Jurnal Inspirasi Pendidikan
14 (2), 2024, 73-87
https://ejournal.unikama.ac.id/index.php/jrnspirasi/index

Inquiry Training with WhatsApp for Learning in Vocational Schools

I Gede Budi Mahendra*[1a], Jocke Jonathan Rapar[1b], Viverdy Memah[1c], Billy Killis[1d]
[1]Universitas Negeri Manado, Tondano, Indonesia
e-mail: [a]igedebudimahendra@unima.ac.id, [b]jockewenas@unima.ac.id, [c]viverdymema@gmail.com, [d]billykillis@unima.ac.id
* Corresponding Author.

Received: December 12, 2024; Revised: January 5, 2025; Accepted: January 5, 2025

Abstract: Learning at vocational schools aims to prepare the younger generation for work or entrepreneurship. However, in Indonesia, vocational school graduates are the highest contributor to unemployment, namely 9.6%. To increase the competitiveness of graduates, vocational schools must improve the quality of education and vocational skills, especially scientific and mathematical process skills. The objective of this research is to assess the influence of incorporating the WhatsApp-assisted inquiry training on the science process skills and mathematical representation abilities of vocational school students enrolled in the electricity skills program. The study was carried out as a quasi-experiment employing a non-equivalent control group design. A saturated sample of 85 respondents from three classes, including one experimental class and two control classes, was utilized. Prior to the intervention, a pretest was administered. The experimental class received the inquiry training with WhatsApp, while the control class 1 received the inquiry training, and the control class 2 received the direct instruction. The findings of the study indicate that the inquiry training with WhatsApp yields a positive impact and is more effective in enhancing the science process skills and mathematical representation abilities of vocational school students in comparison to the inquiry training model and the direct instruction model, achieving an mean score of 84.16 and an N-Gain score of 0.72 in the high category.
Keywords: Inquiry Training, Whatsapp, Science Process Skills, Vocational School, Mathematical Representation Ability.

How to Cite: Mahendra, I. G. B., Rapar, J. J., Memah, V., & Killis, B. (2024). Inquiry Training with WhatsApp for Learning in Vocational Schools. *Jurnal Inspirasi Pendidikan, 14*(2), 73-88. https://doi.org/10.21067/jip.v14i2.11115

Introduction

The introduction section must contain (in sequence) a general background, a previous literature study (state-of-the-art) as a basis for the statement of the scientific novelty of the article, a statement of the scientific novelty of science, and a research problem or hypothesis. At the end of the introduction, the purpose of the article should be clearly written. In the scientific article format, it is not permissible to review the literature as in the research report, but it is manifested in the form of a previous study review (state-of-the-art) to demonstrate the scientific novelty of the article.

https://doi.org/10.21067/jip.v14i2.11115

As a formal education pathway in Indonesia, Vocational High Schools prepare the younger generation with relevant and proficient vocational skills (Suharno et al., 2020). Vocational High Schools prepare each student to successfully transition into the workforce, be employed, or become an entrepreneur (Hassan et al., 2021). However, in reality, in the field, vocational schools still have many problems and challenges (Kailani & Rafidiyah, 2020; Usman & Hamid, 2022). A concerning issue is that vocational school graduates consistently have the highest unemployment rate compared to graduates from other educational levels (Soelistiyono & Feijuan, 2021). In Indonesia, vocational school graduates hold the highest unemployment rate among all education levels, at 9.6% (Yuliyanto & Adam Rahmanto, 2023). It is crucial for vocational schools to raise their standards to ensure their graduates possess stronger competitiveness in the job market. This can be achieved by improving the quality of education or perfecting graduates' skills (Krismadinata et al., 2020).

