Jurnal Ilmiah Pendidikan Fisika Al-BiRuNi
https://ejournal.radenintan.ac.id/index.php/al-biruni/index
DOI: 10.24042/jipfalbiruni.v11i2.12603

P-ISSN: 2303-1832
e-ISSN: 2503-023X

Socioscientific Issues-based Guided-inquiry E-worksheet on Optical Instruments Topic

Febriani[1*], M. Ibnusaputra[1], Pramudya Wahyu Pradana[1], Jumadi[2*]

[1]Physics Education Master Study Program, Faculty of Mathematics and Natural Sciences, Universitas Negeri Yogyakarta, Jl. Colombo No.1, Karangmalang, Sleman, Yogyakarta, 55281, Indonesia
[2]Physics Education Department, Faculty of Mathematics and Natural Sciences, Universitas Negeri Yogyakarta, Jl. Colombo No. 1, Karangmalang, Sleman, Yogyakarta, 55281, Indonesia

*Corresponding Address: febriani.sandr@gmail.com; jumadi@uny.ac.id

Article Info

Article history:

Received: June 17, 2022
Accepted: October 19, 2022
Published: October 30, 2022

Keywords:

Electronic student worksheet;
Guided-inquiry;
Socioscientific issues;
Optical instruments topic;
oPhysics.

ABSTRACT

Optical instruments are one of the physics topics still considered difficult to be taught in the learning process. This difficulty can be overcome by using learning media in the learning process. This study aimed to determine the feasibility of a guided-inquiry Electronic Student Worksheet based on SSI on the topic of optical instruments. The method used in this research is Research and Development (R&D) with 4D steps. At the define stage, it is done by studying literature and conducting short interviews with one physics teacher, design stage contains for lesson plans and electronic student worksheets; the development stage contains product validation activities by four experts and preliminary field testing by 23 students of class XI MIPA SMA Negeri 4 Yogyakarta, dissemination stage contains product distribution. The results of this study are 1) the SSI-based guided-inquiry Electronic Student Worksheet was developed by the objectives, context, and visual aspects, 2) the lesson plan and also the Electronic Student Worksheet are in the very valid category and can be used in the range of 93.75%-100%, and 3) The results of the preliminary field testing are in the valid category, with a range of 77.17%-79-35%. The conclusion is that the Product produced in this study was declared feasible. Hence, the implication of this research is that the resulting product can be used later by the teacher to help the learning process of the optical instrument topic.

INTRODUCTION

Optical instruments are one of the topics of physics that have many applications in everyday life, e.g., in eyes, mirrors, and loupe. However, students still need help in the learning process, especially in understanding the concept of this material (Gurel et al., 2016; Kaniawati et al., 2020). In the context of learning physics on optical instruments, the difficulties experienced by students, i.e., in determining the magnification of optical instruments, explaining the process of image formation, explaining optical functions and processes in lenses, and confusion in understanding terms in optics (Suniati et al., 2013; Rokhmah et al., 2017; Tural, 2015).

The human eye material is one part of the optical instruments topic that students consider difficult. The eye is the only natural optical instrument. The topic of eye disorders is also something that is considered difficult for students because they cannot visualize the process of convex lenses and concave lenses helping someone who has eye disorders (Widiyatmoko & Shimizu, 2018; Jones & Zollman, 2014).

Factors that cause these difficulties can come from the complexity of the material concepts presented by the teacher, textbooks

How to cite Febriani, F., Ibnusaputra, M., Pradana, P., W., & Jumadi, J. (2022). Socioscientific issues-based guided-inquiry e-worksheet on optical instruments topic. *Jurnal ilmiah pendidikan fisika Al-Biruni, 11*(2), 231-241.

that present convoluted material, and the language used in the learning process is difficult for students to understand (Ekici, 2016; Widiyatmoko & Shimizu, 2018), the learning process tends to dwell on calculations and mathematical formulas (Ramaila & Reddy, 2018), and students who cannot find out for themselves the various scientific processes that occur (Marusic & Slisco, 2014). This causes the need for various efforts to overcome the factors that cause difficulties in learning the topic of optical instruments.

Efforts can be made to create learning concepts that can accommodate the needs of students in the learning process on optical instrument topics. This can be done by using the guided-inquiry learning model. Guided inquiry learning involves students maximally in a systematic, logical, critical, and analytical investigation process (Haidir & Salim, 2012). The guided-inquiry learning model can increase students' motivation to be more active in learning activities (Ginanjar, 2015). The involvement of students in learning makes it easier for students to build their knowledge, connect new concepts with the concepts they have and other related concepts, and apply the concepts they have with phenomena that occur in everyday life.

