PhET Simulation Worksheet for Momentum and Impulse Learning Using the POE2WE Model

Muhamad Aqil Ridho, Khusaini* & Sunaryono
Department of Physics, Malang States University, Indonesia
*Corresponding author: khusaini.fmipa@um.ac.id

Received: 18th November 2024; **Accepted**: 16th December 2024; **Published**: 30th December 2024
DOI: https://dx.doi.org/10.29303/jpft.v10i2.8042

Abstract *- This study examines the feasibility and student responses to worksheets based on PhET simulations integrated with the POE2WE (Predict, Observe, Explain, Elaborate, Write, Evaluate) learning model for teaching momentum and impulse. The research employed a 4D development model and involved expert validators, practitioners, and 30 eleventh-grade students from a high school in Pasuruan. Data were collected using validation and student response questionnaires and analyzed descriptively. The results indicate that the developed worksheets were highly feasible for use in physics learning, as reflected in the validation score of 87.6%, categorized as "extremely feasible." Furthermore, student responses to the use of these worksheets during the learning process yielded a score of 89%, categorized as "practical." These findings suggest that integrating PhET simulations with the POE2WE learning model not only enhances the feasibility of the worksheets but also significantly supports the learning process by encouraging active participation and engagement among students. PhET simulations provide an interactive and visually appealing approach to understanding abstract physics concepts like momentum and impulse. Combined with the structured stages of the POE2WE model, the worksheets guide students to predict, observe phenomena, explain concepts, and evaluate their understanding systematically. This structured approach aligns with the needs of modern physics education, emphasizing inquiry-based learning and critical thinking skills. In conclusion, the integration of PhET simulations and the POE2WE learning model in worksheets demonstrates a highly effective and innovative strategy for teaching the concepts of momentum and impulse in physics. The combination of interactive simulations and the structured learning approach not only enhances students' engagement but also fosters a deeper conceptual understanding of the material. Furthermore, the high feasibility of implementation, coupled with overwhelmingly positive student responses, highlights its potential to significantly improve learning outcomes. This approach serves as a valuable resource for educators aiming to create dynamic and impactful learning experiences, ultimately contributing to the advancement of physics education.*

Keywords*: Student worksheet; PhET Simulation; POE2WE Model; Momentum & Impulse; High Quality Education*

INTRODUCTION

Practicum as a laboratory practice is one of the important aspects in physics learning for the students. Thus, theoretical concepts of physics must be tested and verified through hands-on lab work (Alatas & Solehat, 2022). In addition, practicum provides opportunities for students to observe physical phenomena directly, collect data, and analyse the results (Mulia & Murni, 2022). Through practicum, students not only understand the theory more deeply, but also develop critical skills such as problem solving, data analysis, and teamwork (Sarjono, 2018). Therefore, practicum is an integral part of physics learning that helps bridge between theory and real applications in everyday life, such as understanding to concepts of momentum and impulse in various situations (Pertiwi et al., 2020).

The concept of momentum and impulse is one of the important foundations in understanding the dynamics of an object's motion. However, this concept is considered complex and abstract by many students (Pricillya et al., 2022). Overcoming these difficulties, verification of concepts through

laboratory practice is a very crucial step (Wahyudiati, 2016). Through the practicum, students not only memorise formulas, but also build a deeper understanding of the relationship between force, mass and velocity (Rahayuningsih et al., 2023). This understanding is achieved with worksheets that ensure effective and purposeful experimentation (Syarkowi et al., 2023).

Worksheets are a very important component in practical activities. Practical worksheets help students understand the experimental steps and learning objectives clearly (Kristanta, 2021). With the worksheet, students can collect and organise their data systematically (Safitri et al., 2020). Worksheets also allow students to follow lab procedures precisely, reduce errors, and increase the accuracy of experimental results (Lestari & Muchlis, 2021). In addition, the worksheet facilitates students in analysing and concluding the data they have collected (Taofek & Agustini, 2020). Therefore, the use of worksheets is an integral part of practical activities that help students achieve learning objectives effectively (Ramadhan et al., 2020).

