JPPS (Jurnal Penelitian Pendidikan Sains)
Homepage : https://journal.unesa.ac.id/index.php/jpps
Email : jpps@unesa.ac.id

p-ISSN : 2089-1776 ; e-ISSN : 2549-1597
JPPS, Vol. 13, No. 1, November 2023 : 42-53

Developing Learners' Digital Literacy through Guided Discovery Learning on the Matter of Work and Energy

Faisal Rahman[1], Suyidno Suyidno[1*], Sarah Miriam[1], Sadang Husain[2]
[1]Lambung Mangkurat University, Banjarmasin, Indonesia
[2]Taipei Medical University, Taipe, Taiwan

DOI: https://doi.org/10.26740/jpps.v13n1.p42-53

Sections Info
Article history:
Submitted: June 30, 2023
Final Revised: Sept 13, 2023
Accepted: Oct. 12, 2023
Published: Nov. 30, 2023

Keywords:
Digital Literacy
Guided Discovery
Learning Outcomes
Teaching Material

ABSTRACT
Digital literacy is essential in educational field and digital society, but it has received less attention in schools. ***Objective:*** *This paper will analyze the effectiveness of work and energy teaching materials through guided discovery learning to improve students' digital literacy.* ***Method:*** *This study applied a one-group pretest and posttest design on 26 secondary level students of grade X. Data collection techniques used digital literacy questionnaire instruments, learning outcomes tests, and interviews.* ***Results:*** *The results showed that the n-gain of students' digital literacy and learning outcomes were medium criteria and high criteria, respectively. Thus, the developed physics teaching materials through guided discovery learning are effective for improving students' digital literacy.* ***Novelty:*** *Previous studies have not used guided discovery on work and energy teaching material to train students' digital literacy.*

INTRODUCTION

The development of technology and information today offers multidimensional challenges and opportunities, including in the context of education (Leitenstorfer et al., 2023; Perwita et al., 2019; Valko & Osadchyi, 2022). Through the education process, humans can prepare themselves to face an increasingly developing world (Alam, 2022; Callaway-Cole & Kimble, 2021). Various efforts need to be made to improve the quality of education, including through integration. Technology and information products improve the quality of graduates with a positive impact on the quality of education (Rohmawati et al., 2023). Education has a very important role in shaping the character of the nation and preparing quality and competitive human resources for the challenges of the times (Arifah & Azis, 2022; Khan et al., 2023). In facing the challenges of this era, one of the ways needed is to familiarize the use of digital media or digital literacy from the beginning.

Digital literacy describes the ability to use information and communication technology to find, evaluate, utilize, create, and communicate information involving cognitive, ethical, social, and emotional aspects, as well as technical or technological (Asnawati et al., 2023; Rahmat et al., 2023; Yesilyurt & Vezne, 2023). Digital literacy habituation can start in the school environment. Indicators of digital literacy in learning activities include a variety of digital-based reading materials and teaching aids (Pratama et al., 2019). In this case, an educator is required to be skillful in using technology, media, and information that supports the quality of learning (Karakose et al., 2021; Rahim et al., 2022; Sari et al., 2022). Educators can utilize or create technology-based media or teaching materials that are creative, innovative, interesting, and learner-centered (Rosmiati & Satriawan, 2022; Nurjanah et al., 2020; Saputra & Chaeruman, 2022). One way that

educators can do this is by utilizing digital-based learning media or creating teaching materials that can be integrated with digital media (Arifah & Azis, 2022; Wardana et al., 2022).

Digital learning has become the policy of every school, but the implementation is still teacher-centered (Ekawati & Prastyo, 2022; Nasbey et al., 2022). Teachers apply it occasionally in the classroom so that digital literacy does not have much impact on students (Alam, 2022; Haryanto et al., 2022; Prastika et al., 2019). Learners are familiar with using digital literacy to support their success in learning and their careers in the future (Alakrash & Razak, 2021; Reilly & Leopold, 2022; Rizal, 2022). Guided discovery can be an alternative to classroom learning to help train digital literacy, as it connects concepts in the real world (Maullidyawati & Hidayah, 2022; Wahyuni et al., 2022).

Based on the 2018 PISA study, digital literacy skills in Indonesia are low (Amin et al., 2022; Jamaluddin et al., 2022; Laily & Binasdevi, 2023). The learning model used is teacher-centered and rarely utilizes digital media in the learning process (Felitasari & Rusmini, 2022; Maisarah et al., 2022). The results of the initial study of researchers through questionnaires distributed, it was found that the integration of students' digital literacy was still very low with an average score of 29.17. The use of technology by students is still misused to play games rather than open learning sites and there is still not much variety of digital-based reading materials so printed books still dominate learning resources.

