



HOTS-Oriented Student Worksheets with Blended Learning: Improving Students' Science Process Skills

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Abstract

Today's education must meet the needs of 21st-century learning and developments in the digital age. HOTS and science process skills must be trained to carry out scientific investigations. This experimental research aims to identify the improvement of students' science process skills affected by HOTS-oriented student worksheets through blended learning conducted in one of the high schools in Pringsewu District, Lampung Province. The subjects of this study were students of class X SMA Negeri 2 Pringsewu, with a population of 180 people. The research sample was selected using a purposive sampling technique so that class MIPA 2 was obtained as an experimental class with a total of 29 students and MIPA 4 class as a control class with a total of 31 students. The research method used was a non-equivalent control group design which aims to look for the effect of a causal relationship between two factors. The data collection technique used was a pretest and posttest design using a science process skills instrument. The n-gain results show an increase in 5 indicators of students' science process skills, where the increase occurs in the medium category. The results showed an increase after using HOTS-Oriented Student Worksheets (SW) on impulse-momentum material through blended learning to improve students' science process skills.

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INTRODUCTION

Changes in the 21st century are challenges that require teachers and students to adapt to all demands according to the times. Students must acquire 21st-century abilities such as learning skills that focus on mental development, literacy skills that focus on current digital knowledge, and life skills which focus on personal skills and how to work professionally (Illene et al., 2023; Özeren, 2023; Ratama et al., 2021). Through education, students are trained to be able to carry out investigations supported by scientific knowledge (Muntholib et al., 2022; Osborne et al., 2003; Shahali et al., 2017; Supeno et al., 2022), where the ability to show the process of obtaining scientific concepts requires science process skills (Mirian, 2023; Rauf et al., 2013). Mastery of science process skills allows students to get used to solving everyday problems (Gültekin & Altun, 2022; Jack, 2018). However, science process skills in Indonesia are still relatively low (Prahani et al., 2021; Rahayu & Anggraeni, 2017; Rahman et al., 2017; Sari & Zulfadewina, 2018) due to changes in the implementation of learning to online learning due to the Covid-19 pandemic (Giatman et al., 2020; Hidayati & Saputra, 2020; Mirawati et al., 2020) In addition, the results of previous research indicate that students' science process skills are classified as moderate and low (Irwanto & Prodjosantoso, 2018).

Science process skills are cognitive abilities to process information, solve problems, and draw conclusions (Özgelen, 2012). When students engage in practical or experimental activities, their

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process skills are readily apparent (Aldahmash et al., 2019; Ismail et al., 2019). As a result, science process skills transform students into scientific agents and problem solvers in daily situations. Thus, fostering basic science process skills can help students uncover facts, describe things, form concepts, and overcome issues caused by geosphere occurrences in their daily lives (Rizal et al., 2022). In science learning, process skills consist of basic and integrated process skills (Turiman et al., 2012). Competence in the scientific process becomes a means to acquire knowledge and understand how to acquire that knowledge. (Bati et al., 2010).

Improving science skills requires a teacher, knowledge, and appropriate teaching materials (Darmaji et al., 2019). This is supported by the opinion which is to support the learning process. Teaching material is needed. Student worksheets (SW) are designed according to learning competencies to train student independence in learning (Pasani & Kamaliyah, 2017; Sari et al., 2019; Susanti & Wulandari, 2022). SW plays a role in forming basic abilities and providing an understanding following learning indicators (Pulungan et al., 2022). SW can increase students' interest in reading and writing, overcome problems of students' learning difficulties, foster students' activeness in learning activities, and create flexible learning. (Patresia et al., 2020; Sari et al., 2022). In addition, SW is useful for practicing independence, literacy skills, understanding, and creativity which will then impact students' science process skills (Febriani et al., 2017; Kolomuc et al., 2012).

Thinking ability greatly impacts the success of the learning being carried out. The thinking capability will affect the learning capability, the speed, and the effectiveness of learning. Higher Order Thinking Skills (HOTS) teach students how to process and analyze information to determine the goals or problems to be solved (Kwangmuang et al., 2021). A person with HOTS will be capable of learning, giving proper arguments, thinking creatively, making decisions, and settling difficulties. HOTS is one of the keys to building good and quality human resources (Misrom et al., 2020). HOTS develops in students through various thought processes that range from low to high levels simultaneously (Kustati & Sepriyanti, 2022). 21st-century learning demands learning that can facilitate students to participate and actively expand their understanding. By mastering higher-order thinking skills, students can easily build their knowledge independently and respond well to the challenges of the times (Zohar, 2013). The important thing in learning physics is to support and motivate students to learn actively. Through HOTS, students are asked not only to work on questions with memorized formulas but also to analyze (break a problem into several parts and then look for the relationship), evaluate (a combination of the ability to assess, review, and criticize), and creating (creating new methods or modifying existing ones) (Winarso, 2014).