Existing practicum worksheets often face limitations in effectively supporting student activities and fostering a deep understanding of concepts (Fitri et al., 2024). Many worksheets focus excessively on experimental procedures without encouraging critical or creative thinking (Yunita & Nana, 2020). Additionally, most physics practicum worksheets remain paper-based, limiting accessibility and flexibility, whereas digital worksheets offer advantages such as easier data entry, analysis, and integration with simulations or digital tools (Palupi & Pujianto, 2021; Suryaningsih & Nurlita, 2021). Integrating PhET simulations in digital worksheets offers an innovative solution to overcome the limitations of physical labs by enabling virtual experiments, providing interactive visualizations of physical phenomena, and supporting flexible, adaptive learning to enhance the quality of physics education (Banda & Nzabahimana, 2021; Hendikawati et al., 2019; Theasy et al., 2021)

There is a need for research on the integration of PhET digital simulations into digital-based practicum activities using appropriate learning models. One of the appropriate learning models to be integrated with the PhET simulation is the POE2WE learning model (Prediction, Observation, Explanation, Elaboration, Write and Evaluation*)* (Nana & Rizki, 2020). The POE2WE learning model is an effective approach in improving concept understanding through in-depth experimentation and reflection (Fajriyah & Jatmiko, 2021). This research is important because PhET provides a platform that allows students to apply the POE2WE model virtually, starting from predicting experimental results, observing phenomena, explaining results, and making a second observation (Aryuansyah et al., 2022).

The purpose of this study was to develop Student Worksheets in PhET-based virtual practicum integrated with the POE2WE model. The results of this study can provide new insights into the form of Student Worksheets based on PhET simulations that are effective and able to overcome various problems that occur.

RESEARCH METHODS

This study adopted the 4D development model (Define, Design, Develop, Disseminate), focusing on the development phase. Data were collected using validation sheets completed by experts and response questionnaires distributed to 30 students. Feasibility was rated on a Likert scale, and the results were categorized into predetermined criteria.

The response questionnaire for this feasibility assessment has five assessment criteria, namely: very feasible, feasible, feasible enough, less feasible, and not feasible. Each has a different score that indicates the level of feasibility. The validity and practicality tests were analysed by presenting percentages and grouped into criteria in Table 1 and Table 2.

$$P = \frac{\sum X}{\sum Xi} \text{ x } 100\%$$

Description:
P = Percentage of each criterion
$\sum X$ = Scores obtained from each aspect
$\sum Xi$ = Maximum score of each aspect

Table 1. Percentage of Feasibility Criteria

Percentage of Feasibility Criteria	Feasibility Level
81% - 100%	Extremely Feasible
61 % - 80 %	Feasible
41 % - 60 %	Averagely Feasible
21 % - 40 %	Less Feasible
< 20%	Not Feasible

(Partono et al., 2021)

Table 2. Practical Test Criteria

Percentage (%)	Criteria
85 – 100	Practical
70 – 84	Averagely Practical
55 – 69	Less Practical
< 55	Not Practical

(Rezeki et al., 2021)

RESULTS AND DISCUSSION

The results of this development research are in the form of student worksheets assisted by PhET Simulation with the POE2WE learning model. This student worksheet was created and designed directly by researchers to make it easier for educators to prepare teaching materials, improve students' ability to conduct and carry out a virtual practicum in physics learning.

The development model used in this research is 4D developed by Thiagarajan. Define. In the defined stage, the first step taken by the researcher was to identify and determine the main problems faced in the learning process. Researchers analysed various important aspects, including Learning Outcomes (LO), achievement indicators, and expected learning objectives. This analysis was carried out by adjusting the curriculum standards applicable at high school so that the learning process can run in accordance with applicable educational policies. In addition, the researcher also conducted an in-depth analysis of the learners' characteristics. Through this analysis, researchers try to understand the needs, abilities, learning styles, and potential of each learner. This is very important to design learning strategies that are effective, relevant and able to accommodate individual differences in achieving optimal learning goals.

Design. The activities conducted at this stage include test preparation, media selection, format selection, and the creation of the initial product design. The findings from the define stage were used as a reference for developing the initial product design. In making this PhET simulation-assisted student worksheet using POE2WE model, researchers refer to the curriculum used by the school, namely the Merdeka Curriculum. This practicum module is used in physics learning which aims to help improve students' creative thinking and learning outcomes in learning physics. In the initial design stage, researchers compiled the content that would be in the practicum module created. These contents include Learning Outcomes (CP), concept maps, problem identification, momentum and impulse material, several practicums to be carried out, evaluation, references and author history.

