




Lukman Hakim

artikel

-  artikel 1
-  skripsi mahasiswa
-  Universitas PGRI Palembang

Document Details

Submission ID

trn:oid::1:3264677519

Submission Date

May 31, 2025, 1:42 AM GMT+7

Download Date

May 31, 2025, 1:45 AM GMT+7

File Name

article_template_jpmipa.docx

File Size

249.6 KB

21 Pages

8,179 Words

53,078 Characters

12% Overall Similarity

The combined total of all matches, including overlapping sources, for each database.

Filtered from the Report

- Bibliography

Match Groups

- 45** Not Cited or Quoted 10%
Matches with neither in-text citation nor quotation marks
- 6** Missing Quotations 1%
Matches that are still very similar to source material
- 0** Missing Citation 0%
Matches that have quotation marks, but no in-text citation
- 0** Cited and Quoted 0%
Matches with in-text citation present, but no quotation marks

Top Sources

- 11% Internet sources
- 3% Publications
- 4% Submitted works (Student Papers)

Integrity Flags

0 Integrity Flags for Review

No suspicious text manipulations found.

Our system's algorithms look deeply at a document for any inconsistencies that would set it apart from a normal submission. If we notice something strange, we flag it for you to review.

A Flag is not necessarily an indicator of a problem. However, we'd recommend you focus your attention there for further review.

Match Groups

- **45 Not Cited or Quoted 10%**
Matches with neither in-text citation nor quotation marks
- **6 Missing Quotations 1%**
Matches that are still very similar to source material
- **0 Missing Citation 0%**
Matches that have quotation marks, but no in-text citation
- **0 Cited and Quoted 0%**
Matches with in-text citation present, but no quotation marks

Top Sources

- 11% Internet sources
- 3% Publications
- 4% Submitted works (Student Papers)

Top Sources

The sources with the highest number of matches within the submission. Overlapping sources will not be displayed.

1	Student papers	
	Universitas Islam Negeri Raden Fatah	3%
2	Internet	
	journal.uny.ac.id	1%
3	Internet	
	repository.lppm.unila.ac.id	<1%
4	Internet	
	jurnal.ustjogja.ac.id	<1%
5	Internet	
	e-journal.undikma.ac.id	<1%
6	Internet	
	www.ametuniv.ac.in	<1%
7	Internet	
	core.ac.uk	<1%
8	Publication	
	Rama Nida Siregar, Didi Suryadi, Sufyani Prabawanto, Abdul Mujib. "Students' ma...	<1%
9	Internet	
	ojs.amhinternational.com	<1%
10	Internet	
	uir.unisa.ac.za	<1%

11	Internet	www.ojs.cahayamandalika.com	<1%
12	Publication	Urmila Shrawankar, Prerna Mishra. "Cloud Computing for Smart Education and C...	<1%
13	Internet	blantika.publikasiku.id	<1%
14	Internet	journal.universitaspahlawan.ac.id	<1%
15	Publication	Kadonsi Kaziya. "A Systematic Review of Technology Integreation in Mathematics ...	<1%
16	Publication	L Resnita, Yulkifli, R Abdullah, Faradillah. "Preliminary analysis of students work...	<1%
17	Internet	es.scribd.com	<1%
18	Internet	jpmipa.fkip.unila.ac.id	<1%
19	Internet	online-journal.unja.ac.id	<1%
20	Publication	Pengfei Cui, Bity Salwana Alias. "Influencing factors of blended learning in privat...	<1%
21	Internet	doaj.org	<1%
22	Internet	hdl.handle.net	<1%
23	Publication	Eviamanasye Firmaniar, Ruqiah Ganda Putri Panjaitan, Ary Kusmawati. "Impleme...	<1%
24	Internet	www.e3s-conferences.org	<1%

25	Publication	Yisca Berenshtein, Riki Tesler, Inbal Halevi Hochwald, Gizell Green. "The perspecti...	<1%
26	Internet	kwpublications.com	<1%
27	Internet	www.researchgate.net	<1%
28	Internet	hrmars.com	<1%
29	Internet	journal.iipsiliwangi.ac.id	<1%



Volume (Issue), Year, Page-Page
Jurnal Pendidikan MIPA

e-ISSN: 2550-1313 | p-ISSN: 2087-9849
<http://jurnal.fkip.unila.ac.id/index.php/jpmipa/>



Enhancing Students' Conceptual Understanding and Motivation in Electricity Through Web-Based Problem-Solving with PhET Simulations

Patricia Hotma Minar Lubis¹, Lefudin¹, Wacharaporn Khaokhajorn², Emiliannur³,
Nanang Winarno⁴, Lukman Hakim^{1*}

¹Pendidikan Fisika, Faculty of Teacher Training and Education, Universitas PGRI Palembang, Jl. Jend. A. Yani 9/10 Ulu Palembang

²Science Education Department, Sakon Nakhon Rajabhat University, 680 Nittayo Rd, Muang Chang Wat Sakon Nakhon 47000, Thailand

³Physics Education Department, Faculty of Mathematics and Science, Padang State University, Jalan Prof. Dr. Hamka, Air Tawar, Kota Padang, Sumatera Barat

³Physics Education Department, Faculty of Mathematics and Science, Indonesia University of Education, Jl. Setiabudhi No. 229, Bandung, Indonesia

*Corresponding author: lukmanhakim@univpgri-palembang.ac.id

Abstract: This study explores the effectiveness of web-based problem-solving learning integrated with PhET simulations in enhancing students' conceptual understanding and motivation on the topic of electrical circuits. Utilizing a descriptive method, the study involved 30 students from a private university in Palembang who engaged in web-based instruction supported by interactive simulations and contextual problem-solving activities. Data were collected through a learning style questionnaire, a concept understanding test, and a motivation questionnaire administered via Google Forms. The results revealed a significant increase in students' posttest scores across five indicators of conceptual understanding—electric current, potential difference, resistance, Ohm's Law, and circuit configuration—with N-Gain values ranging from moderate to high. Notably, students with auditory and kinesthetic learning styles showed slightly higher gains. Learning motivation also demonstrated a very high category, with 88% of students indicating strong interest and persistence in the learning process. Structural model analysis showed a strong relationship between conceptual understanding and motivation (path coefficient = 0.922), suggesting that improved understanding directly enhances motivation. The integration of web-based platforms and PhET simulations not only facilitated flexible and personalized learning experiences but also supported students' engagement, exploration, and self-regulation. These findings highlight the potential of technology-enhanced science instruction to bridge cognitive and affective learning domains, making it a valuable approach for future pedagogical innovations in physics education

Keywords: Web-based learning, conceptual understanding, learning motivation

Abstrak: Abstrak dan kata kunci ditulis dalam Bahasa Inggris dan Bahasa Indonesia. Abstrak merupakan ringkasan (singkat, padat, dan jelas) dari penelitian Anda. Abstrak harus menjelaskan dengan baik mengenai latar belakang masalah, tujuan penelitian, metode yang digunakan (singkat), hasil penelitian (yang paling utama), dan kesimpulan. Abstrak tidak boleh berisi sitasi, tabel, gambar

Penelitian ini bertujuan untuk mengeksplorasi efektivitas pembelajaran web berbasis pemecahan masalah yang terintegrasi dengan simulasi PhET untuk meningkatkan pemahaman konsep dan

First author et al.
Email: xxx@yyy.ac.id

DOI: <http://dx.doi.org/10.23960/jpmipa/v?i?.pp??-??>
Received: date month year
Accepted: date month year

2 |

Jurnal Pendidikan MIPA, Volume (Issue), Year, Page-Page

motivasi siswa pada topik rangkaian listrik. Metode penelitian yang digunakan adalah metode kuasi eksperimen yang melibatkan 30 mahasiswa dari sebuah universitas swasta di Palembang yang mengikuti pembelajaran berbasis web. Data dikumpulkan melalui kuesioner gaya belajar, tes pemahaman konsep, dan kuesioner motivasi yang diberikan melalui Google Forms. Hasil penelitian menunjukkan bahwa terdapat peningkatan signifikan skor posttest siswa di lima indikator pemahaman konsep pada pokok bahasan arus listrik, beda potensial, resistansi, Hukum Ohm, dan konfigurasi rangkaian dengan nilai N -Gain berkisar dari sedang hingga tinggi. Khususnya, siswa dengan gaya belajar auditori dan kinestetik menunjukkan peningkatan yang sedikit lebih tinggi. Motivasi belajar juga menunjukkan kategori sangat tinggi, dengan 88% siswa menunjukkan minat dan ketekunan yang kuat dalam proses pembelajaran. Analisis model struktural menunjukkan hubungan yang kuat antara pemahaman konsep dan motivasi (koefisien jalur = 0,922), yang menunjukkan bahwa peningkatan pemahaman secara langsung meningkatkan motivasi. Integrasi platform berbasis web dan simulasi PhET tidak hanya memfasilitasi pengalaman belajar yang fleksibel dan personal, tetapi juga mendukung keterlibatan, eksplorasi, dan pengaturan diri siswa. Temuan ini menunjukkan potensi pengajaran sains berbasis teknologi untuk menjembatani ranah pembelajaran kognitif dan afektif, menjadikannya pendekatan untuk inovasi pedagogis masa depan dalam pendidikan fisika.