To be able to support the learning process with the guided-inquiry model, appropriate learning tools are needed. The learning tools that can be used are student worksheets based on a guided-inquiry learning model. Using student worksheets based on a guided-inquiry learning mode will be useful to make students active, develop concepts, and train them to find and develop process skills (Muslimah, 2020).

The use of student worksheets has now been further developed electronically so that it is not only print-based. Electronic student worksheets are packaged digitally so that the display and use of student worksheets are more interactive and attractive (Yulaika et al., 2020).

The guided-inquiry electronic student worksheets are structured to facilitate the main investigation activity. This is done through a collaboration between the syntax of guided inquiry and Socioscientific Issues (SSI) content.

The SSI-based guided-inquiry electronic student worksheets present issues that students will investigate so that the use of context will improve students' understanding of concepts. The issue in the student worksheet related to science and controversy highlights the application of moral and scientific reasoning to real-world situations (Sadler et al., 2007). The use of context in the physics learning process attempts to bridge the gap between abstract concepts and the realities of everyday life (Mahanani, et al., 2019;Febriani et al., 2023).

The investigation process on the SSI-based guided-inquiry electronic student worksheets model requires additional media to assist the visualization process. This is because using visual media can more easily overcome students' difficulties in understanding abstract science concepts (Yuniar et al., 2020). This will be done with the help of an interactive physics simulation.

Research by applying the guided-inquiry learning model to optical instrument materials has also been carried out by Rambe et al. (2019), which develops teaching materials based on guided-inquiry learning models assisted by crossword puzzles (TTS) on optical instrument materials for junior high school students. Other research is on developing digital student worksheets to improve learning outcomes on optical instrument materials (Al-hayati, 2019). Existing research still needs to be expanded beyond the development of guided inquiry-based worksheets. So far, guided-inquiry-based worksheets with a combination of SSI content on high school optical instrument materials have yet to be developed.

Combining the guided-inquiry electronic student worksheets with SSI-based content and the oPhysics-assisted investigation process is expected to help students in the physics learning process on optical instruments. Based on this, this study aimed to determine the feasibility of the electronic student worksheets produced in the physics learning process on the topic of optical instruments.

METHOD

The research method used is Research and Development (R & D). The research and development steps used refer to Thiagarajan, i.e., 4D. This step was chosen because it refers to research by Noprinda et al. (2019) and Fitriyah et al. (2021) that has succeeded in developing similar products. The stages of the research can be seen in Figure 1.

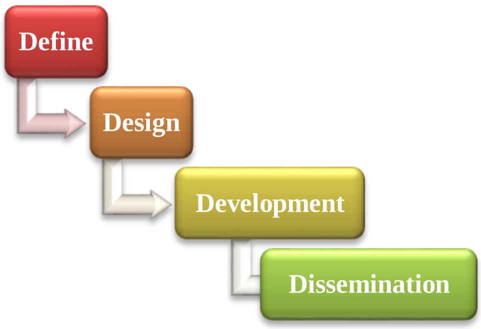


Figure 1. Research Stages

The define stage contains activities to define the product being developed. This stage is carried out by studying literature and short interviews. The resource person in the interview was one physics teacher at SMA N 4 Yogyakarta. Interviews were conducted to obtain information about the constraints and needs in the physics learning process on optical instruments.

The design stage contains design activities for the product that has been determined. The design starts with the learning process plan (RPP). The RPP in this study was compiled concerning the guided-inquiry learning syntax by Nurdyansyah & Wahyuni (2016) with a description of the phases as follows: 1) identifying the problem, 2) asking questions, 3) planning an investigation, 4) collecting data/information and carry out investigations, 5) analyze data, 6) make conclusions, 7) communicate results. E-worksheet is designed based on the requirements for the preparation of the worksheet, namely 1) didactic requirements, 2) construction requirements, and 3) technical requirements (Indriyani, 2013). The research instrument was a validation questionnaire, and student responses were arranged based on four main aspects, namely 1) instructions, 2) content, 3) questions, and 4) appearance. This instrument is designed with a Likert-4 scale, and the number of statement items is 18 items.

The development stage contains the activities of making products based on the designs that have been made and testing the resulting products. E-worksheet was created using Microsoft Word and Adobe Illustrator software to make cover designs, headers, and footers. Product testing is carried out with expert product assessments and limited user trials. Product assessment by experts is carried out by four appraisers (validators) with specifications for three graduates of physics education and one doctoral graduate in physics. The limited trial was carried out in class XI MIPA SMA Negeri 4 Yogyakarta using a subject of 23 students. The trial was carried out in a blended learning method of 2 meetings with a duration of 90 minutes for each meeting. The reference data analysis used to process the results of expert and user assessments can be seen in Table 1.