In addition to mastering existing skills in the 21st century, a learning process that follows developments in the digitalization era is also needed. Blended learning is a form of learning that combines offline learning with online learning (e-learning). The proper use of ICT is needed by teachers in Blended learning (Hatiti et al., 2021). Blended learning allows students to experience an efficient learning environment with flexible learning models, media to convey learning content and independent learning activities. The main purpose of implementing blended learning is to provide learning activities that are interesting and not monotonous and motivate students so that they can increase the effectiveness of student learning. (Chin et al., 2018; Tsai et al., 2017). Besides that, students can find social interaction in blended learning that allows students to prepare themselves in a community that is mutually dependent in positive terms.

The findings of the preliminary research questionnaire analysis, which was given to 47 students in class XI obtained data that 68.1% of students had difficulty understanding physics learning, as many as 61.7% of students stated that the media that teachers often use to convey material is a PowerPoint, and 0% of students reported that there was the utilization of SW in the learning process, 0% of students stated that there was practicum implementation. Based on the preliminary research questionnaire, the teacher did not use HOTS-oriented worksheets through blended learning yet in applied learning. Therefore, HOTS-oriented worksheets with blended learning are needed.

Previous research on implementing SW to improve students' science processing skills has been widely carried out. Among them, student worksheets with PhET simulation (Arifullah et al., 2020), student worksheets on Hooke's Law Material (Syamsidar et al., 2021), problem-based learning-based student worksheets (Yalyn et al., 2022), moodle-based student worksheets (Irdalisa et al., 2022), concept attainment worksheet (Rani et al., 2017). Based on current research, there is no study of

using HOTS-oriented student worksheets to improve science process skills in new normal conditions. The student learned online way before and got no practicum activities yet. This research aims to identify the improvement of students' science process skills affected by HOTS-oriented student worksheets.

METHOD

This research uses a quasi-experimental method to investigate the effect of using HOTS-oriented worksheets in a blended learning framework on students' science process skills. Conducted at a high school in Pringsewu Regency, Lampung Province, this study used an experimental class of 29 students and a control class of 31 students. The study design, described in Table 1, facilitated comparative analysis between groups, allowing researchers to systematically evaluate the impact of interventions. This study focuses on improving students' science process skills through integrating HOTS-oriented worksheets in integrated learning, and quasi-experimental methods ensure this controlled yet insightful exploration of educational approaches.

Table 1. The Research Design

Class	Pretest	Treatment	Posttest
Experiment	O_1	X_1	O'_1
Control	O_2	X_2	O'_2

- O_1 : Pretest score in the experimental class
- X_1 : Learning by applying HOTS-oriented worksheets through blended learning
- O'_1 : Posttest score in the experimental class
- O_2 : Pretest score in the control class
- X_2 : Learning by applying printed book
- O'_2 : Posttest score in the control class

The research flow chart can be seen in Figure 1

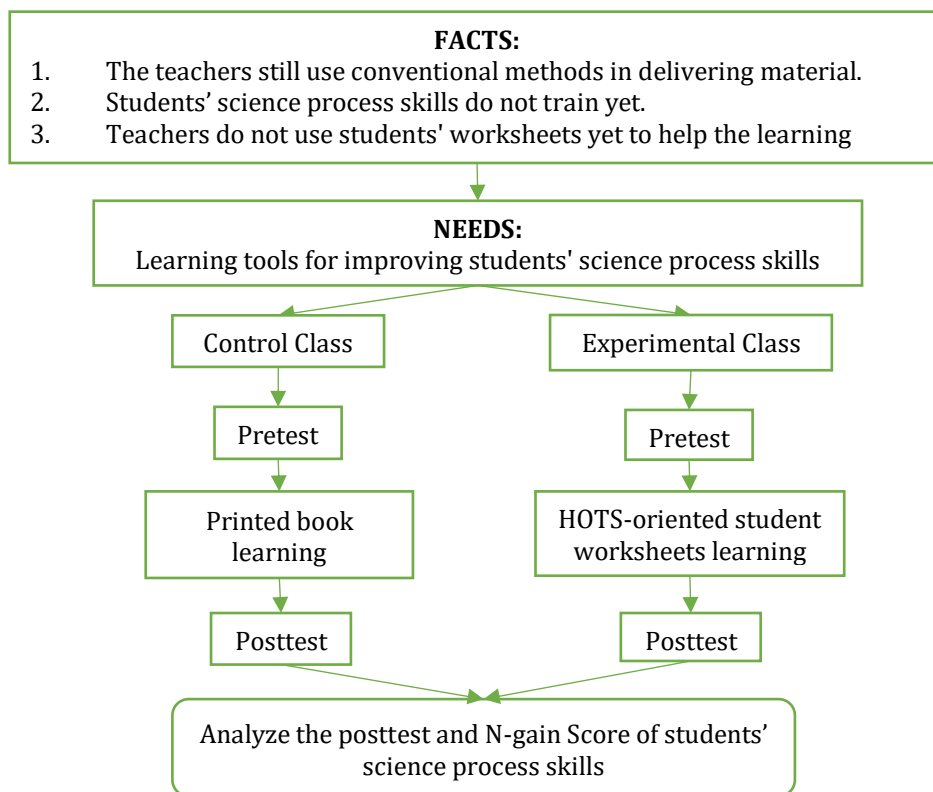


Figure 1. Research Chart Flow

Both classes will do a pretest before getting the appropriate treatment in the class and having the posttest when the learning has been completed. The treatment applied to the experimental class