Providing a quality learning activities is one way to enhance the level of competitiveness among graduates in the global job market (Mahmudah & Putra, 2021). The development of a wide range of skills that can be utilized to solve real-world problems is essential in the teaching and learning process at vocational schools (Suliyanah et al., 2021; Fitriyanti Zulaikha et al., 2021). For this reason, learning must be guided in order to assist students in acquiring a diverse range of knowledge and skills, such as science process skills and scientific skills (Ahmad et al., 2020). Students possessing science process skills can enhance their problem-solving capabilities (Ramdani et al., 2021). However, in reality, students in vocational schools do not master science process skills (Fadilla et al., 2019; Gunawan et al., 2019; Anisa et al., 2021).

Another goal of learning in vocational schools is to help students interpret and build multiple representations. Multiple representations encompass mathematical, verbal, graphic, and visual depictions (Widarti et al., 2022). The utilization of representation strategies has the potential to streamline problems that are deemed intricate and convolute. One of the representation formats that can facilitate students in solving problems is mathematical representation (Septian et al., 2020; Moore et al., 2020). Theories and concepts in vocational school learning are usually described in the form of mathematical equations, especially in vocational school electricity skills programs. Students can understand these theories or concepts and solve problems that are considered complicated and complex easily if they have mathematical representation skills (Goos & Kaya, 2020; Suryani & Mashuri, 2023). However (Putri & Effendi, 2021) found that vocational school students' mathematical representation abilities were still not optimal. This is in line with what was found (snarto Isnarto, 2022) where 66.67% of vocational school students tested had low mathematical representation abilities. This is reinforced by findings (Ratumanan et al., 2022) The results indicate that 77.5% of the students tested have weak mathematical representation skills, highlighting that vocational school students' abilities in this area are still lacking. Therefore, it is essential to implement teaching methods that can enhance their science process skills and mathematical representation abilities to improve overall learning outcomes (Mutlu, 2020; Fathiya et al., 2020).

Inquiry Training offers teachers a viable solution and alternative approach to enhance students' science process skills (Dyan Wulan Sari Hs & Agus Kistian, 2020). Improving students' science process skills can be accomplished by applying educational methods that integrate the principles of Inquiry Training (Solikin et al., 2020). Additional studies have also indicated that the utilization of the

Inquiry Training method in education can enhance students' proficiency in mathematical representation, although not significantly (Wulandari et al., 2019). Learning that uses the Inquiry Training approach implicates students directly in the process of looking for problems and then carrying out investigations into these problems in a systematic, logical and analytical way (Suryono et al., 2023). The Inquiry Training encompasses several steps for learning activities, which are as follows: (1) presenting problems to students, (2) collecting data for verification, (3) conducting experiments to gather data, (4) analyzing data and developing explanations, and (5) evaluating the research process (Fitriani et al., 2020). So Inquiry Training is a very consistent approach to be applied in the learning process at vocational schools which prioritizes skills in work practice.

In the current digital era, technology has experienced rapid development (Bonfield et al., 2020). One example includes the advancement of communication devices such as smartphones (Amaliyah et al., 2021). This rapid development encourages the use of smartphones in various areas of life, thereby opening up opportunities for using smartphones in teaching and learning activities (Qodr et al., 2021). In order to maximize the use of smartphones, it is necessary to innovate by conducting learning through social media (Nuraini et al., 2020). WhatsApp is a social media application that can be utilized for educational purposes (Durgungoz & Durgungoz, 2022; Berewot & Fibra, 2020). WhatsApp is widely recognized as a prevalent and efficient educational instrument, facilitating the learning journey for both educators and learners in both formal and informal settings. Serving as an interactive medium for communication, it holds the promise of enhancing the overall academic standards (Selvan & Kalaiyarasan, 2023). Despite not being specifically designed for educational environments, this application's benefits demonstrate its potential as a valuable tool for providing appropriate education and support in the teaching and learning process at the academic level (Suárez-Lantarón et al., 2022).

Based on the aforementioned explanation, this research will implement a WhatsApp-assisted inquiry training model to aid students in enhancing their science process skills and mathematical representation abilities. So that multiple interpretations do not arise and the research becomes more focused, the problem is limited, namely: (1) Learning is carried out within the scope of the Vocational School for Electrical Skills Program. (2) The science process skills that have been examined encompass the abilities to observe, develop hypotheses, carry out experiments, measure, and draw conclusions. (3) The indicator of mathematical representation ability used is determining mathematical equations and carrying out calculations on the problems used. The objective of this research is to the impact of implementing learning using the Inquiry Training with WhatsApp on the development of science process skills and mathematical representation abilities of vocational school students in the electricity skills program.