The development of electronic teaching materials based on guided discovery is believed to be one of the alternatives to overcome students' low digital literacy. Through guided discovery learning, students can discover something by trial and error, and by studying cases, students will discover the principles of the knowledge learned (Mutiara, 2019). The syntax of guided discovery learning is a data collection phase in this phase, students plan to problem-solve through investigation activities or the results of discovery activities by utilizing existing digital media so that digital literacy can be trained in students.

Nowadays, digital literacy research is attracting the attention of researchers (Rahim et al., 2022; Sari et al., 2022; Skantz-Aberg et al., 2022). Several studies show that students' digital literacy can be improved through the implementation of direct teaching, guided inquiry, and PBL combined with STEM (Alyspa et al., 2022; Maisarah et al., 2022; Sinaga et al., 2023); PjBL (Faridah et al., 2022); self-directed learning (Rini et al., 2022). In addition, digital literacy is developed through the implementation of QR-Code based e-modules (Pratiwi & Indana, 2022), Android-based e-modules (Dewi et al., 2022; Wahyuni et al., 2022); interactive e-books (Shiyamsyah & Yuliani, 2022). Based on the results of this research, it turns out that there has been no research that uses guided discovery to increase students' digital literacy. In fact, in the current digital era, educators need to maximize ICT in facilitating students to discover knowledge in their way. In other words, guided discovery can be an alternative model to help students develop their digital literacy.

The research objective is to analyze the effectiveness of work and energy teaching materials through guided discovery learning to increase digital literacy. The materials of work and energy will be divided into 3 meetings. The first materials are effort. The second materials are energy and power. The third materials are potential energy and conservative force. The materials of work and energy was chosen based on its subject matter which generally discusses several basic things, namely the concept of work, the kinetic energy work theorem, the energy resulting from the interaction of two objects,

conservative and non-conservative forces, and the law of conservation of mechanical energy. Guided discovery learning is expected to be able to train students' digital literacy. However, until now guided discovery learning is still minimally applied, so it makes researchers interested in developing it.

RESEARCH METHOD

The research used included quasi-experimental research. In this study, the independent variable was the teaching material of work and energy through guided discovery learning, while the manipulation variable was digital literacy and learning outcomes of 26 students of class X high school. Before being used, the teaching materials had previously been validated by 2 physics learning experts and 1 physics teacher so that the validity value was obtained in the value range of 0 to 4 in the aspects of format (3.27), language (3.07), content (2.89), presentation (3.25), and benefits (3.33) as well as a reliability value of 0.83; so that the teaching materials meet the valid and reliable criteria so that they can be used in classroom research trials. This trial design used a one-group pretest and posttest. At the pre-test stage, researchers asked students to fill out a digital literacy questionnaire instrument and a learning outcomes test. The digital literacy questionnaire instrument consists of 20 positive and negative statements which can be seen in Table 1.

Table 1. Digital literacy questionnaire instrument

Indicator	Statements
The intensity of application and use of digital literacy in learning activities	1. I do not read electronic books that support physics learning 2. I read information from the internet to support physics learning 3. I know information from the internet and textbooks 4. I participate in discussion forums that discuss physics material 5. I rarely access the web pages of ruang guru, genius, etc. 6. I never correct information if I find sources that are not correct
Number and variety of digital-based reading materials and teaching aids	7. I never read physics books with electronic teaching materials using my cell phone or laptop. 8. I do not use physics learning support applications such as dictionaries, explanations of formulas, terms, etc. 9. I can open learning materials in electronic form 10. I access information in the form of videos of physics materials 11. I use computers in the school ICT laboratory for learning activities 12. I never use experiment simulation such as PhET etc.
Frequency of borrowing books or accessing digital-themed information	13. I borrow/access books at ipusnas with a physics theme 14. I borrow/access books on Google Books with a physics theme 15. I borrowed/accessed physics-themed books at the Ministry of Education and Culture 16. I borrow/access books through the school ICT laboratory
Quantity of school information presentation using digital media or website	17. I never search for information about the school through search sites 18. I open the school's official website 19. I read information about the school profile 20. I access various school information through social media

In the learning implementation stage, researchers used teaching materials through guided discovery learning for 3 meetings. In meeting 1, students discussed business material. In meeting 2, students discussed energy and power. In meeting 3, students discussed potential energy and conservative force. At each meeting, students were given a problem and given the opportunity to investigate the problem, then form a study group of 5-6 people, asked to identify relevant problems, and then make hypotheses in the distributed student worksheet. After that, students collected as much data or information as possible through digital media, finally presenting their findings in front of the class. At the post-test stage, students were asked to fill in the digital literacy questionnaire instrument again answer the learning outcomes test, and conducted in-depth interviews to explore various problems during the learning process using guided discovery.