is student worksheets (SW) through blended learning which has been validated. Based on pretest and posttest scores, each class's progress in science process skills can be calculated using a paired sample t-test. The basis for the decision in the paired sample t-test is a sig. 2-tailed score less than 0.05, which indicates a significant improvement.

The data acquired by the pretest and posttest will be compared to assess if students' science process skills have improved based on the N-gain score. Normalized N-gain (g factor) describes the difference in quality between before and after treatment. The equation used (Lestari & Yudhanegara, 2017) is found in equation 1 below.

$$Gain < g > = \frac{posttest\ score - pretest\ score}{maximum\ score - pretest\ score} \quad (1)$$

The Categories of N-gain are shown in Table 2.

Table 2. N-gain score's categories

The Interval	Category
N-gain ≥ 0,7	High
0,3 ≤ N – gain < 0,7	Medium
N-gain < 0,3	Low

The N-gain score in each class will be tested through an independent sample-t test using SPSS 25.0 to see differences in students' science process skills improvement between classes. The data has a different value in the two classes if the 2-tailed sig value is less than 0.05. Practicum can also assess students' science process skills and convert them into percentages. The following table 3 shows the percentage assessment categories for science process skills.

Table 3. Category of SPS Assessment (Azwar, 2003)

Score Average (%)	Category
X ≤ 24,95	Very Low
24,95 < X ≤ 41,65	Low
41,65 < X ≤ 58,35	Medium
58,35 < X ≤ 75,05	High
75,05 < X	Very High

RESULTS AND DISCUSSION

Results

Learning began by doing a pretest in both classes. The test determined students' initial abilities and understanding of the material. Then, the students did the posttest after implementation. The following presents data on the pretest and posttest results shown in Table 4.

Table 4. Data of Experiment

Score	Experimental Class		Control Class	
	Pretest	Posttest	Pretest	Posttest
Maximal	26.20	78.60	26.20	47.62
Minimal	7.00	39.00	0.00	4.70
Standard Deviation	5.59850	14.34130	7.53638	10.74039
Average	17.3855	53.6221	12.8025	31.6994

The result of paired sample t-test can be tested by pretest and posttest score, the sig 2-tailed score shown in Table 5.

Table 5. The Paired Sample t-tests Result
Paired Differences

Class	Sig (2-tailed)
Pre-test-Post-test Experiment	0.000
Pre-test-Post-test Control	0.000

N-gain score can be determined based on pretest and posttest results, as shown in Table 6.

Table 6. N-gain Score

Class	Lowest N-gain Score	Highest N-gain Score	Average of N-gain score	Category
Experimental	0,21	0,74	0,4435	Medium
Control	0.00	0,44	0,2162	Low

The score of sig. 2-tailed has been calculated based on the N-gain score through an independent sample t-test. The independent sample t-test result is shown in Table 7.

Table 7. Independent Sample T-test Result

Data	Nilai sig. (2-tailed)
N-Gain	0,00

Besides pretest and posttests, students' SPS can be analyzed by observing the indicators of SPS throughout the practicum. The results of students' science process skills are shown in Table 8.

Table 8. The result of Students' SPS

Indicators of SPS	Worksheet's Point	Indicator's Percentage (%)
Observing	Observing phenomenon	65,5
Making a hypothesis	Making a hypothesis	56,9
Defining Variables	Defining Variables	12,9
Testing Hypothesis	Designing the experimental procedure	57,5
	Experiment properly	43,1
Presenting Data	Presenting experimental data in tables	42,5
	Analyzing the experimental results and discussion	26,7
Presenting Results	Making Conclusions	38,8

Discussion

HOTS-oriented student worksheets are used to see the improvement of SPS. In this worksheet, the activities are divided into two categories: online and offline. The online activities used google classroom as the tool's platform for learning. In these activities, students have to do the phenomenon observing, formulate a problem, then make a hypothesis and also discuss it after the practicum is done. In contrast, in offline activities, the student will get practicum activities such as collecting data, analyzing data, and making a conclusion. In both classes, the data of paired sample t-test shows there is an enhancement in science process skills as indicated by sig, a 2-tailed score which is less than 0.05. The students' worksheets are displayed in Figure 2.