Table 1. Reference Validity of Learning Instruments (Akbar, 2013)

No	Score Percentage (%)	Validity Level
1	81,00-100,00	Very valid, can be used without revision
2	61,00-80,00	Valid, can be used but needs to be revised
3	41,00-60,00	Invalid, it is recommended not to use
4	21,00-40,00	Invalid, cannot be used
5	00,00-20,00	Very invalid, should not be used

Dissemination, at this stage the finished guided-inquiry E-worksheet product is distributed to students and teachers at SMA N 4 Yogyakarta.

RESULTS AND DISCUSSION

Student worksheet Electronic guided inquiry based on SSI was developed by considering the objectives, context, and visual aspects. In the aspect of the Electronic Student Worksheet, it aims to guide students' learning process through guided inquiry. This causes the investigation process to be the main thing in this Electronic Student Worksheet. Even so, the Electronic Student Worksheet is divided into two main parts: the matching and investigation sections. This is because, in the matchmaking section, there are also investigating activities that students can carry out with the help of various literature (Kemp, 2018).

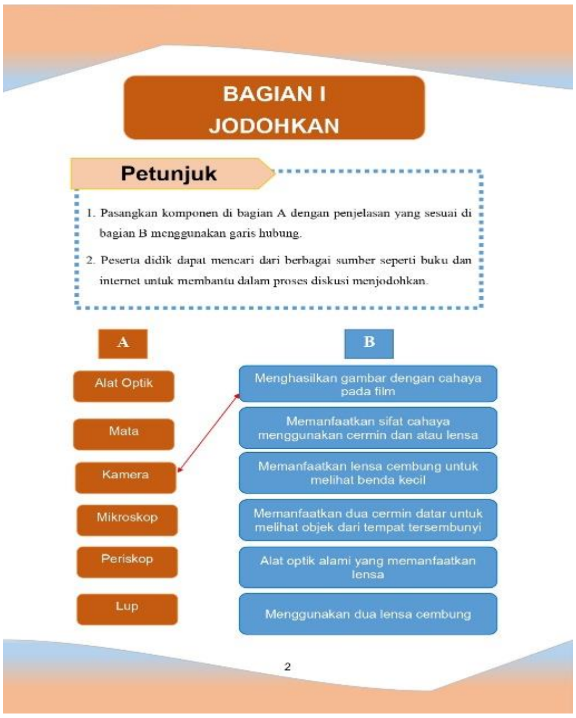
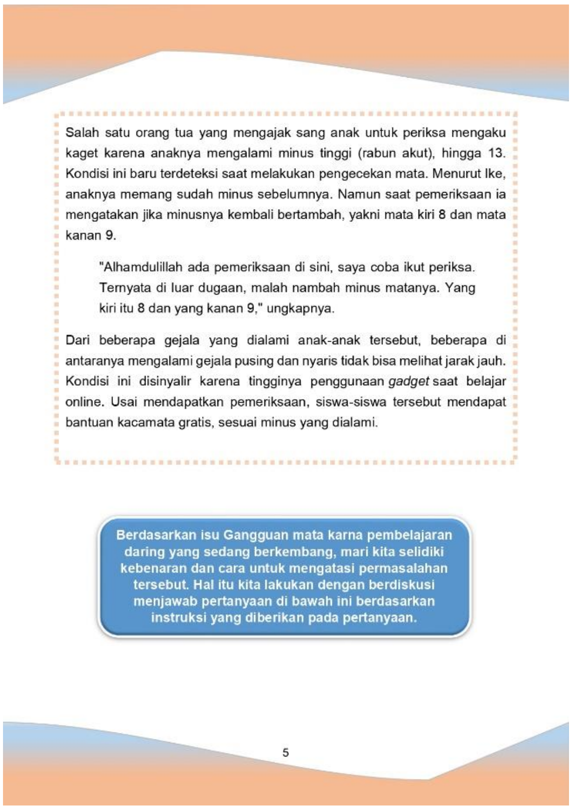


Figure 2. The Display of the Matching Section for Electronic Student Worksheets

In terms of content, in the section on matching physics material, the topic of optical instruments used is all optical instruments in general (see Figure 2). This material is limited to the general definition of each optical instrument. It aims to give students initial knowledge about the general differences between various optical instruments.

In the investigation section, SSI content began to appear. Selecting the right issues to be discussed in learning is key to implementing SSI (Hancock et al., 2019). This causes the issue raised in this research is "Two Years of Online Learning, Hundreds of Students in Bogor Experience Eye Disorders and Acute Myopia" (see Figure 3 (a,b)). That's because this content is related to the material of optical instruments, especially the human eye, and the disturbances that occur. In addition, this issue is controversial in the community. SSI content is the main problem students will investigate because the contextual issues/problems presented by students will be more motivated to conduct investigations in physics learning (Astalini et al., 2019).