Kata kunci: pembelajaran berbasis web, pemahaman konsep, motivasi belajar.

INTRODUCTION

The development of science and technology has an impact on every aspect of human life, including education. The application of technology in education is an effort to make learning more real and interesting. Therefore, teachers and prospective teachers must have the opportunity to develop their abilities in using technology in learning (Kasiry & Wok, 2023; Ojelade et al., 2022).

Web-based learning is the application of technology in learning to help students achieve learning goals by presenting material according to the media used as learning resources. Therefore, teacher knowledge of web-based learning is the key to student success (Amiri et al., 2024; Astalini et al., 2022). Studies show that web-hosted platforms have become increasingly vital to fostering independent and interactive learning.

Web-based learning needs to be supported by interactive media so that students can ensure involvement in the learning process. Student involvement can be observed from their activity in asking and answering questions or commenting on problems. Hence, material must be presented in various formats such as graphs, tables, or images. Student engagement can be enhanced through interpreting multimodal content aligned with their characteristics (Hakim et al., 2022; Vieira et al., 2022). Research by Wulandari et al. (2022) and Simamora et al. (2020) supports the role of Google Sites-based multimedia in strengthening concept understanding and student participation. The implementation of diverse learning strategies (Chinnasami Sivaji et al., 2022; Chua et al., 2020; Safar et al., 2022) further promotes active involvement.

Learning strategies that enhance engagement include problem-solving approaches. Web-based problem-solving learning involves students in addressing real-life phenomena using virtual tools like PhET simulations. These open-access simulations help learners explore core physics topics, particularly current and potential difference in simple circuits. By integrating simulations into instructional design, students gain firsthand experience constructing circuits and analyzing results (Lane et al., 2021; Roski et al., 2024).

To solve these problems, students construct circuits via PhET and measure variables such as current and voltage across resistors, using steps identical to real lab procedures. These tasks also encourage students to explain the reasoning behind their configurations, developing both analytical and verbal competencies. The capacity to reflect on problem-solving strategies fosters deeper understanding (Batsaikhan et al., 2022; Zhu, 2023).

Nonetheless, students face difficulties in electrical circuit topics due to the integration of algebraic reasoning and conceptual diversity in formulas. Some express confusion about current direction and formula memorization, underscoring the importance of scaffolding and guided inquiry (Berenshtein et al., 2023).

In cases where PhET cannot model complex circuits, students are guided to solve problems theoretically, applying Kirchhoff's laws. These hybrid approaches—practical and theoretical—enhance conceptual clarity while compensating for tool limitations.

PhET simulations visualize abstract concepts through images, videos, and interactive modules. Activities such as measuring current at various resistors captivate students' attention and reduce fatigue. They offer alternatives to formulaic calculations, empowering students through autonomy and experimentation. This motivates learners to tackle new challenges, gradually transitioning to theoretical applications like Ohm's Law (Kalogiannakis et al., 2021).

4 | *Jurnal Pendidikan MIPA, Volume (Issue), Year, Page-Page*

This research aims to investigate how web-based problem-solving learning using PhET impacts students' conceptual understanding. The findings will contribute to ongoing discourse on educational technology integration and inform future science pedagogy practices (DeCoito & Estaiteyeh, 2022)

In online learning, discussions remain foundational. Apps like WhatsApp, Telegram, and others support this through text, multimedia sharing, and external link integration. However, such apps lack the functionality to embed and sequence interactive simulations. Web-based systems can unify content delivery, interaction, and virtual labs on a single interface—fostering holistic learning experiences. Therefore, web-based learning can not only enhance understanding and engagement but also stimulate intrinsic motivation and active learning—a critical aspect of education in the digital age.

7 | **METHOD**

The research method used in this research is a descriptive method, to describe the situation that occurred as completely as possible (Fraenkel & Wallen, 2009). The research was conducted at a private university in Palembang involving 30 students as samples for the research. Students who participated in this research learned via the web.

Content analysis is an important step in implementing web-based learning to develop various student skills, especially to develop students' conceptual understanding. The content used in this research is dynamic electricity in accordance with the applied curriculum. The content used in the curriculum is a means of developing various student skills (Drake & Savage, 2016) apart from cognitive and attitude.

The instruments used in this research consisted of a learning style questionnaire, a concept understanding test, and a motivation questionnaire for learning using the web. This instrument is given to students online via Google Form. The learning style questionnaire consists of forty items related to student learning styles, namely visual, auditory and kinesthetic. This questionnaire is scored and accumulated to see students' learning style tendencies. The results of the learning style test are the basis for grouping students who will receive the material provided.

The concept understanding test consists of thirty multiple choice questions on the subject of dynamic electricity consisting of current strength, potential difference, Ohm's law, series circuits, parallel circuits, Kirrhhof's law. The indicators of concept understanding used are explaining, differentiating, interpreting, interpreting and exemplifying. The concept understanding test instrument before use is validated by experts.

Instrument validation includes construct validation and criterion or empirical validation. Construct validation is carried out by experts who aim to guarantee that the test instrument is valid so that it can be used to measure students' understanding of concepts. Aspects assessed at the construct validation stage include suitability between basic competencies and indicators, suitability between indicators and questions, the sentences used in the questions are understandable and unambiguous, each question has only one correct answer choice, and the questions and answers are in accordance with spelling is perfected and there are no errors in writing.

Instrument assessment technique by the validator by ticking yes or no in the column provided. A yes answer indicates that the question indicator matches the question, while a no answer indicates that the question indicator does not match the question given. The validator also provides comments in the column provided as input for revising

questions or question indicators. The results of expert validation show that all question indicators correspond to the questions given. Likewise, other aspects are declared valid.

Criterion validity uses internal validity obtained through testing the instrument on students who have taken the subject of dynamic electricity. The question criteria are declared valid if the correlation coefficient of the score of each question item with the total score is greater than 0.3, whereas if the correlation is smaller than 0.3, the question is declared invalid. The results of instrument testing showed that all questions had a correlation coefficient of item scores with a total score greater than 0.3, so that all questions were declared valid. From the test results, the reliability of the questions was also obtained at 0.7. Thus, the instrument used is empirically valid and reliable.

The third instrument used was a student motivation questionnaire regarding learning using the web. The learning motivation indicators used in this research are 1) interested in participating in learning activities, 2) having the will to complete all the tasks given, 3) being persistent in completing the tasks given and 4) having self-confidence in participating in learning (Sudibyo et al., 2017). The questionnaire was prepared using a Likert scale consisting of four statements, namely strongly agree (SS), agree (S), disagree (TS) and strongly disagree (STS). Student responses are used as scores with the criteria SS = 4, S = 3, TS = 2, and STS = 1. Motivation to learn Physics in web learning is divided into five categories, namely very high, medium high, low and very low. The percentage (%) of each category of students' motivation to learn physics via the web is expressed in the equation following:

$$p = \frac{\sum S}{N \times m} \times 100$$

- p : % Student Motivation
- $\sum S$: the overall score obtained by each student
- N : number of students
- m : maximum score of all students

Interpretation of student learning motivation using criteria (Fitriyani et al., 2020) as follows:

Table 1. Student Learning Motivation Scale

No	Percentage of Student Learning Motivation	Interpretation
1	20% - 36%	Very low
2	37% - 52%	Low
3	53% - 68%	Currently
4	69% - 84%	Tall
5	85% - 100%	Very high

▪ **RESULT AND DISCUSSION**

The distribution of students' learning styles is displayed in Figure 1. Three learning styles have been identified: visual (43%), kinesthetic (30%), and auditory (27%). According to this data, most students prefer visual learning, followed by kinesthetic and auditory preferences. These findings are consistent with earlier research and align with

the VARK model proposed by (Lehman, 2019), which categorizes learners into Visual, Auditory, Reading/Writing, and Kinesthetic types.