IMPULS

Tujuan Pembelajaran

- Melalui tayangan video dan diskusi, siswa mampu menyimpulkan impuls berdasarkan video fenomena.
- Melalui percobaan dan diskusi, siswa mampu merumuskan persamaan impuls dan menganalisis hubungan antara massa benda dengan kecepatan benda.


AKTIVITAS ONLINE SEBELUM TATAP MUKA

Ada beberapa hal yang harus anda lakukan pada kegiatan online, yaitu.

A. Pengamatan Fenomena

Kegiatan pertama

Silahkan amati fenomena dalam video yang sudah disediakan di kelas online!



Video ini menampilkan permainan softball. Dalam permainan ini, bola dilempar dan akan dipukul dengan tongkat baseball oleh pemain.

Kegiatan kedua

Silahkan baca uraian singkat berikut !

Dalam suatu pertandingan tinju, Fara petinju tentunya menggunakan sarung tinju. Seorang pemain bersiap-siap memberikan pukulan terhadap lawannya. Pukulan tersebut tentunya sudah di siapkan untuk menjatuhkan lawannya dan ternyata pukulan tersebut tepat mengenai wajah lawannya. Untuk lebih lanjutnya, silahkan buka video yang telah disediakan pada kelas online. Kemudian setelah anda membaca uraian diatas dan membuka kelas online. Menurut anda apa fungsi dari sarung tinju. Bagaimanakah hubungannya dengan impuls ?

Jawablah pertanyaan-pertanyaan berikut melalui kegiatan diskusi

- Mengapa bola baseball bisa terlempar jauh saat dipukul dengan tongkat oleh pemain?

(1)

- Menurutmu bagaimanakah hubungannya dengan impuls? Jelaskan secara fisika!

(2)

TATAP MUKA

Untuk memahami Impuls lebih lanjut, anda perlu mengumpulkan beberapa data dengan melakukan percobaan mengenai Impuls berikut. Siapkanlah alat dan bahan berikut.

B. Prosedur Penyelidikan Impuls

Alat dan Bahan

- Balok 1; Balok Besi
- Balok 2; Balok Besi yang telah dilapisi karet
- paku
- penggaris
- sterofom
- papan triplek
- benang

Rancanglah percobaan dan kumpulkanlah data-data untuk menguji hipotesis yang telah anda buat berdasarkan alat dan bahan yang telah disediakan!

Prosedur Penyelidikan

C. Analisis Data

Jawablah pertanyaan di bawah ini berdasarkan hasil penyelidikan yang telah kalian lakukan!

- Berdasarkan percobaan yang telah dilakukan, percobaan manakah yang menghasilkan impuls yang paling besar? Mengapa?

(1)

- Bagaimana jika prinsip memperlama selang waktu kontak tumbukan diterapkan pada kehidupan sehari-hari? Berikan contohnya!

(2)

- Buatlah kesimpulan berdasarkan pengamatan dan analisis!

(3)

Setelah membuat prosedur penyelidikan, silahkan isi tabel dibawah ini berdasarkan pengukuran yang telah anda lakukan.

Tabel Hasil Percobaan

No.	Balok		Panjang Awal Paku (l_0)	Panjang paku yang tersisa (l_1)	Paku yang Tertanam ($l_0 - l_1$)
	Jenis	Berat (N)			
1.	Balok 1				
2.	Balok 2				

113

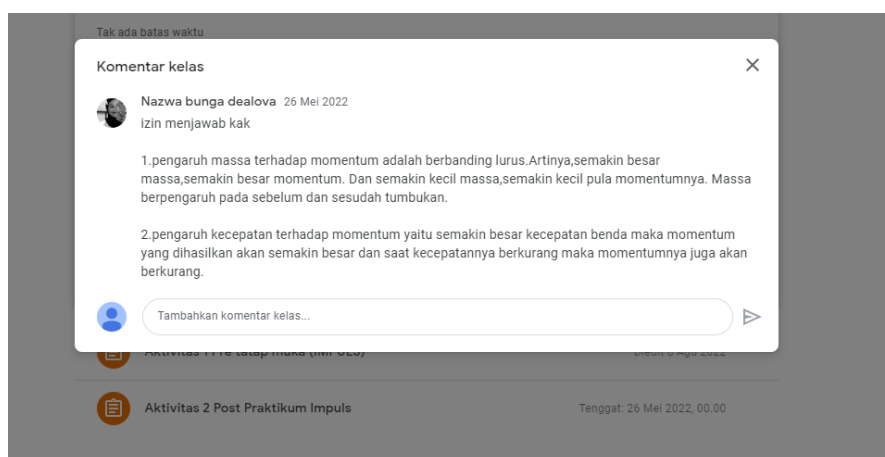
Figure 2. Student Worksheets

Diving deeper into the structure of the study's worksheets, two primary activities take center stage: online learning activities and face-to-face interactions. The online learning phase encompasses the "Observing Phenomena" aspect, where students engage with videos depicting various momentum and impulse-related activities. Through these visual aids, students gain an initial understanding of the concepts surrounding momentum and impulse. This phase is foundational, preparing them for the subsequent scientific exploration and data analysis tasks. Transitioning to the face-to-face activities in the worksheets, the focus shifts toward hands-on investigations and comprehensive data analysis. Here, students delve into the "Investigating Procedures" aspect, where they actively participate in activities that allow them to experiment and manipulate variables related to momentum and impulse. This practical engagement fosters a deeper comprehension of the theoretical concepts introduced earlier.