Method

The research carried out was a quasi-experiment. Quasi-experimental methods were used because they allow exploration of theoretical viewpoints in cause-effect relationships (Miller et al., 2020). The study employed a non-equivalent control group design. This design was implemented because it was impossible to take research samples randomly, because from the start the classes had been determined by the school so that in each class there were students with low, medium and high abilities or it could be said that the distribution of students' abilities was even. The table 1 below presents a detailed summary of the research design.

Table 1. Research Design

Class	Pretest	Treatment	Posttest
Experimental Class	S_{a1}	X_a	S_{a2}
Control Class 1	S_{b1}	X_b	S_{b2}
Control Class 2	S_{c1}	X_o	S_{c2}

There are three classes in this design, consisting of one experimental class and two control classes. Prior to the treatment, a pretest is administered. The experimental class receives treatment through inquiry training with the assistance of WhatsApp. Control class 1 undergoes treatment through inquiry training, while control class 2 undergoes treatment through direct instruction learning. Finally, a posttest is conducted on all three classes to assess the students' abilities after receiving the treatment.

The study sample included all class XI TL students at SMK Negeri 2 Manado during the academic year 2023/2024, comprising a total of three classes. The population in this study is assumed to have an equivalent level of knowledge. The sampling technique used is a saturated sample (Suriani et al., 2023). This method is used if the entire research population is used as the sample. The experimental and control classes were assigned by conducting two independent lottery draws. The first draw was to determine the experimental class, where the selected experimental class was XI TLB, totaling 30 students. The second draw was to determine the first control class, where the first control class selected was XI TLA, totaling 28 students. Meanwhile, the second control class is XI TLC, totaling 27 students. As a result, the total number of research participants amounted to 85 students.

Data collection methods can be categorized into two types: tests and non-tests. Test techniques are used to gather data on mathematical representation abilities, while non-test methods are employed to collect data on science process skills and the implementation of learning models. A pretest is administered before the treatment to assess initial abilities, while a posttest is conducted afterward to evaluate the effect of the treatment. The non-test method involves observation during the treatment process. The steps used in collecting research data are shown in Figure 1.

