidelines for creating media. The resulting product is the development of a modern physics practical guide on single slit diffraction materials to calculate the wavelength of He-Ne lasers and diode lasers. The product results were evaluated and validated by experts three times to obtain improvements before being tested. After validation is complete, it continues with testing on a small group consisting of 35 students.

At this stage the product that has been produced is then validated by a team of experts, namely material experts and media experts, material experts assess the suitability of the media that has been developed. In the material validation process, material experts suggest improvements to content aspects related to the suitability of images to support material explanations. After three validations, the media developed received a positive assessment with an average score of 3.83 in the "Very Good" category, so it was deemed suitable for testing.

The next stage, validation is carried out by media experts, where in media validation, media experts suggest

improvements to the integration and form of the media. After three validations, the media developed received a positive assessment with an average score of 3.33 in the "Very Good" category, so it was considered very suitable for testing.

After validation by material experts and media experts, the product that has been developed will be tested in the form of a small group consisting of 35 students in the 6th semester of class 2021, physics education study program, Jambi University. By using modern physics practicum guides, students can improve their understanding through practicums. Students show enthusiasm and enthusiasm when carrying out the practicum, utilizing the practicum guide as a guide for procedures and work steps. After the practicum is finished, students answer questions related to the results of the practicum, with the Practicum guide as a guide making it easier for them to provide answers if the practicum is followed well.

The results obtained show that the media developed received a positive response from students and was considered very useful. This media helps students carry out practicums, increases understanding, and becomes an effective learning resource. With an answer percentage of 79.6% from all respondents, this value is within the "Very Good" criteria in the range of 75%-100%.

Conclusion

The modern physics practical guide has been developed using the R&D method with a 4D development model, and produced a product in the form of a practical guide book with the title "Modern Physics Practical Guide for Measuring Wavelengths of He-Ne Lasers and Diode Lasers with Single Slit Diffraction Patterns". The practical guide developed is suitable for production and distribution with material validation test results of 3.83 in the (very good) category, and media validation test results of 3.33 in the (very good) category. The practicum guide developed has gone through a student perception test and obtained perception results with a score of 3.45 in the (very good) category.

Suggestion

Some of the suggestions in this research are as follows: Modern physics practicum guidance on single slit diffraction material to calculate the wavelength of He-Ne lasers and diode lasers can be utilized more widely by students taking modern physics courses.

Bibliography

Wine, Freinademetz, Ali Warsito, Albert Zicko Johannes, and Andreas Christian Louk. "Numerical Computational Study of Integrative Models for Circular Slit Diffraction Using the Simpson 1/3 Approach Method." Journal of Physics: Physical Science and its Applications 4, no. 2 (2019): 131–41. https://doi.org/10.35508/fisa.v4i2.1830.

Astuti, Siwi Puji. "The Influence of Initial Ability and Interest in Learning on Physics Learning Achievement." Formative: Scientific Journal of Mathematics and Natural Sciences Education 5, no. 1 (2015): 68–75. https://doi.org/10.30998/formatif.v5i1.167.

Bambang Sumintono, Mohd Ali Ibrahim and Fatin Aliah Phang. "Teaching Science Using Laboratory Practicum: Perspectives from Middle School 8 Science Teachers in Cimahi City." Mathematics and Natural Sciences Teaching 15 (2010): 2.

Candra, Randa, and Dian Hidayati. "Application of Practicum in Improving Students' Process and Work

Skills in Science Laboratories." Edugama: Journal of Education and Social Religion 6, no. 1 (2020): 26–37. https://doi.org/10.32923/edugama.v6i1.1289.

Datangeji, Richard Umbu, Ali Warsito, Hadi Imam Sutaj, Laura AS Lapono, Physics Study Program, Faculty of Science, Nusa Cendana University, and Jl Adisucipto-penfui. "NEWTON RAPHSON'S METHOD" 4, no. 2 (2019).

Dra. Hj. Djusmaini Djamas, M.Si. "INCREASING THE QUALITY OF MODERN PHYSICS LECTURES THROUGH THE IMPLEMENTATION OF AN INTERACTIVE INTEGRATED PROGRAM." Angewandte Chemie International Edition, 6(11), 951–952. 2 (2012): 1–12.

Fauzi, Ahmad, and Mayang Dwinta Trisniarti. "Application of the Diffraction Concept in the Health Sector." Journal of Physics Materials and Learning (JMPF) 6, no. 1 (2016): 1–6.

Gunawan, G., Setiawan, A., Widyantoro, DH "Modern Physics Virtual Laboratory Model to Improve Generic Science Skills of Prospective Teachers." Journal of Education and Learning 20, no. 1 (2013): 25–32.

Hamidah, Afreni, Eka Novita Sari, and Retna S Budianingsih. "Students' Perceptions of Biology Practicum Activities in Public High School Laboratories in Jambi City." Journal of Science 8, no. 1 (2014): 49–59.

Hartono, H. "Modern Physics Learning Oriented to Generic Thinking Skills for Prospective Teachers." Journal of Education and Learning, State University of Malang 18, no. 2 (2011): 195–206.

Hikmah Syiarah, Sri Purwaningsih, and Haerul Pathoni. "Development of Videos to Support Practicum Based on Problem Based Learning on Thermal Radiation and LASER Diffraction Material." Journal of Mathematics Education 12, no. 2 (2022): 379–87. https://doi.org/10.37630/jpm.v12i2.590.

Kholifudin, M. Yasin. "Toy Laser Beam as an Alternative to Monochromatic Light Sources for Practical Light Diffraction Gratings." Physics Learning Research Journal 8, no. 2 (2017): 129–34. https://doi.org/10.26877/jp2f.v8i2.1641.