(a)



(b)

Figure 3. (a, b) The Display of the Socioscientific Issue Section

The investigation process carried out by students on this Electronic Student Worksheet will be assisted by interactive physics simulations of oPhysics (see Figure 4). This is done so students can conduct investigations more realistically with the help of visual media (Yuniar et al., 2020). This investigative stage is carried out by establishing a hypothesis and then conducting an investigation using a simulation with the links provided and in various other literature. The main things investigated include the accommodation of the eye, eye disorders, and the process of correcting eye disorders by the lens. The final stage is to decide on the validity of the hypothesis made at the beginning and provide suggestions based on the results of the investigations that have been carried out.

The use of simulations by interactive physics simulations: oPhysics was chosen because it provides simulation of the required optical tools. In addition, developing student worksheets assisted by oPhysics still need to be developed. This is because most of the student's worksheet developments assisted by simulations mostly use PHET simulation as a medium that helps their student's worksheet. These developments include Bhakti & Napis (2018), who developed a guided-inquiry student worksheet on momentum and impulse material. Other studies have developed guided discovery learning student worksheets on Newton's Law material (Nurahman et al., 2019).

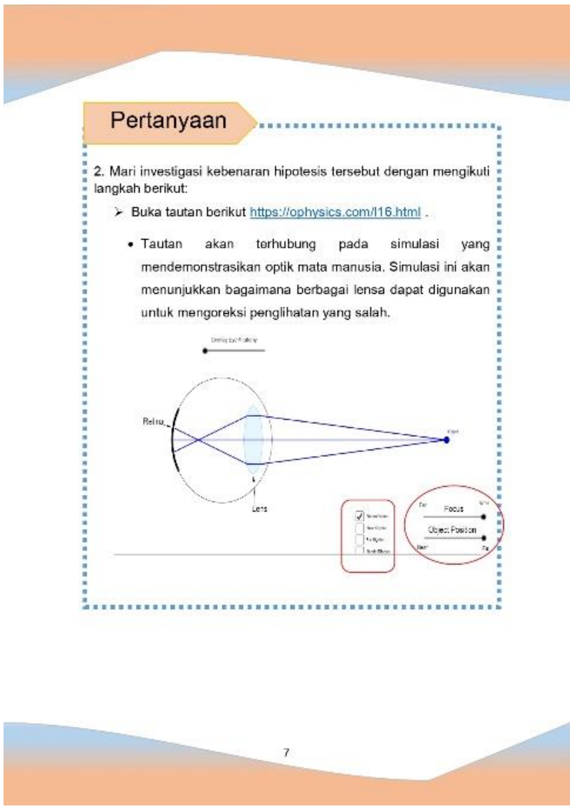


Figure 4. The Display of the Questions Section for Electronic Student Worksheets

The display on this Electronic Student Worksheet is made as attractive as possible. The object on the cover page has a picture of glasses (See Figure 5). This is due to connecting the objects on the cover and the studied physics content. In addition, headers and footers are also used in the content section and frames in certain sections. The attractive appearance of the Electronic Student Worksheet will stimulate students' interest in the learning process (Indriani et al., 2021).

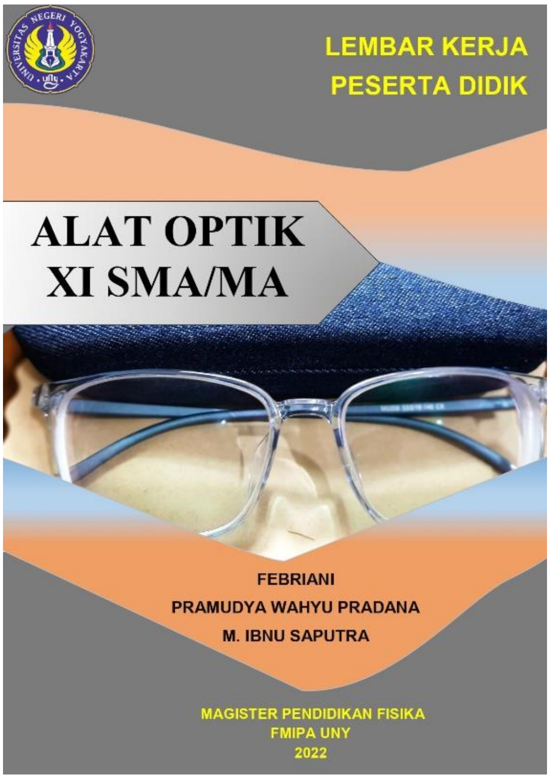


Figure 5. Electronic Student Worksheet Cover Page Display

The selection of the use of the Electronic Student Worksheet with various learning activities carried out in it is based on the results of interviews with supporting teachers and school conditions.