Figure 3 illustrates the culmination of these efforts in the form of student practicum activities. This practical segment of the study showcases students applying the knowledge they've gained through online observations and face-to-face investigations. In this phase, students engage in scientific experimentation, gather data, and subsequently analyze the results. This integration of theory and practical application enhances their ability to grasp the intricacies of momentum and impulse while also honing their scientific inquiry and data interpretation skills. The study's worksheets seamlessly guide students through a structured learning process. It commences with visual learning to establish foundational insights, progresses to active investigations for a hands-on experience, and culminates in practical experimentation and data analysis, fostering a holistic and thorough understanding of momentum and impulse principles.



3(a)



3(b)

Figure 3 (a) & (b) Students' Practicum Activities

Based on Figure 3, students do practicum during offline learning. Students are divided into several groups to investigate and observe the practicum. During online learning, students discuss momentum and impulse through Google Classroom. In Figure 3, students answer about the influence of mass and speed on momentum. During the learning process, both online and offline students look active and more interested.

Pretest and posttest scores show that students' science process skills improved with different scores, with the experimental class scoring higher than the control class. This is also seen in the N-gain score, with the experimental class scoring higher than the control class. It means the usage of HOTS-oriented can improve the science process skills. The sig. The 2-tailed score in the independent sample t-test was less than 0.05, indicating significant differences in students' science process skills between the experimental and control classes. It's supported by research that states science process skills improved by implementing student worksheets. The n-gain score of 29 students was 0.85 in the high category, and eight students were 0.57 in the moderate category. The researcher also said that student worksheets used in learning have proven effective in helping students obtain good learning outcomes (Nurfidayanti & Yonata, 2022). This statement is also supported by previous research on students' science process skills which increased, as evidenced by the N-gain score of 64.97 in the high category. This study uses student worksheets assisted by PhET simulations. It helps students to reduce these errors. In the lab, easily repeat the experiment, and report the results (Arifullah et al., 2020). This research was conducted during the new normal period where previously students did not carry out practical activities.

In Table 4, the standard deviation shows the variation in student learning outcomes; the higher the standard deviation, the greater the variation in student scores. The standard deviation of the experimental class is higher than that of the control class. In the control class, students did practicum, but some missed steps such as hypothesizing, measuring, or collecting data, and some left class. This unfavorable condition can also be seen from the presence of students who play with other friends, and the practicum is not serious, so they cannot master the material properly.

The ability of science process skills is assessed through pretest and posttest and observed when students carry out practicums. The average proportion of occurrence of science process skills indicators is 42.9 in the medium category. The phenomenon observation site had the highest occurrence of science process skills. In this indicator, the student uses their senses to observe the phenomenon and find the cause of the already served problems. The phenomenon observation was the basic skill, and the student did it well. The lowest percentage of occurrence of science process skills was determining the variable because the students did not use to do the practicum, so they got a problem in defining the variable that affected the other variable.

The science process skills points can be completed if they have reached the medium category. Then, they completed their ability points by observing phenomena, making hypotheses, designing experimental procedures, carrying out experiments correctly, and presenting experimental data correctly. Furthermore, the points of science process skills ability that are incomplete are determining variables, analyzing experimental results, and discussing and making conclusions. The

indicator of analyzing the experimental result and discussions were in a low category because the student found a problem analyzing the data and finding the connection between it and its application.

The results of this study indicate an increase in students' science process skills in the high category on the indicators of observing and formulating problems. In line with previous research, science skills help students develop problem-solving, critical thinking, and decision-making confidence (Jack, 2018) because students must use all of their five senses when making observations (Winarti & Sari, 2020; Zahroh et al., 2016). An increase at a moderate level occurred in the indicator for making and testing hypotheses because students are still not able to define variables correctly, interpret, observe, and measure experimental data (Ilham, 2018; Nursa'adah et al., 2021; Nuryadin & Delinda, 2018). Meanwhile, an increase in the low category occurs in the indicators determining the variables and presenting the experimental data due to the lack of students' ability to define variables, conclude research data, and associate phenomena with real life, and students are not used to doing practicum activities.

CONCLUSION

Statistical test results, discussion, and relevant research results concluded that applying HOTS-Oriented Student Worksheets (LKS) Through Blended Learning on Impulse Momentum Material can improve students' scientific process skills. The increase occurred in the moderate category with an average n-gain value of 0.4435. The highest increase in science process skills occurred in the indicators of observing and formulating problems. This increase was supported by activities carried out on HOTS-Oriented Student Worksheets (LKS) Through Blended Learning. The indicator with the lowest increase occurred in the indicator determining the variable.