Kurniawati, Yenni. "Analysis of the Difficulties of Mastering Theoretical and Practical Concepts in Chemistry for Prospective Chemistry Teacher Students." Configuration: Journal of Applied and Chemical Education 1, no. 2 (2018): 146. https://doi.org/10.24014/konfigurasi.v1i2.4537.

Mahmudatun Nisa, Umi. "Practical Methods to Improve Understanding and Learning Outcomes of Grade V MI YPPI 1945 Tripe on Single Substances and Mixtures Practical Methods to Improve Understanding and Learning Outcomes Grade V MI YPPI 1945 Tripe on Single Substances and Mate." Journal of Biology Education 14, no. 1 (2017): 62–68.

Minarni, Saktioto, and Gita Lestari. "Measurement of Diode Laser Light Wavelength Using Reflection and Transmission Diffraction Gratings of He - Ne Lasers, Green Lasers, Red Lasers." Proceedings of the Semirata FMIPA University of Lampung, 2013, 167–71.

Mutiarani, Azizah, Durrotun Nafisah, Luqman Hakim, Putut Marwoto, Fianti Fianti, and Bambang Subali. "Nature Based Simple Diffraction Grating: Leeks (Allium Fistulosum) and Banana Hearts (Musa Paradisiaca)."

Upej 10, no. 1 (2021): 50229. http://journal.unnes.ac.id/sju/index.php/upej.

Natasaputra, Wijaya Widjanarka, Fatkhurrochman Fatkhurrochman, and Riska Dwi Handayani. "Physical Characteristics of Current Voltage and Divergence of Diode Lasers of Different Power Strengths." Transformation 18, no. 2 (2023): 54–60. https://doi.org/10.56357/jt.v18i2.317.

Ningsih, Aziza Putri, Sri Purwaningsih, and Darmaji. "Development of Electronics Practical Guide Based on Temperature and Heat Material Science Process Skills for SMP/MTs." Edumaspul: Journal … 5, no. 1 (2021): 242–51. https://ummaspul.e-journal.id/maspuljr/article/view/1159.

Nitriani, Nengah, Sahrul Saehana, and Darsikin Darsikin. "Development of Teaching Materials for Modern Physics Courses Using the ADDIE Model." JPFT (Journal of Tadulako Online Physics Education) 6, no. 1 (2018): 6. https://doi.org/10.22487/j25805924.2018.v6.i1.10012.

Novita, Eva. "Development of a Practical Manual Based on Basic Science Process Skills for Class IV Elementary Schools." Journal Evaluation in Education (JEE) 1, no. 1 (2020): 34–41. https://doi.org/10.37251/jee.v1i1.38.

Prisdiansyah, RV, A Hambali, and ... "Downstream and Upstream Wavelength Analysis in the Ng-Pon 2 Network System Using Twdm Technology." EProceedings … 4, no. 2 (2017): 1932–39. https://openlibrarypublications.telkomuniversity.ac.id/index.php/engineering/article/view/550%0Ahttps://openlibrarypublications.telkomuniversity.ac.id/index.php/engineering/article/download/550/520.

Pristiwanti, D, B Badariah, S Hidayat, and R. S Dewi. "Understanding Education." Journal of Education and Counseling (JPDK) 4, no. 6 (2022): 1707–15.

Rokhaniyah. "Physics Practical Tools for Determining the Wavelength and Frequency of the Sun's Spectrum." ORBITH Journal 15, no. 2 (2019): 47–55.

Sariyanto, Eko, Sri Wahyu Suciyati, and Gurum Ahmad Pauzidan Junaidi. "Wavelength Measurement of Monochromatic Light Sources from Webcam and Borland Delphi Based Light Diffraction Patterns." JOURNAL of Theory and Applications of Physics 02, no. 02 (2014): 199–204.

Sartika, Dewi, and Nur Aisyah Humairah. "Analysis of the Difficulty of Solving Problems in Modern Physics Courses for Prospective Physics Teacher Students." Journal of Mathematics and Natural Sciences Education 7, no. 1 (2017): 7–11.

Sugiana, I Nyoman, Ahmad Harjono, Hairunnisyah Sahidu, and Gunawan Gunawan. "The Influence of Generative Learning Models Assisted by Virtual Laboratory Media on Students' Mastery of Physics Concepts on Momentum and Impulse Material." Journal of Physics and Technology Education 2, no. 2 (2017): 61–65. https://doi.org/10.29303/jpft.v2i2.290.

Susilayati, Muslimah. "Diffraction in Lasers: Interpretation of 'Light Above Light'?" SHAHIH: Journal of Multidisciplinary Islamicate 1, no. 2 (2016): 193–205. https://doi.org/10.22515/shahih.v1i2.332.

Tindangen, Makrina, and Elsje Theodora Maasawet. "Analysis of teacher and student problems related to inquiry-based high school biology learning tools and their solutions." Journal of

Biology Education 5, no. 3 (2016): 271–78. http://journal.unnes.ac.id/sju/index.php/ujbe.

Widiarty, Widiarty. "Design and Build a Practical Information Systems Website for the Department of Information Engineering, Palangka Raya University." SAINTEKOM Journal 6, no. 2 (2017): 12. https://doi.org/10.33020/saintekom.v6i2.9.

Yayuk Widamarti, Minarni, Maxi Ginting. "THE MICHELSON INTERFEROMETER OPTICAL SYSTEM USES TWO LASER SOURCES TO OBTAIN THE FRIENDLY PATTERN." Applied Microbiology and Biotechnology 85, no. 1 (2014): 2071–79.

Yuanita, Dessiana Irma, Hamdi Akhsan, and Ketang Wiyono. "Development of Spectroscopy Practical Guide in Modern Physics Courses." Journal of Physics Innovation and Learning 2, no. 1 (2015): 77–87.