> "Students in schools on average already have smartphones, and the learning process can be carried out in the computer laboratory to access the Electronic Student Worksheet and simulation assistance."- Teacher.

All students can access this Electronic Student Worksheet through *Google Docs* (Gdocs). This platform was chosen so all group members could share the blended learning process information. This platform supports student collaboration and discussion during learning (Andrew, 2019; Neumann & Kopcha, 2019). GDocs have also been proven to enable better engagement in learning compared to the use of the Learning Management System (Morse, 2021). Besides that, the use of Electronic Student Worksheets with GDocs is still rarely used because some other studies have developed it with 3D page flips (Hidayah et al., 2020), live worksheets (Teresa et al., 2022), and Google slides with Peardeck (Fatimah, 2022).

Feasibility based on Media & Content Experts. The content validity test was conducted on the lesson plan product and the Electronic Student Worksheet. This assessment was carried out by four validators of media and content physics experts (See Figure 6 (a,b)). Based on the results in Figure 6 (a), it can be seen that the assessment for lesson plan products ranges from 93.75%-100% and is in the range of 81-100%. Figure 6 (b) shows the results of the assessment for students' worksheets ranging from 87.5%-100% and in the range of 81-100%. This causes the product produced in this study to be included in the very valid category and can be used without revision (Akbar, 2013). Even so, there are several inputs given by the validators to improve the product, including 1) How to write the number of lesson hours, and 2) it is necessary to pay attention to the arrangement of questions number 2 points b to d so that the intent of the questions is easier for students to understand.

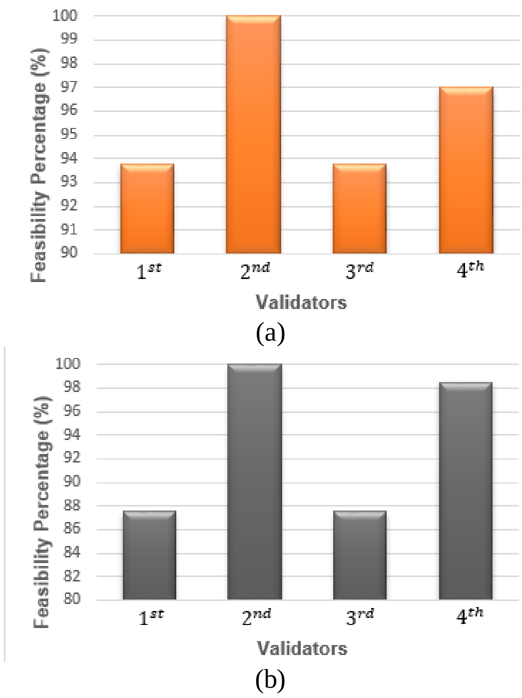


Figure 6. (a) Lesson Plan Feasibility (b) Student's Worksheet Feasibility

Feasibility based on Preliminary Field Testing, The results of the preliminary field testing, derived from the responses of 23 user students, are shown in Figure 7. Based on these results, it is known that the response results are in the range of 61.00-80.00%. In the overall aspect (see Figure 7 "ALL"), which covers the entire learning process from design to worksheets, the general feasibility percentage is 79.35%. This means that it is in the valid category and can be used, but it needs to be revised.

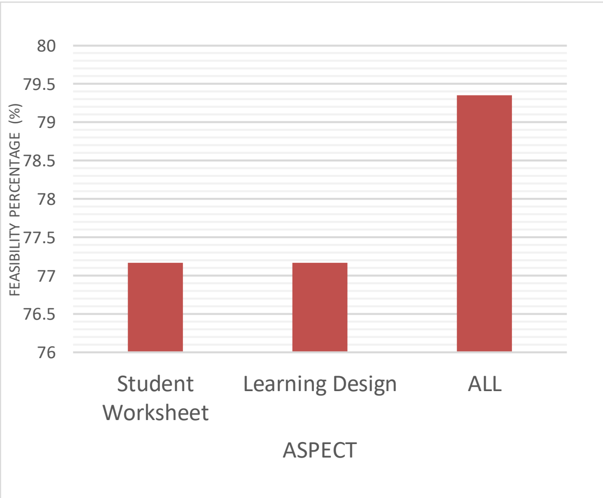


Figure 7. Feasibility of Student's Worksheet and Learning Model

The revisions made came from various inputs given, including Google Docs. If students are not carefully using them, they can shift various image features. This will then be overcome by making the images in Google Docs permanent so they stay the same if participants' students misclick and cause the image to be stacked or distorted. The teacher gives another revision of the process in the early part of learning at a tempo that is too fast. This makes the time allocation at the beginning of learning need to be added.