Develop. At this stage, the activities carried out include product validation and product trials. The initial product design that has been made then goes through a validation process by experts in related fields to ensure the quality and suitability of the product with the development objectives. In addition, validation is also carried out through a practitioner, who provides feedback and suggestions for improvement. Expert validation was selected from Malang State University lecturers and the results of the validation were in the form of assessments and suggestions for product improvement. The product trial aims to obtain student responses to the developed student worksheet. Student responses were used to revise the product, to produce the final product.

The result of the development stage is the final product in the form of student worksheet momentum and impulse assisted by PhET simulation with POE2WE learning model. Figure 1 shows the initial appearance of the student worksheet. The cover display also displays visualizations related to momentum and impulse material to increase student interest.

Figure 1. Initial View of Student Worksheet

Figure 2 shows the part of the student worksheet where students are invited to make initial predictions about the phenomenon of momentum and impulse before conducting simulations. In this section, students are given questions or hypothetical situations that require them to think about the possible outcomes of the experiments they will conduct. This stimulated students to start thinking critically and activate their prior knowledge.

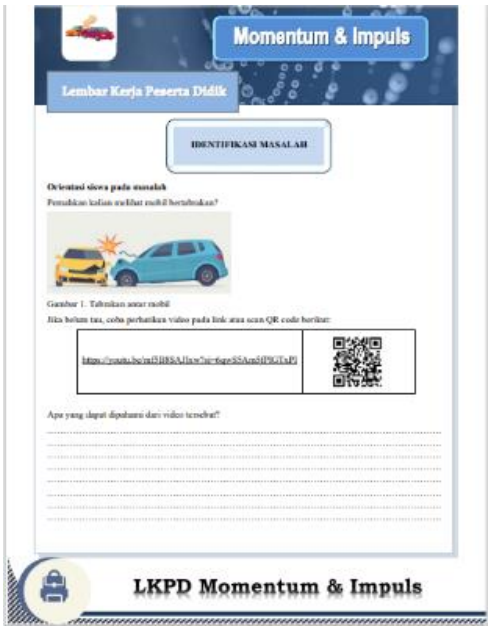

Figure 2. Integration of Student Worksheet with POE2WE Model Syntax (Prediction)

In Figure 3, students are led to make observations of the PhET simulation. The student worksheet provides specific instructions that students should follow during observations, such as noticing how changes in mass or velocity affect momentum and impulse in objects. This section emphasizes the importance of careful observation to understand the relationship between variables that exist in physical phenomena. Next, students are asked to explain their observations. They must compose an explanation based on the data

they have collected from the PhET simulation. The student worksheet provides sufficient space for students to write logical arguments and scientific explanations regarding the concepts learned, such as the relationship between force, impact time, and momentum change.

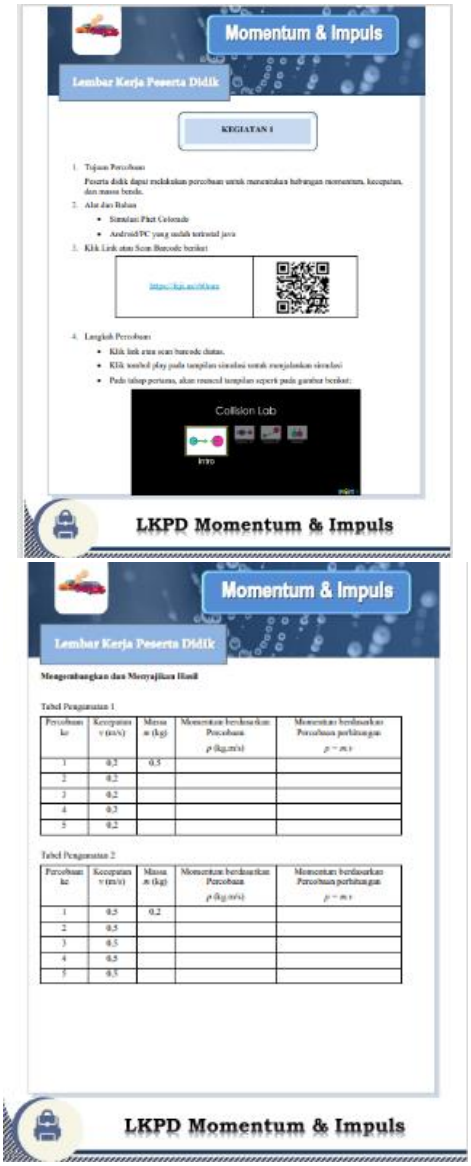

Figure 3. Integration of Student Worksheet with POE2WE Model Syntax (Observation & Explanation)

Figure 4 shows the elaboration stage, where the student worksheet directs students to develop further understanding by presenting more complicated scenarios or contextual problems. At this stage, students are invited to apply the concepts they have learned in real situations or more challenging problems. PhET simulation is again used to explore other variables or different scenarios.