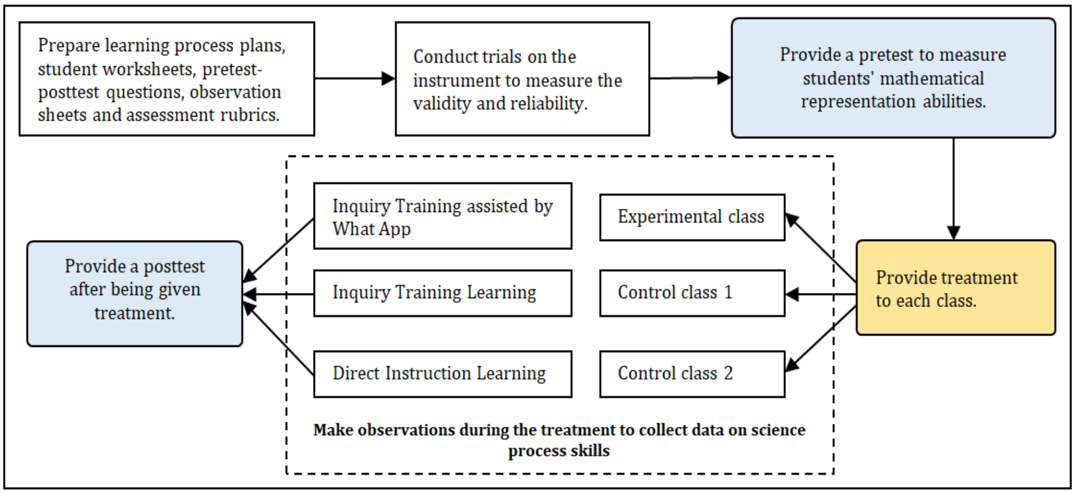

Figure 1. Research data collection steps

Test instruments and non-test instruments are utilized in this study. The test instrument aims to assess mathematical representation abilities through pretest-posttest question sheets. Conversely, an observation sheet is used as a non-test instrument to assess science process skills and the implementation of the learning model. Science process skills are evaluated using observation sheets, which contain specific indicators of these skills as identified by the researcher. Observers conduct observations while students are engaged in group learning activities. This sheet is utilized in all three sample classes.

The questions used are questions describing cognitive levels C2 and C4. The same questions were used during the pretest and posttest. The items used are items that have passed validity tests, both logical validity (expert opinion) and empirical validity (trial testing). The pretest is administered prior to the treatment to assess mathematical representation skills before any intervention is provided. Following the treatment, the posttest is conducted to evaluate mathematical representation abilities. Additionally, the scores obtained are used to evaluate the impact of the treatment on mathematical representation skills within each group.

The Learning Model Implementation Observation Sheet evaluates the teacher's application of the learning model using three distinct sheets. The first assesses Inquiry Training supported by WhatsApp in the experimental class, the second evaluates Inquiry Training in control class 1, and the third focuses on direct instruction in control class 2.

Data analysis is conducted to examine data related to scientific process skills, mathematical representation abilities, and the utilization of inquiry training with the support of WhatsApp for learning about measuring electrical quantities. This research uses descriptive statistics for data analysis, including the mean, minimum, maximum, standard deviation, and implementation percentage. The mean is assessed against established criteria, detailed in Table 2.

Table 2. Science Process Skills Category

Score	Category
80.1 - 100	Very high
60.1 - 80	High
40.1 - 60	Currently
20.1 - 40	Low
0.0 - 20	Very low

The mathematical representation ability data obtained through the test was analyzed for improvement using N-Gain. Each student and class has their N-Gain value calculated. The equation used is as follows.

$$\mathrm{N-Gain} = \frac{\text{Posttest score} - \text{Pretest score}}{\text{Maximum score} - \text{Pretest score}}$$

The values that have been obtained are then interpreted into the N-Gain criteria. The N-Gain criteria are presented in Table 3.

Table 3. Mathematical Representation Ability Category

N-Gain Score	N-Gain Category
0.70 < *N-Gain* ≤ 1.00	High
0.30 < *N-Gain* ≤ 0.70	Medium
N-Gain ≤ 0.30	Low

The percentage of implementation of the model can be calculated using the following equation.

$$\text{Persentase } 100\% = \frac{\sum(\text{steps carried out in learning})}{\sum(\text{total learning steps})} \times 100\%$$

Results

This study was conducted at SMK Negeri 2 Manado, focusing on XI grade students in the Electrical Engineering program. Three classes were selected as samples: one experimental group and two control groups. The main objective was to evaluate the effect of WhatsApp-assisted Inquiry Training on students' science process skills and mathematical representation abilities, using a quasi-experimental design.

In each class, treatment is given in three meetings (9 JP) on measuring electrical quantities. The experimental class received inquiry training treatment assisted by WhatsApp, while control group 1 received inquiry learning treatment and control group 2 received direct learning treatment. Before being given treatment, a pretest was administered to evaluate the students' initial mathematical representation abilities. During the treatment, two types of observations were carried out, namely observations that focused on science process skills during experimental activities, and observations on the application of learning during the learning process. After completing the treatment, a posttest is carried out to measure final abilities and compare them with the initial abilities assessed previously. Observers use observation sheets to make observations. The science process skills observation sheet serves as a measurement tool to assess the level of science process skills demonstrated.

Science Process Skills

Observers observe the science process skills of each student while they conduct experiments. The experiments at the first meeting, second meeting, and third meeting respectively were experiments on single-phase power measurements, lighting measurements, and ground resistance measurements. The value of science process skills in this research was obtained by adding up the value of each meeting and then dividing it by the number of meetings. A description of the data from measuring science process skills is presented in Table 4.