Digital literacy pretest and posttest data were analyzed descriptively and quantitatively. The learners' digital literacy score for positive statements is very often = 5, often = 4, sometimes = 3, rarely = 2, and never = 1. Negative statements are given a point for very often = 1, often = 2, sometimes = 3, rarely = 4, and never = 5. The digital literacy score is obtained by summing the score obtained divided by the maximum score and multiplying it by 100. Then adjust the criteria: 84 < very good ≤ 100, 68 < good ≤ 84, 52 < sufficient ≤ 68, 36 < less ≤ 52, very less < 36. Furthermore, to determine the level of improvement before and after guided discovery learning was applied, the pretest and posttest data of digital literacy were tested using the n-gain equation, with high, medium, and low criteria.

RESULTS AND DISCUSSION

Results

The quality of learning resources greatly supports the improvement of learning quality (Asfuri & Ambarsari, 2021; Lukman et al., 2022). Therefore, the use of learning resources through guided discovery learning is believed to be able to train students' digital literacy in physics learning. The results of the analysis of students' digital literacy can be seen in Table 2.

Table 2. Analysis of Students' digital literacy

Indicator	Pretest		Posttest		N-Gain	
	Score	Criteria	Score	Criteria	Score	Criteria
The intensity of application and use of digital literacy in learning activities	32.05	Very less	67.15	Sufficient	0.52	Medium
Number and variety of digital-based reading materials and teaching aids	30.77	Very less	60.58	Sufficient	0.43	Medium
Frequency of borrowing books or accessing digital-themed information	25.72	Very less	60.10	Sufficient	0.46	Medium
Quantity of school information presentation using digital media or website Laman	28.13	Very less	59.86	Sufficient	0.44	Medium
Average	**29.17**	**Very less**	**61.92**	**Sufficient**	**0.46**	**Medium**

Based on Table 2; the achievement of digital literacy indicators before and after the study shows that there are differences in digital literacy skills between before and after the study. The acquisition of the N-gain value shows that students' digital literacy skills can be improved in the medium category. The indicator of the intensity of application and use of digital literacy in learning activities trains learners to apply and utilize as much digital-based media as possible to support learning. The activities carried out in this indicator are students reading electronic books that have been provided, reading information and knowing through the internet, participating in online discussion forums, accessing learning resources such as the teacher's room, Genius, and others, and students are expected to examine the information from other sources if the information obtained is not correct. Indicators of the number and variety of reading materials and digital-based teaching aids train students to try to increase the variety of facilities and infrastructure in the use of digital-based media. The activities carried out in this indicator are students utilizing mobile phones or laptops to access electronic teaching materials, using physics learning support applications such as physics online dictionaries, accessing information in the form of videos related to physics learning, using school ICT laboratories for learning facilities, and using simulation teaching aids such as PhET. The indicator of the frequency of borrowing books or accessing digital-themed information trains students to be able to utilize learning resources on the internet. The activities carried out in this indicator are that learners can borrow or access books on the Ipusnas, Kemendikbud, and Google book sites, and utilize school libraries that are integrated with technology.

The indicator of the number of information presentations using e-media or websites trains learners to know the initial ability of how often to access their school information. The activities carried out in this indicator are students looking for information about schools through social media or school web pages. In addition, the effectiveness of electronic teaching materials is also strengthened by the learning outcomes test (LOT). The use of LOTs to measure student learning outcomes before and after guided discovery learning using the developed electronic teaching materials. The LOT questions, which totaled 6 questions, were then determined through the N-gain equation. The learning outcomes of students who met these criteria amounted to 26 out of 41 people in the test subjects and can be seen in Table 3.

Table 3. Analysis of students' learning outcomes

Pretest	Posttest	N-gain	Criteria
28.80	81.07	0.73	High

Table 3 shows that the average pre-test score is still low, meaning that the student's learning outcomes are still low while the average post-test score increases, which means that the student's learning outcomes have improved or are better. The acquisition of the N-gain value shows an increase in their learning outcomes in the high category. The developed electronic teaching materials are effectively used in learning activities to train students' digital literacy.

Discussion

Effectiveness describes the achievement of the goals of learning, or there is an influence and results obtained from researching predetermined goals. Meanwhile, the effectiveness

of learning devices means the quality standards of education as measured by examining the learning objectives derived from the learning outcomes test (Rohmawati, 2018). The learning outcomes test is a tool to measure learning outcomes before and after learning is applied using the developed materials. Learning tools are said to be effective if the learning objectives are achieved. Learning using this electronic teaching material must achieve learning objectives. The achievement of learning objectives is seen from the learning outcomes measured using the learning outcomes test. The learning outcomes test is divided into two, namely the pretest conducted before the study and the posttest conducted at the end of the study (Astra & Halimah, 2022; Fatmawati, 2018; Sinon et al., 2022).