Based on the results of student worksheet Development, validation tests, and limited trials, it is known that the guided-inquiry Electronic Student Worksheet based on SSI on optical instruments is feasible. Various similar results were also obtained from developing other worksheets, such as in the study of Fhadhila et al. (2018), who developed a physics worksheet. The results also stated that it was feasible to use a development process that considered the various components of a good worksheet based on the ability of the science process. The differences in the products produced by the research are based on students' worksheet development. The worksheets were developed based on the ability to process science, while the worksheets in this paper were developed based on the collaboration of guided-inquiry learning models and SSI. The results of the other products are derived from the development of the research by Firdaus & Wilujeng (2018); the worksheets developed in this study were declared feasible to use with the development of worksheets only focusing on guided inquiry. Another development was by Al-Hayati (2019), which developed digital worksheets on optical instrument materials. The product resulting from this research is still limited to making student worksheets for digital optical devices without emphasizing the specifications of certain learning models and additional components in its development. Another product was developed by Budi et al. (2021), who developed a PHET simulation-assisted worksheet. The worksheet uses a different simulation platform from the one developed in this study and has not been integrated with a particular learning model.

Based on various comparisons with products developed in other studies, it is known that the novelty of this research is in the collaboration between guided-inquiry learning models and SSI content in the development of student worksheets on optical instrument materials. This collaboration is also supported by the use of oPhysics simulation software which helps the investigation process in the physics learning process for optical instrument materials and Gdocs in the student's worksheet work process. The collaboration of these various components on this worksheet can help students become more interested in the optical instrument physics learning process through the investigation activities presented. The collaboration process between students can occur through the Gdocs platform in accessing worksheets, the optical instrument physics learning process becomes more contextual with the social issues presented, and understanding the concepts in the physics of optical instruments becomes easier to obtain with simulation activities that show various processes more realistically. This indicates that the use of this worksheet can help the success of the physics learning process for optical instruments.

CONCLUSION

The guided-inquiry student worksheet electronic based on SSI on optical instruments produced in this study was declared feasible. This is based on a theoretical study of the development of the Electronic Student Worksheet, Feasibility based on media and content Experts, and Feasibility based on Preliminary Field Testing.

LIMITATION

This research is limited to developing student worksheets and preliminary field testing. This causes there to be no specific effectiveness test for certain abilities.

SUGGESTION

The suggestion that can be made based on this research is that further research is needed to test the effectiveness of using this Electronic Student Worksheet on certain ability variables in the physics learning process on the topic of optical instruments.

ACKNOWLEDGMENTS

The researcher would like to thank the Faculty of Mathematics and Natural Sciences, Universitas Negeri Yogyakarta, and SMA Negeri 4 Yogyakarta, who helped carry out this research**.**

AUTHOR CONTRIBUTIONS

F: contributed to developing student worksheets, manuscript writing ideas, and data collection, MI: contributed to data collection and instrument making, PW: contributed to instrument making and reference search, and J: contributed by providing suggestions in the development and data collection process.

REFERENCES

Akbar, S. (2013). *Instrumen perangkat pembelajaran.* Remaja Rosdakarya Offset.

Al-hayati, U. F. (2019). *Pengembangan lembar kerja siswa (LKS) digital untuk meningkatkan hasil belajar pada materi alat-alat optik (Skripsi)*, UIN Syarif Hidayatullah, Jakarta.

Andrew, M. (2019). Collaborating online with four different google apps :Benefits to learning and usefulness for future work. *The Journal of AsiaTEFL*, *16*(4), 1268–1288. https://doi.org/10.18823/asiatefl.2019.16.4.13.1268

Astalini, A., Darmaji, D., Pathoni, H., & Perdana, R. (2019). Motovation and attitude of students on physics subject in the middle school in Indonesia. *International Education Studies*, *12*(9), 15-26. http://dx.doi.org/10.5539/ies.v12n9p15

Bhakti, Y. B. & Napis, N. (2018). The development of guided-inquiry work sheet for student with physicss interactive simulation. *Jurnal Pendidikan Fisika*, *7*(2), 124-130. https://doi.org/10.22611/jpf.v7i2.10308

Budi, A. S., Sari, S. W., Sanjaya, L. A., Wibowo, F. C., Astra, I. M., Puspa, R. W., Misbah, M., Prahani, B. K., & Pertiwi, W. A. (2021). PhET-assisted electronic student worksheets of physics (eSWoP) on heat for inquiry learning during covid. *Journal of Physics: Conference Series*, *2104*(1), 1-6. https://doi.org/10.1088/1742-6596/2104/1/012030

Ekici, E. (2016). Why do I slog trough the physics? Understanding high school students' difficulties in learning physics. *Journal of Education and Practice*, *7*(7), 95-107. https://eric.ed.gov/?id=EJ1095264.