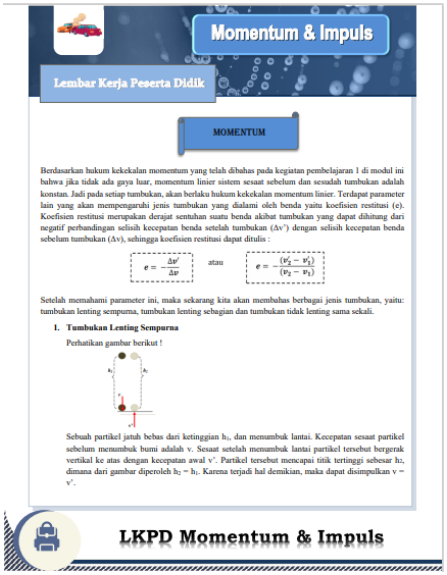

Figure 4. Integration of Student Worksheet with POE2WE Model Syntax (Elaboration)

Figure 5 shows the section of the student worksheet that provides space for students to write down their observations, explanations, and thoughts in the form of a scientific report. This writing not only helps students to summarize their learning, but also trains scientific communication skills by including graphs, diagrams, or important notes from the simulation results.

Figure 5. Integration of Student Worksheet with POE2WE Model Syntax (Write)

Figure 6 shows the evaluation section, where students are given the opportunity to evaluate their own understanding of the material learned. The student worksheet provides self-assessment instruments, as well as questions designed to measure the extent to which students have mastered the concepts of momentum and impulse. Students are also asked to reflect on whether their initial predictions are in line with their observations and explanations.

Figure 6. Integration of Student Worksheet with POE2WE Model Syntax (Evaluation)

Validation of Momentum and Impulse Student Worksheet

The validation of the student worksheet includes both material and media evaluations. The material evaluation covers three main aspects: 1) content of the material, 2) presentation of the material, and 3) language and visuals. Meanwhile, the media evaluation focuses on two aspects: appearance and usage. Each of these aspects is further broken down into several sub-aspects. The scores from each sub-aspect are then analyzed to generate a score for each main aspect, as outlined in Table 3.

The validation results showed that all aspects of the assessment were extremely feasible with an average percentage of 92.5% across all evaluated criteria. Improvements made based on the suggestions include: 1) providing more attractive colours, 2) adding videos, 3) improving writing procedures related to vectors, 4) sharpening the syntactic linkage of the POE2WE learning model with the student worksheet. In the language respect, some of the validators pointed out that ambiguous sentences need to be avoided within the material (Wahyuni et al., 2023).

Table 3. Result of Student Worksheet Validation

Aspect	Score	Category
Content of material	81%	Extremely Feasible
Presentation of material	90%	Extremely Feasible
Language and visuals	93%	Extremely Feasible
Appearance	87%	Extremely Feasible
Usage	87%	Extremely Feasible
Average all aspect	87,6%	Extremely Feasible

These results highlight the robustness of the development process, ensuring that the student worksheet not only meets educational standards but also effectively supports the learning process. The incorporation of improvements based on expert feedback demonstrates a commitment to refining the student worksheet to enhance its pedagogical impact and usability. By integrating visually appealing elements, interactive videos, and precise instructional content, the worksheet becomes a more engaging and comprehensive learning tool. Additionally, the strengthened alignment between the POE2WE learning model and the student worksheet structure ensures that the learning activities flow seamlessly,

fostering critical thinking and a deeper understanding of momentum and impulse concepts.

Student Response to Momentum and Impulse Student Worksheet

The revised student worksheet was tested with students to gather their feedback on its practicality. Student responses were evaluated based on five aspects: 1) content of the material, 2) language and visuals, 3) presentation of the material, 4) appearance, and 5) usage. The results of the student feedback are presented in table 3.