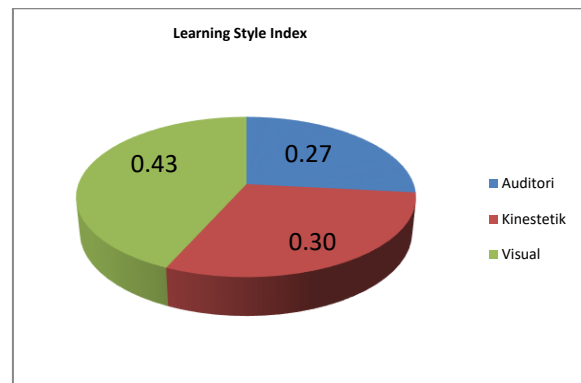


Figure 1. Student Learning Style Test Results

The dominance of visual learning among high school students can be attributed to the highly visual nature of both traditional and digital learning environments. This is further corroborated by studies such as those conducted by Subagja & Rubini (2023), who analyzed student learning styles using the VARK model in science subjects, and Umbrella (2024), who profiled **the learning styles of junior high school students.**

The significant role of visual learning in enhancing comprehension, especially in science topics, is well-supported in the literature. (Yusnidah et al., 2023) demonstrated that interactive visual media in web-based learning environments improves students' understanding of electrical materials. Likewise, Rahmawati et al. (2024) found that visual learners benefit significantly from multimedia-based learning, particularly when studying abstract scientific topics such as dynamic and static electricity. Similar conclusions were drawn by Arni et al. (2024), who reported that different learning styles (visual, auditory, kinesthetic) significantly influence learning outcomes in science education.

Additional insights come from studies like those of (Abdamia et al., 2023), Alimah (2023) and Ayub et al. (2023), which examined learning style distributions among various student populations and confirmed the prevalence of visual learning. Fahim et al. (2021) and Inam & Haq (2022) reinforced this through VARK-based assessments among medical and biology students.

Understanding kinesthetic learners' needs is also vital. Doyle et al. (2023) further analyzed how content design on digital platforms influences kinesthetic engagement in learning communities. Meanwhile, auditory learners are supported through elements such as narration and audio discussions in web-based learning, which aligns with findings from Ma et al. (2023) and Siddiquei & Khalid (2021) which emphasize multimodal online engagement and learning style adaptability.

Thus, tailoring instruction—particularly for abstract science topics like electricity—to visual learners using animated videos, digital simulations, and interactive graphics while also incorporating auditory and kinesthetic features is crucial. This approach not only aligns with the constructivist model but also promotes better learning outcomes through adaptive, student-centered instruction.

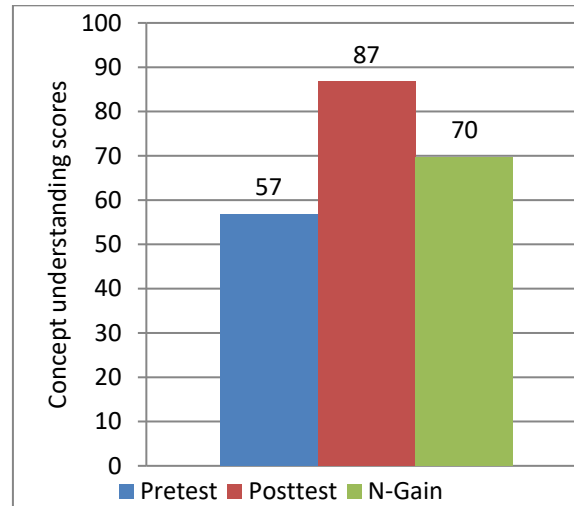


Figure 2. Test Results for Students' Understanding of the Concept of Static Electricity

Figure 2 shows a significant improvement in the understanding of static electricity concepts, where the pretest score of 57 increased to 87 on the posttest with an N-Gain value of 70. This shows the effectiveness of the web-based problem-solving approach in improving students' learning outcomes. Web-based learning is an educational innovation that presents material in various formats, making it appear more tangible for students. As a form of innovation, this learning method significantly contributes by providing opportunities for students to observe, demonstrate, and engage in activities that enhance their involvement in learning (Zahara et al., 2024).

The application of problem-solving in web-based learning provides students with the opportunity to identify the problems they face and actively engage in the problem-solving process. This process generates new knowledge, making learning more meaningful. In the problem identification stage, students are invited to understand physical phenomena to discover patterns that form the basis of new concepts. This activity fosters critical and analytical thinking skills, as supported by the findings Pertiwi et al. (2024), which indicate that problem-based approaches are highly effective in enhancing conceptual understanding of science. Choi et al. (2022) further highlight the efficacy of e-problem-based learning in improving conceptual grasp in specialized domains.

Student observations during the learning process indicate that the use of videos and dynamic simulations, such as PHET, plays a crucial role in helping students understand electrical concepts. PHET allows students to see changes in electric current and potential differences in simple circuits directly. The use of this simulation not only makes the concepts easier to understand but also provides students with opportunities to conduct virtual experiments. This aligns with the characteristics of visual and kinesthetic learning styles that are dominant in the student population and reinforces the findings (Afolabi, 2021). Studies like Kırıkkaya & Yıldırım (2021) also report improvements in student outcomes and self-directed learning through the integration of Web 2.0 tools and simulations.

Web-based learning transforms the conventional process, which is generally dominated by teacher explanations, into an active, exploration-based learning experience. Student activities become more diverse and can be tailored to each individual's learning style. This makes web-based learning more adaptive to students' learning needs compared to conventional classroom learning. Banda & Nzabahimana

(2021) emphasizes that this variation in activities directly impacts the improvement of learning outcomes. Providing links to materials that match students' interests increases motivation and makes learning more personal and enjoyable. According to Goodyear et al. (2021), activity-centered design fosters such personalization by aligning tasks with learners' cognitive and emotional engagement.

Figure 3 presents the results of the students' electrical concept understanding test, based on five indicators of concept understanding: electric current, potential difference, resistance, Ohm's Law, and electrical circuits. There was a significant increase in scores from the pretest to the posttest for all indicators. For example, on the electrical current indicator, the score increased from 55 to 93 with an N-Gain of 71. Similar improvements also occurred in other indicators, with N-Gain values ranging from 52 to 73. This demonstrates that the web-based learning approach, combined with problem-solving strategies, can significantly enhance students' understanding of various aspects of dynamic electricity concepts. The effectiveness of using PHET simulations in this context is also validated by Anisa & Astriani (2022), who demonstrated improved understanding through discovery learning.

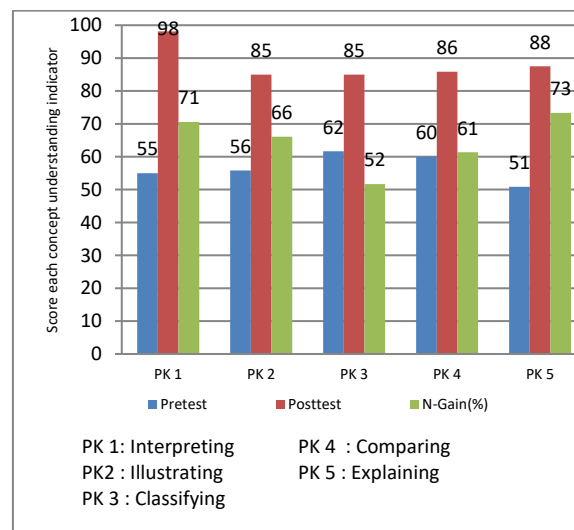


Figure 3. The results of students' conceptual understanding tests are based on indicators of understanding electrical concepts

This improvement is closely related to the flexibility of material presentation in web-based learning. As explained by Pradana et al. (2023), web-based learning enables the presentation of materials in various formats tailored to the characteristics of the students, thereby motivating them to be more actively engaged in the learning process. Visual materials, interactive animations, and virtual experiment simulations provide a more engaging and contextual learning experience. This alignment helps students form a deeper conceptual understanding because the information is presented in an easily understandable form and is relevant to their daily experiences. Önder et al. (2023) further emphasize that well-designed web-based systems can support the development of science process skills, which are foundational to understanding complex concepts.