Fatimah, U. N. (2022). *Pengembangan e-worksheet (elektronik lembar kerja peserta didik) interaktif menggunakan google slide with pear deck dengan pendekatan kontruktivisme (Skripsi).* Uin Raden Intan, Lampung.

Febriani, F., Jumadi, J., and Dwandaru, W. S. B. (2023). Socioscientific issues in physics learning to improve students' critical thinking skills. *Revista Mexicana de Física E*, 20(1 Jan-Jun), pp. 010202. https://doi.org/10.31349/RevMexFisE.20.010202 .

Fhadhila, F., Ertikanto, C., & Rosidin, U. (2018). Developing student worksheet of temperature and heat based on scientific process skill. *Jurnal Ilmiah Pendidikan Fisika Al-Biruni*, *7*(1), 21–32. https://doi.org/10.24042/jipfalbiruni.v7i1.2318

Firdaus, M., & Wilujeng, I. (2018). Pengembangan LKPD inkuiri terbimbing untuk meningkatkan keterampilan berpikir kritis dan hasil belajar peserta didik. *Jurnal Inovasi Pendidikan IPA*, *4*(1), 26–40. https://doi.org/10.21831/jipi.v4i1.5574

Fitriyah, I. M. & Ghofur, M. A. (2021). Pengembangan E-LKPD berbasis android dengan model pembelajaran problem based learning (PBL) untuk meningkatkan berpikir kritis peserta didik. *Edukatif: Jurnal Ilmu Pendidikan*, *3*(5), 1957-1970. https://doi.org/10.31004/edukatif.v3i5.718 .

Ginanjar, A. (2015). Pengaruh metode belajar inkuiri terhadap motivasi belajar siswa SMP. *Jurnal Kependidikan*, *45*(2), 123-129. http://dx.doi.org/10.21831/jk.v45i2.7489

Gurel, D. K., Eryilmaz, A. & Dermott, C. (2016). Identifying pre-service physics teachers' misconceptions and conceptual difficulties about geometrical optics. *European Journal of Physics*. *37*(4), 1-30 https://doi.org/10.1088/0143-0807/37/4/045705 .

Haidir, H., & Salim, S. (2012). *Strategi pembelajaran*. Perdana Publishing.

Hancock, T. S., Friedrischen, P.J. Kinslow, A.T., & Sadler, T.D. (2019). Selecting socioscientific issues for teaching a grounded theory study of how science teachers collaboratively design SSI-based curricula. *Science & Education, 28*, 639-667. https://doi.org/10.1007/s11191-019-00065-x .

Hidayah, A. B., Winingsih, P. H., & Amalia, A. F. (2020). Development of physics E-LKPD (electronic worksheets) using 3D pageflip based on problem based learning on balancing and rotation dynamics. *COMPTON: Jurnal Ilmiah Pendidikan Fisika*. *7*(2), 37-43. https://doi.org/10.30738/cjipf.v7i2.9091

Indriani, S., Nuryadi, N., & Marhaeni, N. H. (2021). Student's worksheet design assisted with liveworksheets to improve students concept understanding skills on quadrilterals and triangels. *Multidiscipline- International conference*, *1*(1), 462-469.

Indriyani N.A. (2013). Analisis buku teks SMA berdasarkan hakikat sains. Universitas Pendidikan Indonesia.

Jones, D. L., & Zollman, D. (2014). Understanding vision: Students' use of light and optics resources. *European Journal of Physics*, 35 (5), 055023, http://dx.doi.org/10.1088/0143-0807/35/5/055023 .

Kaniawati, I., Rahmadiani, S., Fratiwi, N. J., Suyana, I., Danawan, A., Samsudin, A., & Suhendi, E. (2020). An analysis of students' misconceptions on the implementation of active learning of optics and photonics approach assisted by computer simulation. *International*

Journal of Emerging Technologies in Learning (iJET), *15*(09), 76–93. https://doi.org/10.3991/ijet.v15i09.12217

Kemp, A., McDougal, E. R., & Syrdal, H. (2018). The matchmaking activity: An experiential learning exercise on influencer marketing for the digital marketing classroom. *Journal of Marketing Education*, *41*(2), 141-153. http://dx.doi.org/10.1177/0273475318803415

Mahanani, I., Rahayu, S., & Fajaroh, F. (2019). Pengaruh pembelajaran inkuiri berkonteks socio scientific-issues terhadap keterampilan berpikir kritis dan scientific explanation. *Jurnal Kependidikan Penelitian Inovasi Pembelajaran*, *3*(1), 53-68. http://dx.doi.org/10.21831/jk.v3i1.20972 .