Table 4. Result of Student Response to Student Worksheet

Aspect	Score	Category
Content of material	91,7%	Practical
Language and visuals	88,8%	Practical
Presentation of material	87,9%	Practical
Appearance	91,3%	Practical
Usage	85%	Practical
Average all aspect	89%	Practical

The student feedback results indicate that all assessment aspects were rated in the "Practical" category with an average score of 89%. However, the usage aspect received the lowest score of 85% compared to the other aspects. This is due to inadequate internet access during testing, which interfered with the experiments carried out in the PhET simulation. This affects the acquisition of the use response aspect which is lower than other aspects. Nevertheless, the category of student response results, student worksheet assisted by PhET simulation with POE2WE model of momentum and impulse material obtained a positive response so that students can use it as a learning resource.

The revised student worksheet was tested with students to gather their feedback on its practicality. The validation process confirmed that the student worksheet has the potential to be an effective learning tool, as it supports active engagement and provides a structured approach to learning. However, its implementation presents several technical and pedagogical challenges, including ensuring compatibility with diverse digital devices, providing teacher training for optimal use, and designing content that aligns with varied student needs and learning styles. Addressing these challenges is essential for maximizing the effectiveness of student worksheets (Khulaifatuzzahra et al., 2024).

These findings are in line with recent research such as that conducted by nana which demonstrated the effectiveness of PhET simulations in improving students' conceptual understanding, especially when paired with an inquiry-based model such as POE2WE (Nana, 2020). Akbar et al also explained that simulations bridge theoretical and practical knowledge, encourage deep engagement and improve learning outcomes (Akbar et al., 2024). Similarly, Hidayatulloh and Haryadi emphasised the role of simulation in creating an interactive and inquiry-based learning environment, making it particularly effective for abstract concepts (Hidayatullah & Haryadi, 2024). This study also underlines that the design of the student worksheet may be considered attractive and supports the clarity of the material, but it still requires further training for teachers to have it implemented to the fullest.

CONCLUSION

This research concludes that the researchers successfully created teaching materials in the form of student worksheet assisted by PhET Simulation on the topic of momentum and impulse learning using POE2WE model. The validation results are extremely feasible for testing in schools.

These tools offer a promising approach to enhancing physics education by fostering interactive and practical learning experiences. Future research should explore their effectiveness in diverse contexts and expand the approach to other physics topics. Additionally, the product has only been tested for practicality and has yet to undergo further validation for effectiveness in broader implementation. Suggestions from researchers for future studies include testing the student worksheet assisted by PhET simulation using POE2WE model on the topic of momentum and impulse on a broader subject population, so that the developed teaching materials can be utilized in the learning process at schools.

REFERENCES

Akbar, A. M., Saputra, Syahrul, & Alam, N. S. (2024). Pengembangan Strategi Pembelajaran Berbasis Teknologi dan Manajemen Kualitas untuk Meningkatkan Inklusivitas dan Relevansi Pendidikan Vokasi Keteknikan. *Jurnal Review Pendidikan Dan Pengajaran, 7 Nomor 4*. https://doi.org/10.31004/jrpp.v7i4.38126

Alatas, F., & Solehat, D. (2022). Pengembangan Media Audiovisual Praktikum Fisika Dasar Berbasis I-SETS (Islamic-Science, Environment, Tecnology, Society) sebagai Solusi Praktikum saat New Normal. *Jurnal Penelitian Pembelajaran Fisika*, *13*(1), 103–116. https://doi.org/10.26877/jp2f.v13i1.11401

Aryuansyah, R. A. W., Sucahyo, I., & Hari Nugroho, Y. (2022). *Pengembangan "AndroPhys" sebagai Media Interaktif Berbasis Android untuk Meningkatkan Hasil Belajar Materi Momentum dan Impuls*. *6*(1), 1–10. https://doi.org/10.19109/jifp.v6i1.12459

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). https://doi.org/10.1103/PhysRevPhysEducRes.17.023108

Fajriyah, R. L., & Jatmiko, B. (2021). Penerapan Model POE2WE Berbasis Virtual Learning pada Materi Listrik Arus Bolak Balik (AC) untuk Melatihkan High Order Thinking Skills (HOTS) Peserta Didik SMA. *PENDIPA Journal of Science Education*, *5*(1), 102–107. https://doi.org/10.33369/pendipa.5.1.102-107