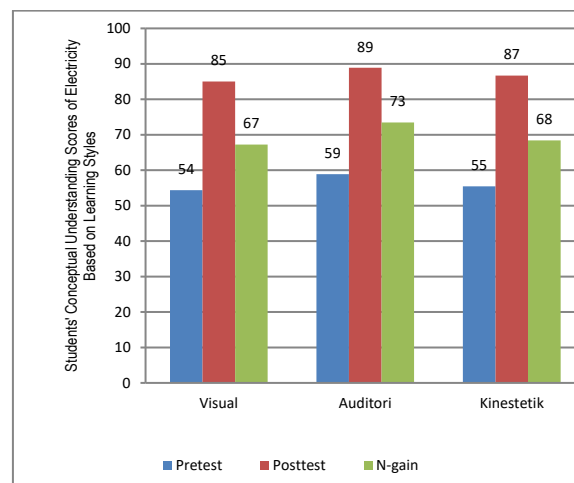
The improvement in students' understanding of dynamic electrical concepts is generally in the moderate category, except for two indicators that fall into the high N-Gain category, namely the ability to interpret and explain. The interpretation skills developed in web-based learning include the ability to understand trends in graphs and

data tables, as well as information in various formats, such as text, images, simulations, and videos. Meanwhile, the ability to explain is honed through discussion activities where students are asked to express their opinions and explain their answers. Both of these skills are essential for science learning because they help students convey and interpret concepts logically and structurally. According to Fendi et al. (2021), the integration of AR-based worksheets can also stimulate critical thinking and enhance explanatory competence.

The implications of these results for science education are vast. Web-based approaches with support for visualization and interactivity can serve as an effective learning model for science subjects. Science teachers need to utilize digital media effectively to bridge abstract concepts and accommodate diverse learning styles. The presentation of material through simulations, such as PHET, educational videos, and interactive quizzes, can enhance student engagement and create a more active and enjoyable learning environment. This approach also provides students with space to explore and validate their understanding independently. Maunula et al. (2023) and (Berenshtein et al., 2023) show that such models also positively affect student engagement and well-being, particularly in digital environments.

The consistent increase in N-Gain scores across all indicators shows that web-based learning not only enhances understanding but also strengthens students' independence and motivation to learn. They no longer rely entirely on the teacher's explanations but instead actively seek, try, and build understanding through various digital resources available to them. Web-based learning also provides a flexible learning system, allowing **students to learn at their own pace and** according to **their** own learning style, anytime and anywhere. In the context of 21st-century education, independence, and digital literacy are crucial for shaping adaptive and highly competitive students

Based on the three primary learning styles of visual, auditory, and kinesthetic, Figure 4 shows the students' electrical concept comprehension scores. The pretest scores, which are 54 for visual, 59 for auditory, and 55 for kinesthetic, show an almost equal range. Nonetheless, the posttest showed a significant improvement, with scores of 85, 89, and 87, respectively. The auditory learning style had the highest N-Gain score (73), followed by the kinesthetic (68) and visual (67) learning styles. This demonstrates that the problem-solving-based web-based learning approach benefits all learning styles and produces consistent improvement in every category. **These findings align with Ramezani et al. (2022), who emphasized that** problem-solving styles are positively associated with learning achievements across diverse cognitive approaches.



1
0***Jurnal Pendidikan MIPA, Volume (Issue), Year, Page-Page***

Figure 2. Results of pretest, posttest and N-gain Concept Understanding Based on Learning Style

The ability of web-based learning to present materials in various formats, including text, audio, video, and simulations, is directly tied to its success. While visual learners benefit from animations, diagrams, and visual simulations like PHET, auditory learners benefit from the use of video narration and discussion forums. Interactive elements such as virtual experiments offer kinesthetic learners an exploratory environment that mimics actual practice. El-Sabagh (2021) which emphasizes the importance of presenting content based on students' learning styles, supports these findings. Similarly, Jumadi et al. (2021) and Ramalingam et al. (2021) showed that online learning environments incorporating interactive labs and blended strategies enhance scientific reasoning and comprehension across varied learner profiles.

This study supports that of (Lin & Wu, 2021), who found that dynamic and interactive content in web-based science education can improve motivation and conceptual understanding. Furthermore, studies (Meng & Hong, 2024) demonstrate that digital media with an audiovisual component can significantly enhance the learning outcomes of students with diverse learning preferences. This highlights how equitable learning outcomes in diverse classrooms are facilitated by learning platforms that are sensitive to a range of learning styles. Reinforcing this, (Chen, 2024) underscores the importance of equity and differentiated instruction in achieving just educational outcomes. Additionally, Asad & Malik (2024) advocate for cybergogical approaches that blend inclusion and quality through adaptive learning in digital contexts.

Science teachers must create inclusive learning environments due to the variety of learning styles among their students. Differentiating the content is possible with web-based learning without altering the material's structure. Teachers can give students the freedom to select the learning strategies that work best for them and offer a variety of adaptable learning resources. This promotes the development of **21st-century skills**, including **digital proficiency, critical thinking, and self-directed learning**, while also enhancing conceptual understanding. In this regard, Maya & Suseno (2022) and Ichsana et al. (2023) all stress that integrating digital tools with 21st-century learning outcomes significantly enhances student preparedness. Moreover, Kathayat (2024) reveals that digital differentiation supports metacognitive development crucial for complex problem-solving.

A more individualized and flexible approach to learning is indirectly promoted by web-based learning. While visual and kinesthetic learners can select suitable animations or simulations, auditory learners can select audio-based content. This personalization accelerates the improvement of learning outcomes, enabling students to grasp complex concepts, such as electricity. This strategy aims to enhance the efficacy of science education in the digital age. As noted by Shabbir et al. (2021), personalization increases both short-term and long-term motivation. Studies by Ulya et al. (2024) further substantiate how technology-enhanced strategies empower learners through personalized inquiry and adaptive content delivery in science and math education.

Based on four motivation indicators (M1, M2, M3, and M4), Figure 5 displays the average percentage of students who are motivated to learn electrical concepts through a problem-solving approach. Overall, 88% of students were found to be encouraged to learn. The M3 indicator had the highest score, at 89%, while the other indicators ranged

from 87% to 88%. All aspects of student learning motivation fall into the very high category, according to the data, which suggests that the web-based learning strategy used in this study was successful in providing students with an interesting, demanding, and relevant learning environment. Similar results were highlighted in the work of Aboobaker & K.H. (2021) who emphasized the importance of intrinsic motivation and learner engagement in effective web-based environments.

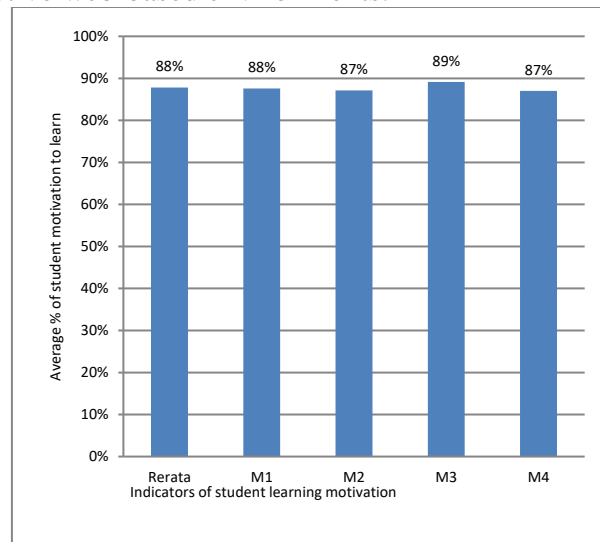


Figure 3 Student learning motivation scores in web-based learning

These findings are consistent with research by Asad et al. (2022), which found that using web-based learning resources can increase students' intrinsic motivation, particularly in conceptual subjects such as physics. They observed that students' motivation to learn rises dramatically when they believe they have control over the manner and speed of their education. In addition to giving students that freedom, the web-based learning approach employed in this study provides a platform for self-directed inquiry, which enhances their emotional investment in the educational process. This is reinforced by Özdal et al. (2022), who found that self-regulated learning skills significantly influence students' attitudes toward online learning, and (Doghan, 2023), who linked motivation to sustainable knowledge transfer.