The effectiveness of guided discovery is seen in the achievement of digital literacy and student learning outcomes. The transfer of knowledge from teachers to their students is considered ineffective if they have not understood, processed, and constructed the knowledge conveyed by educators (Hassan et al., 2022; Putra et al., 2022; Putri et al., 2023). The achievement of digital literacy is carried out by paying attention to indicators that are adapted to the use of learning in schools adapted to the needs of the study, then applied in questionnaire statements distributed before and after treatment (Brata et al., 2022; Rahayu & Mayasari, 2018).

The indicators of digital literacy before treatment (Table 2), namely the intensity of application and use of digital literacy in learning activities; number and variety of digital-based reading materials and teaching aids; the frequency of students borrowing books or accessing digital-themed information; schools present a lot of information through digital media or websites is still in the very small category. Consistent with Pratama *et al*. (2019) that students' digital literacy is within the very less criteria. Furthermore, after digital literacy is given treatment, the results show a change in the moderate criteria. This indicates that the application of electronic teaching materials and learning tools using guided discovery learning can train digital literacy because students are facilitated to use electronic teaching materials and innovative education combines learning models with digital media to prepare them to compete in the digital era and create more relevant science learning (Nurcahyo & Setyowati, 2021). The achievement of student learning outcomes indicates the effectiveness of the developed learning tools (Rifansyah et al., 2018). Students learn outcomes through test procedures in the form of pretests and posttests with a type of written description test consisting of six questions sorted based on Bloom's taxonomy with a minimum completeness criterion of 70. Problem number 1 is a matter of understanding (C2), questions number 2 and 3 are questions of applying (C3), and questions number 4, 5, and 6 are questions of analyzing (C4). In Table 3, the pretest data of students' learning outcomes show an increase seen from the high category n-gain value (Khaldi & Murhamatillah, 2022). This means, guided discovery can increase student activeness and have a positive impact on improving student learning outcomes in physics subjects. Guided discovery activities and the facilities provided greatly support students' digital literacy skills (Ekawati et al., 2020). It facilitates critical thinking, creativity, and independence in solving the problems given. (Satriawan et al., 2022; Rosmiati et al., 2020; Salimah et al., 2019).

The advantages of guided discovery learning that has been implemented are developing students' skills in the cognitive process, gaining independent knowledge through digital media, and increasing students' motivation in learning, as well as coordinating it to be used in technology and information in groups or individually

(Irfandi, 2022). In line with the learning theories of cognitivism and constructivism, guided discovery prioritizes the thinking process and the active role of students in discovering new ideas or concepts based on their knowledge or experience (Arafah et al., 2023).

CONCLUSION

Fundamental findings: The application of effort and energy teaching materials through guided discovery is effective in improving students' digital literacy at school. Learners are familiar with investigating problems, group discussions, collecting data or information, and presentations to understand the physics of effort and energy. This has an impact on improving students' digital literacy and learning outcomes, which are moderate and high, respectively. **Implications:** Learners can cultivate digital literacy in physics learning, and access various information or reading materials with digital themes. **Limitation:** This research only focuses on the physics materials of work and energy. **Future research:** Further research is needed for wide-scale trials on physics materials or other levels of education.

ACKNOWLEDGEMENTS

Thanks to Lambung Mangkurat University and SMAN 4 Banjarmasin for facilitating the implementation of this research.

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Faisal Rahman
The study program of physics education, Lambung Mangkurat University Banjarmasin, Jl. Brigjen. H. Hasan Basry Kayu Tangi, Banjarmasin utara, Banjarmasin, Kalimantan Selatan, Indonesia.
Email: rahmanfaisal026@gmail.com

***Dr. Suyidno, M.Pd. (Corresponding Author)**
The study program of physics education, Lambung Mangkurat University Banjarmasin, Jl. Brigjen. H. Hasan Basry Kayu Tangi, Banjarmasin utara, Banjarmasin, Kalimantan Selatan, Indonesia.
Email: suyidno_pfis@ulm.ac.id

Sarah Miriam, M.Sc., M.Pd.
The study program of physics education, Lambung Mangkurat University Banjarmasin, Jl. Brigjen. H. Hasan Basry Kayu Tangi, Banjarmasin utara, Banjarmasin, Kalimantan Selatan, Indonesia.
Email: sarah_pfis@ulm.ac.id

Sadang Husain, S.Pd., M.Sc.
Taipei Medical University, No. 250 號, Wuxing St, Xinyi District, Taipei City, Taiwan 110, Taiwan
Email: sadanghusain@yahoo.com