Fitri, N., Hidayat, A., & Putra, K. E. (2024). Pengembangan Lembar Kerja Siswa (LKS) Berbasis RME untuk Memfasilitasi Kemampuan Pemahaman Konsep Matematis pada Materi Lingkaran Kelas VIII SMP/MTS. In *Jurnal Ilmiah Pendidikan Matematika p* (Vol. 12, Issue 2). Bulan Juli Hal. https://doi.org/10.31941/delta.v12i2.4401

Hendikawati, P., Zahid, M. Z., & Arifudin, R. (2019). Android-based Computer Assisted Instruction development as a learning resource for supporting self-regulated learning. *International Journal of Instruction*, *12*(3), 389–404. https://doi.org/10.29333/iji.2019.12324a

Hidayatullah, S., & Haryadi, R. (2024). Model pembelajaran online fisika berbasis pemodelan. In *Academy of Education Journal* (Vol. 15, Issue 1). Online.

Khulaifatuzzahra, I., Arni, Y., Rianti, D. N., & Fathier, S. C. (2024). Tentang Pengenalan Sistem Tata Surya Sekolah Dasar Kelas Tinggi di Sumatera Selatan. In *Education Achievment: Journal of Science and*

Research (Vol. 5). https://doi.org/10.51178/jsr.v5i3.2180

Kristanta, A. (2021). Metode Pratikum Sebagai Upaya Meningkatkan Motivasi Belajar Peserta Didik Pada Kegiatan Pembelajaran Daring. *Jurnal Didaktika Pendidikan Dasar*, *5*(2), 443–464. https://doi.org/10.26811/didaktika.v5i2.307

Lestari, D. D., & Muchlis. (2021). E-LKPD Berorientasi Contextual Teaching and Learning untuk Melatihkan Keterampilan Berpikir Kritis Siswa pada Materi Termokimia. *Jurnal Pendidikan Kimia Indonesia*, *5*, 25–33. https://ejournal.undiksha.ac.id/index.php/JPK/index

Mulia, S., & Murni, S. (2022). Implikasi Pembelajaran Praktikum Ilmu Pengetahuan Alam Dalam Kemajuan Kognitif Siswa. *Science Education Research (Search) Journal*, 1–11.

Nana. (2020). *Penerapan Eksperimen Virtual PHET Terhadap Model Pembelajaran POE2WE pada Tumbukan untuk Melatih Keterampilan Proses Sains* (Vol. 07, Issue 1). https://doi.org/10.36706/jipf.v7i1.10912

Nana, & Rizki, S. (2020). Penerapan Pembelajaran Melalui Model POE2WE Sebagai Upaya Melatih Literasi Saintifik Salam Domain Kompetensi Pada Pembelajaran Fisika di SMA. *Jurnal Pendidikan Fisika FKIP Universitas Siliwangi*, 1. https://doi.org/10.31219/osf.io/rcu8f

Palupi, F. R., & Pujianto. (2021). *Development Multimedia Based Electronic Student Worksheet's to Increase Student Achievement on Physics and Learning Independence of High School Students*. https://doi.org/10.1088/1742-6596/2309/1/012070

Partono, P., Wardhani, H. N., Setyowati, N. I., Tsalitsa, A., & Putri, S. N. (2021). Strategi Meningkatkan Kompetensi 4C (Critical Thinking, Creativity, Communication, & Collaborative). *Jurnal Penelitian Ilmu Pendidikan*, *14*(1), 41–52. https://doi.org/10.21831/jpipfip.v14i1.35810

Pertiwi, T. D., Sunarno, W., & Budiharti, R. (2020). Penerapan Pembelajaran Kooperatif Tipe Numbered Heads Together Melalui Metode Eksperimen Dan Metode Demonstrasi Ditinjau Dari Perilaku Kerjasama Siswa Kelas X Mia Sma Negeri 4 Surakarta. *Jurnal Sains Edukatika Indonesia (JSEI)*, *2*(2), 28–33.

Pricillya, S., Fernanda, M., Qorimah, F., & Hanisa, A. R. (2022). SPEKTRA: Jurnal Fisika dan Aplikasinya Implementasi Pembelajaran Impuls dan Momentum: Review Publikasi Ilmiah. *Mitra Pilar: Jurnal Pendidikan, Inovasi, Dan Terapan Teknologi*, *1*(2), 191–212.