A strong desire to learn is a necessary condition for science education to be successful, particularly when it comes to comprehending abstract and complex ideas. More motivated students are more eager to learn more, carry out investigations, and learn more about the scientific phenomena they are studying. This method strengthens the cognitive and affective components of the learning process by providing opportunities for both independent and group learning when teaching the concept of electricity. Lajane et al. (2021) demonstrated that formative e-assessment based on the ARCS model enhances student motivation, while Oluwajana et al. (2021) showed that web-based collaboration platforms can reduce cognitive load and boost engagement in project-based learning.

Given the effectiveness of this method in boosting motivation, science instructors are encouraged to incorporate web-based learning techniques into their lessons regularly. Web-based simulations, project-based assignments, and the creation of interactive content ought to be essential components of physics and science education in general. Students are more motivated and better equipped to handle the demands of 21st-century learning thanks to this approach's emphasis on visual, interactive, and contextual

1
2**Jurnal Pendidikan MIPA, Volume (Issue), Year, Page-Page**

components. According to Çoban & Göksu (2022), virtual reality environments can play a similar role in motivating learners, while Zourmpakis et al. (2023) highlight the motivational impact of adaptive gamification. Moreover, Shkëmbi et al. (2024) emphasize the broader psychological benefits of online education on student well-being and sustained motivation.

Figure 6 shows a structural model of the relationships between two latent variables: Latent Variable 1 (Understanding of Electrical Concepts) and Latent Variable 2 (Learning Motivation). Each conceptual understanding variable is measured using five indicators (PK1–PK5) and four indicators (M1–M4) for learning motivation. The fact that all of the indicators have factor loading values greater than 0.96 indicates that they are trustworthy and have a substantial impact on how the construct being measured is represented. The path coefficient value of 0.922 indicates a powerful relationship between learning motivation and the concept understanding variable. Electrical concept understanding explains 84.9% of the variation in learning motivation, according to the learning motivation R-square value of 0.849.

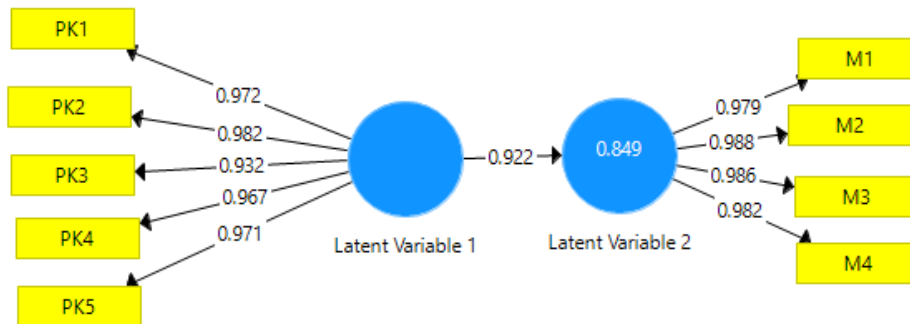


Figure 6 Structural Equation Model of Concept Understanding and Student Learning Motivation

This model illustrates how understanding electrical concepts through web-based learning significantly boosts students' motivation to learn. When students fully understand the material, especially in complex subjects like electricity, they feel more confident and motivated to learn more. The Self-Determination Theory (Deci & Ryan, 2012) supports this conclusion by asserting that competence is one of the basic psychological needs influencing intrinsic motivation. When students understand concepts through dynamic and engaging learning experiences, they will feel more capable and internally motivated. Edisherashvili et al. (2022) and Fauzizah et al. (2022) both emphasize the role of self-regulated learning in reinforcing this internal drive, particularly in technology-enhanced environments.

The idea that a web-based science learning design that emphasizes conceptual understanding can be used as a strategy to boost students' motivation to learn is empirically supported by this model. To design learning activities that foster deep understanding, science teachers should utilize interactive animations, virtual experiments, and simulations. Building knowledge through contextual learning experiences will increase students' motivation to learn, thereby improving the efficacy and sustainability of science education. This is echoed by Kusairi et al. (2022), who showed that integrating formative e-assessment in collaborative inquiry enhances conceptual comprehension.

25 According to this model, students should be encouraged to learn independently and with interest once they have a solid conceptual understanding. Students who have a solid conceptual understanding will be more motivated to study independently and go deeper into scientific material. Web-based learning, which provides users with access to a range of educational resources and interactive media, makes these opportunities possible. Therefore, this approach is efficacious in improving learning outcomes while also creating independent, motivated students who are well-prepared to meet the demands of education in the twenty-first century. Nonthamand & Suaklay (2021) highlight how digital literacy and self-regulated learning correlate with autonomy and improved outcomes.

12 Concurrently, the study's results indicate that student learning outcomes and motivation significantly improve when web-based learning, utilizing a problem-solving approach, is employed. The high posttest scores and N-Gain results demonstrate significant improvement in learning outcomes across almost all electrical concept understanding measures. Students' learning motivation also falls into the very high category, with an average percentage of 88% across the four motivation indicators. This finding implies that learning that is relevant, interactive, and tailored to the individual learning preferences of each student can simultaneously enhance affection and cognition. Phanphech et al. (2022) note that reduced anxiety in synchronous/asynchronous formats enhances engagement in physics learning.

The positive correlation between learning outcomes and motivation further supports the importance of an integrated learning approach. Web-based learning that uses simulations, visualizations, and virtual experiments not only enhances conceptual understanding but also creates a positive learning environment for students. This approach is perfect for use in the context of science education because it emphasizes observation, inquiry, and reflection—three essential elements of constructivist learning. The foundation of thorough and enduring learning may be the improvement of both cognition and affect. Porras (2021) and Rao et al. (2021) provide further support by explaining how self-regulation minimizes academic stress and fosters deeper cognitive processing.

18 The results of the study show that when web-based learning is combined with a problem-solving approach, students' understanding of electrical concepts and motivation to learn are both significantly and substantially enhanced. This approach simultaneously enhances students' cognitive and affective abilities, which aligns with 21st-century learning objectives that emphasize conceptual understanding, self-directed learning, and digital literacy. Regan et al. (2022) and Rusdi et al. (2023) underscore that mastery in science involves adaptive learning behaviors and digital competencies.

Students demonstrate strong interpretative and explanatory abilities, in addition to understanding basic concepts such as current and voltage, as evidenced by the N-Gain values for all electrical concepts, which show a significant improvement in post-test scores. The N-Gain categories, which mostly fall within the medium to high level, particularly on the concept explanation indicator in Bloom's taxonomy, demonstrate how the learning process can produce a profound understanding. These conclusions are supported by data on student learning motivation, which indicates an average score of 88%, with all indicators falling into the very high category. This demonstrates that the employed learning strategy not only enhances learning outcomes but also provides students with an enjoyable, challenging, and rewarding educational experience.

1
4***Jurnal Pendidikan MIPA, Volume (Issue), Year, Page-Page***

One of the key factors contributing to the success of web-based learning is its capacity to accommodate different learning styles. Students with fairly evenly distributed visual, auditory, and kinesthetic learning styles all show a significant improvement in conceptual understanding after the learning process. Because the content is presented in a variety of formats, such as text, audio, animation, and interactive simulations, students are free to choose the learning strategy that best suits their preferences. The principles of Universal Design for Learning (Munfaridah et al., 2021), which emphasize the importance of presenting a range of information so that all students can access and use it, are consistent with this approach. Weruwanaruk et al. (2023) extend this by showing that flipped metaverse-based designs enhance conceptual understanding and engagement through learning personalization.

Furthermore, this learning model contributes to enhancing digital literacy and promoting student autonomy in their education. Students who have access to a range of online learning resources are better able to adjust to learning at their speed, complete assignments on time, and conduct independent research. This corroborates the results of Hasas et al. (2024), who discovered that digital learning fosters learning responsibility and intellectual inquiry. Instead of merely relying on the teacher's explanations, students in this environment develop into active learners who create knowledge via introspective and exploratory experiences. Utari et al. (2023) confirm that improving self-regulation directly boosts conceptual understanding, particularly when supported by structured learning models like POGIL.