Marusic, M. & Slisco, J. (2014). High school students believe school physics helps in developing logical but not creative thinking: active learning can change this idea. *European Journal of Physics Education*. *5*(4), 30-41. https://www.proquest.com/docview/1807490153 .

Morse, M. (2021). Increase engaged student learning using google docs as a discussion platform. *Teaching & Learning Inquiry*, *9*(2), 1-18. https://doi.org/10.20343/teachlearninqu.9.2.20

Muslimah, M. (2020). Pentingnya worksheet pada pendekatan scientific pembelajaran matematika. *Journal SHEs: Conference Series*, *3*(3), 71-79. https://jurnal.uns.ac.id/SHES/article/download/56958/33600 .

Neumann, K. L., & Kopcha, T. J. (2019). Using google docs for peer-then-teacher review on middle school students' writing. *Computers and Composition*, *54* (102524), 1-16. https://doi.org/10.1016/j.compcom.2019.102524 .

Noprinda, C. T. & Soleh, S. M. (2019). Pengembangan lembar kerja peserta didik (LKPD) berbasis high order thinking skill (HOTS). *Indonesian Journal of Science and Mathematics Education*. *2*(2), 168-176. https://doi.org/10.24042/ijsme.v2i2.4342 .

Nurahman, A., Widodo, W., Ishafit, I., & Saulon, B. O. (2019). The development of worksheet based on guided discovery learning method helped by phet simulations interactive media in newton's laws of motion to improve learning outcomes and interest of vocational education 10th grade students. *Indonesian Review of Physics*, *1*(2), 37-41. https://doi.org/10.12928/irip.v1i2.776

Nurdyansyah, N., & Wahyuni, E. F. (2016). *Inovasi model pembelajaran*. Nizamia Learning Center.

Ramaila, S. & Reddy, L. (2018). South african science students perceptions of physics as a fundamental discipline. *Journal of Physics: Conference Series*, *1512*, 1-6. https://iopscience.iop.org/article/10.1088/1742-6596/1512/1/012007 .

Rambe, A., Lubis, A. M., & Aritonang, S. (2019). Development of physics teaching materials of optical devices based on learning assisted guided-inquiry crossed puzzles. *Jurnal Pendidikan Fisika Indonesia*, *15*(2), 70–79. https://doi.org/10.15294/jpfi.v15i2.21649

Rokhmah, A., Sunarno, W., & Masykuri, M. (2017). Science literacy indicators in optical instruments of highschool physics textbook chapter. *Jurnal Pendidikan Fisika Indonesia*, *13*(1), 19–24. https://doi.org/10.15294/jpfi.v13i1.8391

Sadler, T. D., Barab, S. A., Scott, B. (2007). What do students gain by engaging in socioscientific inquiry?. *Research in Science Education*, *37*,371-391.

https://doi.org/10.1007/s11165-006-9030-9.

Suniati, N. M. S., Sadia, I. W., & Suhandana, G. A. (2013). Pengaruh implementasi pembelajaran kontekstual berbantuan multimedia interaktif tehadap penurunan miskonsepsi (studi kuasi eksperimen dalam pembelajaran cahaya dan alat optik di SMP Negeri 2 Amlapura). *Jurnal Administrasi Pendidikan Indonesia*, *4*(1), 1-13. https://doi.org/10.23887/japi.v4i1.1019

Teresa, Kurniati, T., & Fadhillah, R. (2022). pengembangan elektronik lembar kerja peserta didik (e-worksheet) berbasis liveworksheet materi konsep mol pada siswa kelas x mipa man 3 pontianak. *Ar-Razi Jurnal Ilmiah*, *10*(1), 13-19. http://dx.doi.org/10.29406/arr.v10i1.3245.

Tural, G. (2015). Active learning environment with lenses in geometric optics. *Asia-Pacific Forum on Science Learning and Teaching*, *16* (1), 11–18. https://eric.ed.gov/?id=EJ1070731

Widiyatmoko, A. & Shimizu, K. (2018). The development of two-tier multiple choice test to assess students' conceptual understanding about light and optical instruments. *Jurnal Pendidikan IPA Indonesia*, *7*(4), 491-501. https://doi.org/10.15294/jpii.v7i4.16591

Yulaika, N. F., Harti, & Sakti, N. C. (2020). Pengembangan bahan ajar elektronik berbasis flip book untuk meningkatkan hasil belajar peserta didik. *Jurnal Pendidikan Ekonomi, Manajemen Dan Keuangan*, *4*(1), 67–76. https://doi.org/10.26740/jpeka.v4n1.p67-76 .

Yuniar, R. E., Suprapto, N., Mubarok, H. (2020). Triggering student's scientific literacy through static fluid scrapbook. *Journal of Physics: Conference Series*. *1491*. https://doi.org/10.1088/1742-6596/1491/1/012057 .