Rahayuningsih, J., Lubis, I., & Sulistiawati, P. H. (2023). Pengaruh Model Pembelajaran Discovery Learning terhadap Kemampuan Analisis Siswa pada Materi Momentum dan Impuls dengan Berbantuan Software Tracker di SMA PGRI Sialingan. *Jurnal Pendidikan Fisika Dan Fisika Terapan*, *9*(1), 2023.

Ramadhan, G., Rostiana, I., Rakhmatika, E., & Nana. (2020). Penerapan Model POE2WE Berbantuan Simulasi Lab Virtual dalam Materi Gelombang Mekanik pada Pembelajaran Fisika. *Jurnal Kreatif Online*, *8*(1), 128–136. https://doi.org/10.31219/osf.io/az2gb

Rezeki, S., Andrian, D., & Safitri, Y. (2021). Mathematics and cultures: A new concept in maintaining cultures through the development of learning devices. *International Journal of Instruction*, *14*(3), 375–392. https://doi.org/10.29333/iji.2021.14322a

Safitri, W., Studi Pendidikan Matematika, P., & Bengkulu, U. (2020). Pengembangan Lembar Kerja Peserta Didik (LKPD) dengan Menggunakan Model Discovery Learning yang Terintegrasi Nilai-Nilai Islam pada Materi Lingkaran di Kelas VIII SMP Negeri 12 Kota Bengkulu. *Jurnal Penelitian Pembelajaran Matematika Sekolah*, *4*(JP2MS), 123–135. https://doi.org/10.33369/jp2ms.4.1.123-135

Sarjono. (2018). Pentingnya Laboratorium Fisika di SMA/MA dalam Menunjang Pembelajaran Fisika. *Jurnal Madaniyah*, *8*(3), 262–271.

Suryaningsih, S., & Nurlita, R. (2021). Pentingnya Lembar Kerja Peserta Didik Elektronik (E-LKPD) Inovatif dalam Proses Pembelajaran Abad 21. *Jurnal Pendidikan Indonesia (Japendi)*, *2*(7). https://doi.org/10.36418/japendi.v2i7.233

Syarkowi, A., Hamdani, D., & Defianti, A. (2023). Perbedaan Jenis Kelamin Terhadap Kepuasan Siswa Terhadap Pembelajaran Fisika Online. *EduFisika: Jurnal Pendidikan Fisika*, *8*(1), 01–05. https://doi.org/10.59052/edufisika.v8i1.24718

Taofek, I., & Agustini, R. (2020). Development of Student Worksheets Based on Contextual Teaching and Learning to Improve Students Critical Thinking Skills in the Matter of Reaction Rate of Senior High School Class XI. In *UNESA Journal of Chemical Education* (Vol. 9, Issue 1). https://doi.org/10.24815/jipi.v8i3.39884

Theasy, Y., Bustan, A., & Nawir, M. (2021). Penggunaan Media Laboratorium Virtual PhET Simulation untuk Meningkatkan Pemahaman Konsep Fisika Mahasiswa pada Mata Kuliah Eksperimen Fisika Sekolah. *Institute of Managing and Publishing of Scientific Journals, STKIP Singkawang*, *4*(2), 39–45. https://doi.org/10.26737/var.v4i2.2607

Wahyudiati, D. (2016). Analisis Efektivitas Kegiatan Praktikum Sebagai Upaya Peningkatan Hasil Belajar Mahasiswa. *Jurnal Tatsqif*, *14*(2), 143–168. https://doi.org/10.20414/jtq.v14i2.27

Wahyuni, Yurnetti, Lestari, & Arif. (2023). *Development of E-LKPD Biotechnology Topic Intregrated with Local Wisdom Based on Scientific Approach* (Vol. 4, Issue 1). https://doi.org/10.24036/universe.v4i1.246

Yunita, & Nana. (2020). Pengunaan Model Pembelajaran POE2WE dengan Bantuan aplikasi Zenius Education untuk Meningkatkan Pemahaman Konsep dalam Pembelajaran Fisika. *Jurnal Ilmiah Kependidikan*, *7*(1), 17–23. http://dx.doi.org/10.35542/osf.io/ecxyw