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 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
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 student 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>
<thead>
<tr>
<th>Class</th>
<th>Pretest</th>
<th>Treatment</th>
<th>Posttest</th>
</tr>
</thead>
<tbody>
<tr>
<td>Experiment</td>
<td>$O_1$</td>
<td>$X_1$</td>
<td>$O'_1$</td>
</tr>
<tr>
<td>Control</td>
<td>$O_2$</td>
<td>$X_2$</td>
<td>$O'_2$</td>
</tr>
</tbody>
</table>

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.

**FACTS:**
1. The teachers still use conventional methods in delivering material.
2. Students' science process skills do not train yet.
3. Teachers do not use students' worksheets yet to help the learning

**NEEDS:**
- Learning tools for improving students' science process skills

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.

\[
Gain < g > = \frac{posttest score - pretest score}{maximum score - pretest score}
\]  

(1)

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

<table>
<thead>
<tr>
<th>The Interval</th>
<th>Category</th>
</tr>
</thead>
<tbody>
<tr>
<td>N-gain ≥ 0,7</td>
<td>High</td>
</tr>
<tr>
<td>0,3 ≤ N − gain &lt; 0,7</td>
<td>Medium</td>
</tr>
<tr>
<td>N-gain &lt; 0,3</td>
<td>Low</td>
</tr>
</tbody>
</table>

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>
<thead>
<tr>
<th>Score Average (%)</th>
<th>Category</th>
</tr>
</thead>
<tbody>
<tr>
<td>X ≤ 24,95</td>
<td>Very Low</td>
</tr>
<tr>
<td>24,95 &lt; X ≤ 41,65</td>
<td>Low</td>
</tr>
<tr>
<td>41,65 &lt; X ≤ 58,35</td>
<td>Medium</td>
</tr>
<tr>
<td>58,35 &lt; X ≤ 75,05</td>
<td>High</td>
</tr>
<tr>
<td>75,05 &lt; X</td>
<td>Very High</td>
</tr>
</tbody>
</table>

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>
<thead>
<tr>
<th>Score</th>
<th>Experimental Class</th>
<th>Control Class</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Pretest</td>
<td>Posttest</td>
</tr>
<tr>
<td>Maximal</td>
<td>26.20</td>
<td>78.60</td>
</tr>
<tr>
<td>Minimal</td>
<td>7.00</td>
<td>39.00</td>
</tr>
<tr>
<td>Standard Deviation</td>
<td>5.59850</td>
<td>14.34130</td>
</tr>
<tr>
<td>Average</td>
<td>17.3855</td>
<td>53.6221</td>
</tr>
</tbody>
</table>

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>
<thead>
<tr>
<th>Paired Differences</th>
</tr>
</thead>
</table>

Table 5. The Paired Sample t-tests Result
N-gain score can be determined based on pretest and posttest results, as shown in Table 6.

<table>
<thead>
<tr>
<th>Class</th>
<th>Lowest N-gain Score</th>
<th>Highest N-gain Score</th>
<th>Average of N-gain score</th>
<th>Category</th>
</tr>
</thead>
<tbody>
<tr>
<td>Experimental</td>
<td>0.21</td>
<td>0.74</td>
<td>0.4435</td>
<td>Medium</td>
</tr>
<tr>
<td>Control</td>
<td>0.00</td>
<td>0.44</td>
<td>0.2162</td>
<td>Low</td>
</tr>
</tbody>
</table>

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

<table>
<thead>
<tr>
<th>Data</th>
<th>Nilai sig. (2-tailed)</th>
</tr>
</thead>
<tbody>
<tr>
<td>N-Gain</td>
<td>0.00</td>
</tr>
</tbody>
</table>

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>
<thead>
<tr>
<th>Indicators of SPS</th>
<th>Worksheet’s Point</th>
<th>Indicator’s Percentage (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Observing</td>
<td>Observing phenomenon</td>
<td>65.5</td>
</tr>
<tr>
<td>Making a hypothesis</td>
<td>Making a hypothesis</td>
<td>56.9</td>
</tr>
<tr>
<td>Defining Variables</td>
<td>Defining Variables</td>
<td>12.9</td>
</tr>
<tr>
<td>Testing Hypothesis</td>
<td>Designing the experimental procedure</td>
<td>57.5</td>
</tr>
<tr>
<td></td>
<td>Experiment properly</td>
<td>43.1</td>
</tr>
<tr>
<td>Presenting Data</td>
<td>Presenting experimental data in tables</td>
<td>42.5</td>
</tr>
<tr>
<td></td>
<td>Analyzing the experimental results and</td>
<td>26.7</td>
</tr>
<tr>
<td></td>
<td>discussion</td>
<td>26.7</td>
</tr>
<tr>
<td>Presenting Results</td>
<td>Making Conclusions</td>
<td>38.8</td>
</tr>
</tbody>
</table>

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.
**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.
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.
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.

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