CONCLUSION

This study explores the effectiveness of web-based problem-solving learning integrated with PhET simulations in enhancing students' conceptual understanding and motivation on the topic of electrical circuits. Utilizing a descriptive method, the study involved 30 students from a private university in Palembang who engaged in web-based instruction supported by interactive simulations and contextual problem-solving activities. Data were collected through a learning style questionnaire, a concept understanding test, and a motivation questionnaire administered via Google Forms. The results revealed a significant increase in students' posttest scores across five indicators of conceptual understanding—electric current, potential difference, resistance, Ohm's Law, and circuit configuration—with N-Gain values ranging from moderate to high. Notably, students with auditory and kinesthetic learning styles showed slightly higher gains. Learning motivation also demonstrated a very high category, with 88% of students indicating strong interest and persistence in the learning process. Structural model analysis showed a strong relationship between conceptual understanding and motivation (path coefficient = 0.922), suggesting that improved understanding directly enhances motivation. The integration of web-based platforms and PhET simulations not only facilitated flexible and personalized learning experiences but also supported students' engagement, exploration, and self-regulation. These findings highlight the potential of technology-enhanced science instruction to bridge cognitive and affective learning domains, making it a valuable approach for future pedagogical innovations in physics education.

REFERENCES

- Abdamia, N., Puteh, F., & Jah, N. J. A. (2023). Investigating Learning Modalities Among Diploma Students. *International Journal of Academic Research in Progressive Education and Development*, 12(2).
<https://doi.org/10.6007/ijarped/v12-i2/16552>
- Aboobaker, N., & K.H., M. (2021). Effectiveness of Web-Based Learning Environment: Role of Intrinsic Learning Motivation, Computer Self-Efficacy, and Learner Engagement. *Development in Learning Organizations an International Journal*, 36(4), 13–16. <https://doi.org/10.1108/dlo-07-2021-0139>
- Afolabi, F. (2021). Learning styles: Tools for understanding media selection and learners' academic achievement in physics. *Journal of Educational Sciences*, 5(4), 584–597.
- Alimah, S. (2023). Profile of Culinary Vocational School Students' Learning Styles as a Basis for Choosing Science Learning Methods. *Journal of Mangifera Edu*, 8(1), 25–31. <https://doi.org/10.31943/mangiferaedu.v8i1.174>
- Amiri, F., Quraishi, T., Hakimi, M., & Fazil, A. W. (2024). Assessing the Efficiency of Web-Hosted E-Learning Platforms in Afghanistan Academic Settings. *Edutrend*, 1(1), 39–56. <https://doi.org/10.59110/edutrend.309>
- Anisa, V. M., & Astriani, D. (2022). Implementation of PhET Simulation With Discovery Learning Model to Improve Understanding of Dynamic Electricity Concepts. *Jurnal Pijar Mipa*, 17(3), 292–301.
<https://doi.org/10.29303/jpm.v17i3.3438>
- Arni, Y., Utami, W. W., Khoirunnisak, L., & Amelia, F. (2024). The Effect of Visual, Auditory, Kinesthetic Learning Styles on Student Learning Outcomes in Science Subjects. *Journal of Education and Teaching Learning (Jetl)*, 6(1), 119–129.
<https://doi.org/10.51178/jetl.v6i1.1794>
- Asad, M. M., Khan, S., Sherwani, F., & Banerjee, J. S. (2022). Impact of asynchronous Web-based learning environment on students' interest and motivation in mathematics: a quantitative research study. *The International Journal of Information and Learning Technology*, 39(4), 340–359.
- Asad, M. M., & Malik, A. (2024). Educational Quality and Inclusion Through Collaborative Hybridized Cybergogy: Transformative Learning Horizons in Pakistani Universities. *Interactive Technology and Smart Education*, 21(4), 672–689. <https://doi.org/10.1108/itse-10-2023-0193>
- Astalini, A., Darmaji, D., Kurniawan, D. A., Jaya, H., & Husna, S. M. (2022). Analysis of Teacher Responses to the Use of Web-Based Assessment to Assess Students' Attitudes Towards Science Subjects. *Integrated Science Education Journal*, 3(3), 66–71. <https://doi.org/10.37251/isej.v3i3.282>
- Ayub, S., Karim, A., & Laraib, A. (2023). Learning Styles of Medical Students. *The Professional Medical Journal*, 30(09), 1214–1218.
<https://doi.org/10.29309/tpmj/2023.30.09.7650>
- Banda, H. J., & Nzabahimana, J. (2021). Effect of integrating physics education technology simulations on students' conceptual understanding in physics: A review of literature. *Physical Review Physics Education Research*, 17(2), 023108.
- Batsaikhan, A., Kurtz, W., & Hachinger, S. (2022). Web Technologies to Support Scientific Research and Education in Citizen Science—A Case Study in Germany. *Digital*, 2(1), 53–64. <https://doi.org/10.3390/digital2010004>

- Berenshtein, Y., Tesler, R., Hochwald, I. H., & Green, G. (2023). The Perspectives of Health Sciences Students the New Way of Learning: Mixed Methods Design. *Digital Health, 9*. <https://doi.org/10.1177/20552076231216539>
- Chinnasami Sivaji, M. R., Murugan, A., & Raja, C. (2022). Instructional Design of Collaborative Learning Environments. *Journal on Innovations in Teaching and Learning, 1*(1), 1–8.
- Choi, Young-Rim, Lee, Y., Kim, Dayeong, Park, Won H, Kwon, Dai Y, & Chang, Sung O. (2022). An E-Problem-Based Learning Program for Infection Control in Nursing Homes: A Quasi-Experimental Study. *International Journal of Environmental Research and Public Health, 19*(20), 13371. <https://doi.org/10.3390/ijerph192013371>
- Chua, E. R., Sibbaluca, B. G., Mack, M. R., & Militante, S. V. (2020). Technological strategies in teaching: Towards the design of virtual learning environment. *International Journal of Scientific and Technology Research*.
- Çoban, M., & Göksu, İ. (2022). Using Virtual Reality Learning Environments to Motivate and Socialize Undergraduates in Distance Learning. *Participatory Educational Research, 9*(2), 199–218. <https://doi.org/10.17275/per.22.36.9.2>
- Deci, E. L., & Ryan, R. M. (2012). Self-determination theory. *Handbook of Theories of Social Psychology, 1*(20), 416–436.
- DeCoito, I., & Estaiteyeh, M. (2022). Online Teaching During the COVID-19 Pandemic: Exploring Science/Stem Teachers' Curriculum and Assessment Practices in Canada. *Disciplinary and Interdisciplinary Science Education Research, 4*(1). <https://doi.org/10.1186/s43031-022-00048-z>
- Doghan, M. A. A. (2023). Prediction of Sustainable Environment Training Towards Knowledge Transfer Through Motivation to Learn. *Journal of Law and Sustainable Development, 11*(12), e2255. <https://doi.org/10.55908/sdgs.v11i12.2255>
- Doyle, C., Chiu, Y.-T., Nagle, T., & Luczak-Roesch, M. (2023). *Unraveling the Relationship Between Content Design and Kinesthetic Learning on Communities of Practice Platforms*. <https://doi.org/10.24251/hicss.2023.079>
- Drake, S. M., & Savage, M. J. (2016). Negotiating Accountability and Integrated Curriculum from a Global Perspective. *International Journal of Learning, Teaching and Educational Research, 15*(6), 127–144.
- Edisherashvili, N., Saks, K., Pedaste, M., & Leijen, Ä. (2022). Supporting Self-Regulated Learning in Distance Learning Contexts at Higher Education Level: Systematic Literature Review. *Frontiers in Psychology, 12*. <https://doi.org/10.3389/fpsyg.2021.792422>
- El-Sabagh, H. A. (2021). Adaptive e-learning environment based on learning styles and its impact on development students' engagement. *International Journal of Educational Technology in Higher Education, 18*(1), 53.
- Fahim, A., Rehman, S., Fayyaz, F., Javed, M., Alam, M. A., Rana, S., Jafari, F. H., & Alam, M. K. (2021). Identification of Preferred Learning Style of Medical and Dental Students Using VARK Questionnaire. *Biomed Research International, 2021*(1). <https://doi.org/10.1155/2021/4355158>
- Fauzizah, U., Nurhayati, N. D., & Masykuri, M. (2022). The Relationship Between Self-Regulated Learning and Technology Literacy With Conceptual Understanding