This research cannot be separated from the weaknesses caused by the constraints encountered during the implementation process. One is the lack of students' ability to do a practicum and understand the hypothesis's meaning and the problem's formulation. In addition, the allocation of learning time is less due to implementing the new normal rules by making learning time less effective. This research was conducted to provide learning alternatives that can be used to improve students' science processing skills more effectively, as well as a reference if similar problems are found in similar learning, especially in Impulse and Momentum material.

REFERENCES

- Aldahmash, A. H., Alshamrani, S. M., Alshaya, F. S., & Alsarrani, N. A. (2019). Research trends in in-service science teacher professional development from 2012 to 2016. *International Journal of Instruction*, 12(2), 163–178. <https://doi.org/10.29333/iji.2019.12211a>
- Arifullah, A., Halim, A., Syukri, M., & Nurfadilla, E. (2020). The development of student worksheets with PhET assisted to improve student science process skill. *Journal of Physics: Conference Series*, 1460(1), 1–4. <https://doi.org/10.1088/1742-6596/1460/1/012144>
- Azwar, S. (2003). *Penyusunan skala psikologi*. Pustaka Pelajar.
- Bati, K., Ertürk, G., & Kaptan, F. (2010). The awareness levels of pre-school education teachers regarding science process skills. *Procedia-Social and Behavioral Sciences*, 2(2), 1993–1999.
- Chin, C. K., Munip, H., Miyadera, R., Thoe, N. K., Ch'ng, Y. S., & Promsing, N. (2018). Promoting education for sustainable development in teacher education integrating blended learning and digital tools: An evaluation with exemplary cases. *Eurasia Journal of Mathematics, Science and Technology Education*, 15(1), em1653.
- Darmaji, D., Kurniawan, D. A., & Irdianti, I. (2019). Physics education students' science process skills. *International Journal of Evaluation and Research in Education*, 8(2), 293–298.
- Febriani, S., Sudomo, J., & Setianingsih, W. (2017). Development of student worksheet based on problem based learning approach to increase 7th grade student's creative thinking skills. *Journal of Science Education Research*, 1(1), 1–4.
- Giatman, M., Siswati, S., & Basri, I. Y. (2020). Online learning quality control in the pandemic Covid-19 era in Indonesia. *Journal of Nonformal Education*, 6(2), 168–175.
- Gültekin, S. B., & Altun, T. (2022). Investigating the impact of activities based on scientific process skills on 4th grade students problem-solving skills. *International Electronic Journal of Elementary Education*, 14(4), 491–500. <https://doi.org/10.26822/iejee.2022.258>