- of Salt Hydrolysis. *J-Pek (Jurnal Pembelajaran Kimia)*, 7(2), 99–107.
<https://doi.org/10.17977/um026v7i22022p099>
- Fendi, R. D., Suyatna, A., & Abdurrahman, A. (2021). Augmented Reality-Based Student Worksheet to Stimulate Students' Critical Thinking Skills. *Indonesian Journal of Science and Mathematics Education*, 4(2), 118–133.
<https://doi.org/10.24042/ij sme.v4i2.9017>
- Fitriyani, Y., Fauzi, I., & Sari, M. Z. (2020). Motivasi Belajar Mahasiswa Pada Pembelajaran Daring Selama Pandemi Covid-19. *Profesi Pendidikan Dasar*, 7(1), 121–132. <https://doi.org/10.23917/ppd.v7i1.10973>
- Fraenkel, J. R., & Wallen, N. E. (2009). *How to Design and Evaluate Research in Education*. McGraw-Hill Companies, Inc.
- Goodyear, P., Carvalho, L., & Yeoman, P. (2021). Activity-Centred Analysis and Design (ACAD): Core Purposes, Distinctive Qualities and Current Developments. *Educational Technology Research and Development*, 69(2), 445–464.
<https://doi.org/10.1007/s11423-020-09926-7>
- Hakim, L., Lubis, P. H. M., & Khaokhajorn, W. (2022). Developing the adaptive materials based on learning style to increase student's conceptual understanding. *Jurnal Kependidikan*, 6(1), 115–128.
- Hasas, A., Enayat, W., Hakimi, M., & Ahmady, E. (2024). A comprehensive review of ict integration in enhancing physics education. *MAGNETON: Jurnal Inovasi Pembelajaran Fisika*, 2(1), 36–44.
- Ichsan, I., Suharyat, Y., Santosa, T. A., & Satria, E. (2023). Effectiveness of STEM-Based Learning in Teaching 21 St Century Skills in Generation Z Student in Science Learning: A Meta-Analysis. *Jurnal Penelitian Pendidikan Ipa*, 9(1), 150–166. <https://doi.org/10.29303/jppipa.v9i1.2517>
- Inam, S., & Haq, A. (2022). Exploring the Preferred Learning Styles Among First and Final Year MBBS Students Using VARK Inventory at Fauji Foundation Hospital Rawalpindi. *Health Professions Educator Journal*, 5(1), 9–13.
<https://doi.org/10.53708/hpej.v5i1.1257>
- Jumadi, J., Perdana, R., Riwayani, R., & Rosana, D. (2021). The Impact of Problem-Based Learning With Argument Mapping and Online Laboratory on Scientific Argumentation Skill. *International Journal of Evaluation and Research in Education (Ijere)*, 10(1), 16. <https://doi.org/10.11591/ijere.v10i1.20593>
- Kalogiannakis, M., Papadakis, S., & Zourmpakis, A.-I. (2021). Gamification in Science Education. A Systematic Review of the Literature. *Education Sciences*, 11(1), 22.
<https://doi.org/10.3390/educsci11010022>
- Kasiry, F., & Wok, S. (2023). Factors Influencing the Usage of Web-based Video Conferencing Platforms in Knowledge Acquisition Among Students. *International Social Science Journal*, 73(248), 261–277. <https://doi.org/10.1111/issj.12392>
- Kathayat, B. B. (2024). Metacognitive Skills in Mathematics Learning: A Systematic Review of Literature. *J. Musikot Campus*, 2(1), 41–57.
<https://doi.org/10.3126/jmc.v2i1.70785>
- Kırıkaya, E. B., & Yıldırım, İ. (2021). Investigating the Effect of the Use of Web 2.0 Tools in 7th Grade on Students' Academic Achievements and Their Self-Directed Learning With Technology Levels. *Journal of Turkish Science Education*, 18(3), 439–460. <https://doi.org/10.36681/tused.2021.83>

- Kusairi, S., Muhamad, S., Razak, N. A., & Trapsila, A. P. (2022). The Role of Local Wisdom “Ugahari” and The Impact of Internet and Mobile Technology on Work-Life-Balance During COVID-19 Outbreak: Data Set From Malaysian Workers.” *Data in Brief*, *40*, 1–8. <https://doi.org/10.1016/j.dib.2021.107779>
- Lajane, H., Arai, M., Gouifrane, R., Qaisar, R., Idrissi, W. E. machtani El, Chems, G., & Radid, M. (2021). A Scenario of the Formative E-Assessment Based on the ARCS Model: What Is the Impact on Student Motivation in Educational Context? *International Journal of Emerging Technologies in Learning (Ijet)*, *16*(24), 135–148. <https://doi.org/10.3991/ijet.v16i24.24121>
- Lane, B., Garousi-Nejad, I., Gallagher, M. A., Tarboton, D. G., & Habib, E. (2021). An Open Web-based Module Developed to Advance Data-driven Hydrologic Process Learning. *Hydrological Processes*, *35*(7). <https://doi.org/10.1002/hyp.14273>
- Lehman, M. E. (2019). Using VARK learning styles to predict instructional preferences. *NACTA Journal*, *63*(2), 109–114.
- Ma, J., Johnson, E. A., & McCrory, B. (2023). Understanding Learning Engagement With User-Centered Human-Computer Interaction in a Multimodal Online Learning Environment. *Proceedings of the Human Factors and Ergonomics Society Annual Meeting*, *67*(1), 2018–2023. <https://doi.org/10.1177/21695067231193675>
- Maunula, M., Maunumäki, M., Marôco, J., & Harju-Luukkainen, H. (2023). Developing Students Well-Being and Engagement in Higher Education During COVID-19—A Case Study of Web-Based Learning in Finland. *Sustainability*, *15*(4), 3838. <https://doi.org/10.3390/su15043838>
- Maya, L., & Suseno, M. (2022). Investigating the Incorporation of Digital Literacy and 21st-Century Skills Into Postgraduate Students’ Learning Activities. *Ele Reviews English Language Education Reviews*, *2*(1), 13–27. <https://doi.org/10.22515/elereviews.v2i1.5121>
- Munfaridah, N., Avraamidou, L., & Goedhart, M. (2021). The use of multiple representations in undergraduate physics education: what do we know and where do we go from here? *Eurasia Journal of Mathematics, Science and Technology Education*, *17*(1), em1934.
- Nonthamand, N., & Suaklay, N. (2021). Self-Regulation Students’ Online Learning Behavior in General Education Courses of University of Phayao. *International Journal of Emerging Technologies in Learning (Ijet)*, *16*(14), 269. <https://doi.org/10.3991/ijet.v16i14.19897>
- Oluwajana, D., Adeshola, I., & Clement, S. (2021). Does the Use of a Web-Based Collaborative Platform Reduce Cognitive Load and Influence Project-Based Student Engagement? *Current Psychology*, *42*(10), 8265–8278. <https://doi.org/10.1007/s12144-021-02145-0>
- Önder, E. Y., Zorluoğlu, S. L., Demirer, V., Özdemir, M., Baturay, M. H., Timur, S., & Timur, B. (2023). Needs Analysis for a Web-Based Learning System to Develop Students’ Science Process Skills. *Shanlax International Journal of Education*, *11*(S1-July), 37–53. <https://doi.org/10.34293/education.v11is1-july.5844>
- Özdemir, H., Özden, C., Atasoy, R., & Güneşli, A. (2022). Effectiveness of Self-Regulated Learning Skills on Web-Based Instruction Attitudes in Online Environments. *Pepegog*, *12*(1). <https://doi.org/10.47750/pepegog.12.01.18>