- Hatiti, A., Distrik, I. W., & Rosidin, U. (2021). The effect of HOTS-oriented blended learning student worksheets on students' cognitive learning outcomes on work and energy materials. *Berkala Ilmiah Pendidikan Fisika*, 9(3), 381–389.
- Hidayati, D., & Saputra, W. A. (2020). Implementation of online learning during the covid-19 epidemic in Indonesia: Assessment of higher education students' use and implementation of online learning technology. *Universal Journal of Educational Research*, 8(10), 4514–4519.
- Ilham, M. (2018). Pengaruh pembelajaran inkuiri terbimbing terhadap keterampilan proses sains siswa kelas VII MTs Nurul Falah Juai pada konsep saling ketergantungan dalam ekosistem. *Jurnal Pendidikan Hayati*, 4(3), 120–129.
- Illene, S., Feranie, S., & Siahaan, P. (2023). Create multiple-choice tests based on experimental activities to assess students' 21st century skills in the heat and heat transfer topic. *Journal of Education and Learning (EduLearn)*, 17(1), 44–57. <https://doi.org/10.11591/edulearn.v17i1.20540>
- Irdalisa, I., Akbar, B., Amirullah, G., Marjan Fuadi, T., Elvianasti, M., & Safahi, L. (2022). Implementation of Moodle platform to acquire the students' knowledge and science process skills. *Cypriot Journal of Educational Sciences*, 17(9), 3238–3247. <https://doi.org/10.18844/cjes.v17i9.7349>
- Irwanto, R., & Prodjosantoso, A. K. (2018). Undergraduate students' science process skills in terms of some variables: A perspective from Indonesia. *Journal of Baltic Science Education*, 17(5), 751–764.
- Ismail, S. N., Muhammad, S., Kanesan, A. G., & Ali, R. M. (2019). The influence of teachers' perception and readiness towards the implementation of critical thinking skills (CTS) practice in mathematics. *International Journal of Instruction*, 12(2), 337–352.
- Jack, G. U. (2018). Chemistry students' science process skills acquisition: Influence of gender and class size. *Global Research in Higher Education*, 1(1), 80–97. <https://doi.org/10.22158/grhe.v1n1p80>
- Kolomuc, A., Ozmen, H., Metin, M., & Acisli, S. (2012). The effect of animation enhanced worksheets prepared based on 5E model for the grade 9 students on alternative conceptions of physical and chemical changes. *Procedia-Social and Behavioral Sciences*, 46, 1761–1765.
- Kustati, M., & Sepriyanti, N. (2022). The effect of 21st-century learning on higher-order thinking skills (hots) and numerical literacy of science students in Indonesia based on gender. *Jurnal Pendidikan IPA Indonesia*, 11(2), 314–321.
- Kwangmuang, P., Jarutkamolpong, S., Sangboonraung, W., & Daungtod, S. (2021). The development of learning innovation to enhance higher order thinking skills for students in Thailand junior high schools. *Heliyon*, 7(6), e07309. <https://doi.org/10.1016/j.heliyon.2021.e07309>
- Mirawati, I., Mahameruaji, J. N., & Trulline, P. (2020). Indonesian student's perception of online learning activities in the time of pandemic. *European Journal of Molecular and Clinical Medicine*, 7(1), 3645–3652.
- Mirian, O. B. (2023). An assessment of science process skills among science students in River State, Nigeria. *Journal of Advance Research in Applied Science*, 9(3), 1–5.
- Misrom, N. S. B., Muhammad, A. S., Abdullah, A. H., Osman, S., Hamzah, M. H., & Fauzan, A. (2020). Enhancing students' higher-order thinking skills (HOTS) through an inductive reasoning strategy using geogebra. *International Journal of Emerging Technologies in Learning (IJET)*, 15(3), 156–179. <https://doi.org/10.3991/ijet.v15i03.9839>
- Muntholib, M., Rahayu, S., Alsulami, N., & Rosli, M. S. (2022). Investigating the immersion of inquiry in lecture in improving students' understanding about scientific inquiry. *Jurnal Cakrawala Pendidikan*, 41(3), 806–818. <https://doi.org/10.21831/cp.v41i3.33020>
- Nurfidayanti, H. N., & Yonata, B. (2022). Development of student worksheets based on guided inquiries to train students science process skills on reaction rate materials. *Jurnal Pijar Mipa*, 17(1), 8–15.
- Nursa'adah, E., Sanjaya, Namirah, I., & Sundaryono, A. (2021). Guided inquiry learning in the concept of carbon compounds to enhance students' science process skills. *Proceedings of the International Conference on Educational Sciences and Teacher Profession (ICETeP 2020)*, 170–174. <https://doi.org/10.2991/assehr.k.210227.030>
- Nuryadin, E., & Delinda, D. (2018). Pengaruh inkuiri terbimbing (guided inquiry) terhadap

- keterampilan proses sains dasar peserta didik pada materi sistem ekskresi manusia. *Jurnal Pelita Pendidikan*, 6(4), 218–224.
- Osborne, J., Simon, S., & Collins, S. (2003). Attitudes towards science: A review of the literature and its implications. *International Journal of Science Education*, 25(9), 1049–1079. <https://doi.org/10.1080/0950069032000032199>
- Özeren, E. (2023). Predicting secondary school students' 21st-century skills through their digital literacy and problem-solving skills. *International Education Studies*, 16(2), 61–75. <https://doi.org/10.5539/ies.v16n2p61>
- Özgelen, S. (2012). Students' science process skills within a cognitive domain framework. *Eurasia Journal of Mathematics, Science and Technology Education*, 8(4), 283–292.
- Pasani, C. F., & Kamaliyah, K. (2017). Developing student worksheet for learning matrix. *Proceedings of the 5th SEA-DR (South East Asia Development Research) International Conference 2017 (SEADRIC 2017)*, 58–60. <https://doi.org/10.2991/seadric-17.2017.13>
- Patresia, I., Silitonga, M., & Ginting, A. (2020). Developing biology students' worksheet based on STEAM to empower science process skills. *JPBI (Jurnal Pendidikan Biologi Indonesia)*, 6(1), 147–156.
- Prahani, B. K., Deta, U. A., Lestari, N. A., Yantidewi, M., Jauhariyah, M. N. R., Kelelufna, V. P., Siswanto, J., Misbah, M., & Mahtari, S. (2021). A profile of senior high school students' science process skills on heat material. *Journal of Physics: Conference Series*, 1760(1), 12010.
- Pulungan, M., Maharani, S. D., Waty, E. R. K., Safitri, M. L. O., Suganda, V. A., & Husni, F. T. (2022). Development of e-student worksheets in the form of picture stories using live worksheets in primary schools. *Jurnal Iqra': Kajian Ilmu Pendidikan*, 7(2), 157–167. <https://doi.org/10.25217/ji.v7i2.1759>
- Rahayu, A. H., & Anggraeni, P. (2017). Analisis profil keterampilan proses sains siswa Sekolah Dasar di Kabupaten Sumedang. *Jurnal Pesona Dasar*, 5(2), 22–33.
- Rahman, A., Wahyuni, I., & Rifqiawati, I. (2017). Profil keterampilan proses sains dan sikap ilmiah siswa di SMP Satu Atap Pulau Tunda. *School Education Journal PGSD FIP Unimed*, 7(1), 1–7.
- Rani, S. A., Wiyatmo, Y., & Kustanto, H. (2017). Concept attainment worksheet to enhance concept knowledge and science process skills in physics instruction. *Jurnal Pendidikan IPA Indonesia*, 6(2), 326–334. <https://doi.org/10.15294/jpii.v6i2.10520>
- Ratama, I. P., Padmadewi, N. N., & Artini, L. P. (2021). Teaching the 21st century skills (4Cs) in english literacy activities. *Journal of Education Research and Evaluation*, 5(2), 223–233. <https://doi.org/10.23887/jere.v5i2.30849>
- Rauf, R. A. A., Rasul, M. S., Mans, A. N., Othman, Z., & Lynd, N. (2013). Inculcation of science process skills in a science classroom. *Asian Social Science*, 9(8), 1911–2017.
- Rizal, S., Putra, A. K., Suharto, Y., & Wirahayu, Y. A. (2022). Creative thinking and process science skill: Self-organized learning environment on watershed conservation material. *Jurnal Pendidikan IPA Indonesia*, 11(4), 578–587.
- Sari, P. M., Herlina, K., & Abdurrahman, A. (2022). Online learning with multi-representation worksheets for oral and written communication skills on light reflecting material. *Online Learning in Educational Research*, 2(1), 49–56.
- Sari, P. M., & Zulfadewina, Z. (2018). Profile of science process skill mastery from pre-service elementary school teacher. *Jurnal Inovasi Pendidikan Dasar*, 3(2), 65–72.
- Sari, Y. S., Selisne, M., & Ramli, R. (2019). Role of students worksheet in STEM approach to achieve competence of physics learning. *Journal of Physics: Conference Series*, 1185(1), 12096.
- Shahali, E. H. M., Halim, L., Treagust, D. F., Won, M., & Chandrasegaran, A. L. (2017). Primary school teachers' understanding of science process skills in relation to their teaching qualifications and teaching experience. *Research in Science Education*, 47, 257–281.
- Supeno, S., Ridlo, Z. R., & Setiawan, A. M. (2022). Exploring inquiry skills during home experiments about science in the online instruction. *Journal of Physics: Conference Series*, 2392(1), 012019. <https://doi.org/10.1088/1742-6596/2392/1/012019>
- Susanti, V. D., & Wulandari, R. (2022). Development of geogebra assisted electronic student worksheets (e-worksheets) to improve student independent learning. *Formatif: Jurnal Ilmiah Pendidikan MIPA*, 12(2), 199–212. <https://doi.org/10.30998/formatif.v12i2.11811>
- Syamsidar, R., Khaeruddin, K., & Helmi, H. (2021). The effectiveness of using student worksheets to

- practice science process skills on hooke's law material. *Jurnal Penelitian dan Pengembangan Pendidikan Fisika*, 7(1), 83-90.
- Tsai, T. P., Lin, J., & Lin, L. C. (2017). A flip blended learning approach for ePUB3 eBook-based course design and implementation. *Eurasia Journal of Mathematics, Science and Technology Education*, 14(1), 123-144.
- Turiman, P., Omar, J., Daud, A. M., & Osman, K. (2012). Fostering the 21st century skills through scientific literacy and science process skills. *Procedia - Social and Behavioral Sciences*, 59, 110-116. <https://doi.org/10.1016/j.sbspro.2012.09.253>
- Winarso, W. (2014). Membangun kemampuan berfikir matematika tingkat tinggi melalui pendekatan induktif, deduktif dan induktif-deduktif dalam pembelajaran matematika. *Eduma: Mathematics Education Learning and Teaching*, 3(2), 95-118.
- Winarti, W., & Sari, M. P. (2020). Escalation in students' science process skills on chapter wave vibration and sound through guided inquiry learning model. *Journal of Teaching and Learning Physics*, 5(2), 70-79.
- Yalyn, D., Sari, D. A. P., & Widodo, W. (2022). The implementation of student worksheets based on problem-based learning to improve students science process skill. *Jurnal Pijar Mipa*, 17(5), 569-576.
- Zahroh, F. P. A., Sudiby, E., & Mitarlis. (2016). Peningkatan keterampilan proses sains siswa melalui model pembelajaran guided inquiry pada materi suhu dan perubahannya. *Pensa E-Jurnal: Pendidikan Sains*, 4(2), 1-7.
- Zohar, A. (2013). Challenges in wide scale implementation efforts to foster higher order thinking (HOT) in science education across a whole school system. *Thinking Skills and Creativity*, 10, 233-249.