- Pertiwi, N. P., Saputro, S., Yamtinah, S., & Kamari, A. (2024). Enhancing Critical Thinking Skills through STEM Problem-Based Contextual Learning: An Integrated E-Module Education Website with Virtual Experiments. *Journal of Baltic Science Education*, 23(4), 739–766.
- Phanphech, P., Tanitteerapan, T., Mungkung, N., Arunrungrusmi, S., Chunkul, C., Songruk, A., Yuji, T., & Kinoshita, H. (2022). An Analysis of Student Anxiety Affecting on Online Learning on Conceptual Applications in Physics: Synchronous vs. Asynchronous Learning. *Education Sciences*, 12(4), 278. <https://doi.org/10.3390/educsci12040278>
- Porras, J. F. C. (2021). Self-Regulated Learning and Academic Stress in University Students. *Revista Gestão Inovação E Tecnologias*, 11(3), 719–726. <https://doi.org/10.47059/revistageintec.v11i3.1970>
- Pradana, F., Setyosari, P., & Ulfa, S. (2023). Development of Gamification-Based E-Learning on Web Design Topic. *International Journal of Interactive Mobile Technologies*, 17(3).
- Rahmawati, O. S., Hartono, H., & Nugroho, K. Y. (2024). EFL Students' Anxiety in Writing Scientific Papers for Publication: Levels and Types. *Journal of Advanced Multidisciplinary Research*, 5(2), 133. <https://doi.org/10.30659/jamr.5.2.133-143>
- Ramalingam, S., Yunus, M. M., & Hashim, H. (2021). Exploring ESL Learners' Blended Learning Experiences and Its' Effectiveness Through Web-Based Technologies. *International Journal of Evaluation and Research in Education (Ijere)*, 10(4), 1436. <https://doi.org/10.11591/ijere.v10i4.21465>
- Ramezani, G., Norouzi, A., Arabshahi, S. K. S., Sohrabi, Z., Zazoly, A. Z., Saravani, S., & Pourbairamian, G. (2022). Study of Medical Students' Learning Approaches and Their Association With Academic Performance and Problem-Solving Styles. *Journal of Education and Health Promotion*, 11(1), 252. https://doi.org/10.4103/jehp.jehp_900_21
- Rao, X., Luo, L., Su, Q., & Wang, X. (2021). *Online Study: Understanding the Laws of Self-Regulated Study*. <https://doi.org/10.21203/rs.3.rs-775791/v1>
- Regan, L., Hopson, L. R., Gisondi, M. A., & Branzetti, J. (2022). Creating a Better Learning Environment: A Qualitative Study Uncovering the Experiences of Master Adaptive Learners in Residency. *BMC Medical Education*, 22(1). <https://doi.org/10.1186/s12909-022-03200-5>
- Roski, M., Ewerth, R., Hoppe, A., & Nehring, A. (2024). Exploring Data Mining in Chemistry Education: Building a Web-Based Learning Platform for Learning Analytics. *Journal of Chemical Education*, 101(3), 930–940. <https://doi.org/10.1021/acs.jchemed.3c00794>
- Rusdi, R., Ristanto, Rizhal H., Prabowo, G. O., & Sarwono, E. (2023). Self-Regulated Learning and Digital Literacy: Relationship With Conceptual Understanding of Excretory System. *Journal of Science Learning*, 6(1), 1–10. <https://doi.org/10.17509/jsl.v6i1.47269>
- Safar, N. Z. M., Kamaludin, H., Ahmad, M., Jofri, M. H., Wahid, N., & Gusman, T. (2022). Intervention strategies through interactive gamification e-learning web-based application to increase computing course achievement. *JOIV: International Journal on Informatics Visualization*, 6(2), 376–381.
- Sardiman, A. M. (2012). *Interaksi dan Motivasi Belajar Mengajar*. PT Raja Garafindo Persada.

- Shabbir, S., Ayub, M., Khan, F. A., & Davis, J. (2021). Short-Term and Long-Term Learners' Motivation Modeling in Web-Based Educational Systems. *Interactive Technology and Smart Education*, 18(4), 535–552. <https://doi.org/10.1108/itse-09-2020-0207>
- Shkëmbi, F., Sauku, V. H., Ibrahim, S., & Ibrahim, E. (2024). The Psychological Impact of Online Education on Student Well-Being and Motivation. *Issej*, 2(2), 01–08. <https://doi.org/10.61424/issej.v2i2.122>
- Siddiquei, N. L., & Khalid, R. (2021). Development and Validation of Learning Style Scale for E-Learners. *Sage Open*, 11(2). <https://doi.org/10.1177/21582440211022324>
- Simamora, R. M., De Fretes, D., Purba, E. D., & Pasaribu, D. (2020). Practices, challenges, and prospects of online learning during Covid-19 pandemic in higher education: Lecturer perspectives. *Studies in Learning and Teaching*, 1(3), 185–208.
- Subagja, S., & Rubini, B. (2023). Analysis of Student Learning Styles Using Fleming's VARK Model in Science Subject. *Jurnal Pembelajaran Dan Biologi Nukleus*, 9(1), 31–39. <https://doi.org/10.36987/jpbn.v9i1.3752>
- Sudiby, E., Jatmiko, B., & Widodo, W. (2017). Pengembangan Instrumen Motivasi Belajar Fisika: Angket. *Jurnal Penelitian Pendidikan IPA*, 1(1), 13. <https://doi.org/10.26740/jppipa.v1n1.p13-21>
- Ulya, H., Sugiman, S., Rosnawati, R., & Retnawati, H. (2024). Technology-Based Learning Interventions on Mathematical Problem-Solving: A Meta-Analysis of Research in Indonesia. *International Journal of Evaluation and Research in Education (Ijere)*, 13(1), 292. <https://doi.org/10.11591/ijere.v13i1.26380>
- Umbrella, G. (2024). Identify the Learning Styles of St. Anthony Junior High School Students in the 2023/2024 Academic Year. *Armada*, 1(3), 151–158. <https://doi.org/10.59613/armada.v1i3.2852>
- Utari, A. P., Hasan, M., Adlim, M., & Elisa, E. (2023). Correlation Between Improving Self-Regulated and Students' Conceptual Understanding of Colloidal Topics Using POGIL Approach. *Jurnal Penelitian Pendidikan Ipa*, 9(9), 7317–7325. <https://doi.org/10.29303/jppipa.v9i9.4906>
- Vieira, A., Vidal, M., Menassol, J.-B., Mateus, T. L., Santos, A. S., Durieux, J.-P., & Oliveira, M. D. (2022). ANIPHI: An Innovative Pedagogical Platform Based on the Delphi Method to Support Animal Welfare Teaching. *Plos One*, 17(11), e0277189. <https://doi.org/10.1371/journal.pone.0277189>
- Weruwanaruk, P., Kanjung, I., Sarakorn, W., & Moeikao, N. (2023). The Designing Framework for Flipped Learning Environment on Metaverse to Enhance Mathematical Conceptual Understanding for Seven Grade Students. *Iiai Letters on Institutional Research*, 3, 1. <https://doi.org/10.52731/lir.v003.141>
- Wulandari, A., Hakim, L., Sulistyowati, R., & Mian, Y. (2022). *Interactive multimedia development using Google Sites to improve student learning outcomes and energy*. *EDUSAINS*, 14 (2), 188-201.
- Yusnidah, Y., Hidayat, M. I., & Maulana, D. (2023). The Effectiveness of Using Interactive Learning Media Based on the Google Sites Website on Dynamic Electricity Material. *Jurnal Sinestesia*, 13(2), 941–947.
- Zahara, S. R., Imanda, R., Alvina, S., Sirait, A. F., Irsyat, M., & Harahap, M. A. (2024). Web-Based Science Learning Media at High School Level. *Proceedings of*



International Conference on Social Science Political Science and Humanities (Icospolhum), 4, 00033. <https://doi.org/10.29103/icospolhum.v4i.410>

Zhu, L. (2023). Exploring the Implementation Path of Teaching Civics in Online Courses in Colleges and Universities Under the Background of Big Data. *Applied Mathematics and Nonlinear Sciences*, 9(1). <https://doi.org/10.2478/amns.2023.2.00530>

Zourmpakis, A.-I., Kalogiannakis, M., & Papadakis, S. (2023). *Adaptive Gamification in Science Education: An Analysis of the Impact of Implementation and Adapted Game Elements on Students' Motivation*. <https://doi.org/10.20944/preprints202306.1513.v1>

▪