Table 4. Data Description Science Process Skills

Criteria	Class		
	Experimental	Control 1	Control 2
mean	84.16	80.98	77.22
maximum	92.50	92.50	85.00
minimum	75.00	70.00	70.00
St. Deviation	5.14	6.06	4.87
Variance	26.43	36.73	23.71

Data analysis in Table 4 shows that the mean scores for the experimental class, control class 1, and control class 2 were 84.16, 80.98, and 77.22, respectively. The experimental class is categorized as very high, as is control class 1, while control class 2 is classified as high. The experimental class's average score exceeds that of control class 1 by 3.18 points.

The science process skills that have been examined include observation, hypothesis formulation, experimentation, measurement, and conclusion. The outcomes of the mean scores analysis for each science process skill type in the three sample classes are shown in Figure 2.

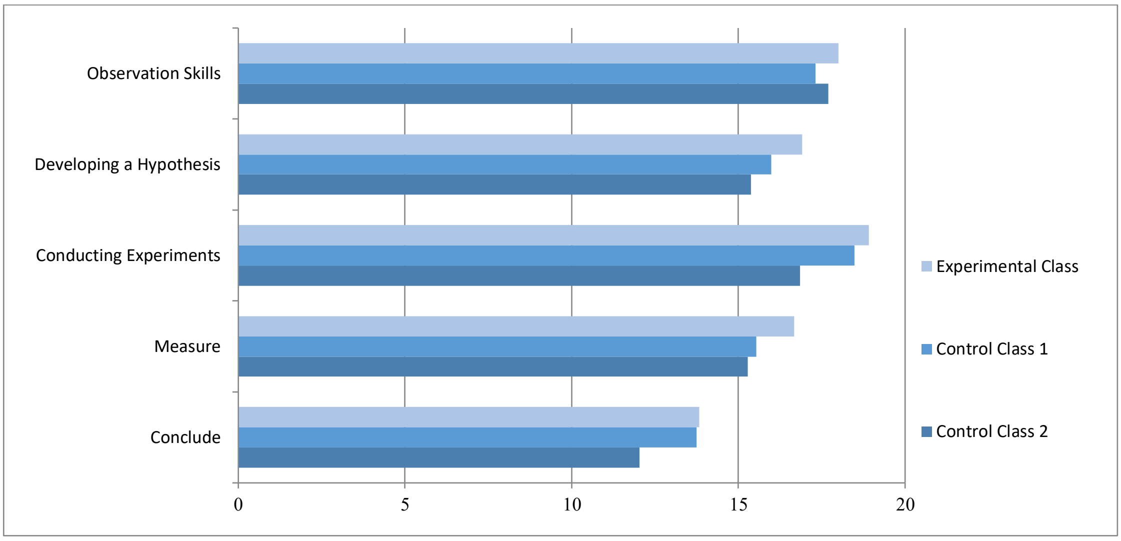

Figure 2. Scores for types of Science Process Skills in each sample class

Figure 2 illustrates that in both the experimental class and control class 1, the skill with the highest mean score is the ability to conduct experiments, with mean scores of 18.92 for the experimental class and 18.48 for the control class 1. Meanwhile, in control class 2, the highest score was observation skills with a mean score of 17.69. Meanwhile, concluding skills are the skills with the lowest mean score in all sample classes. The mean score in each class was 13.83 for the experimental class, 13.75 for control class 1, and 12.104 for control class 2.

Mathematical Representation Ability

Assessment items designed to evaluate representational skills consist of pretest and posttest questions. These questions are identical, totaling 8 essay questions. Table 5 presents data on the pretest and posttest results regarding the mathematical representation abilities of the experimental class and the two control classes.

Table 5. Data Description Mathematical Representation Ability

Criteria	Class					
	Experimental		Control 1		Control 2	
	Pretest	Posttest	Pretest	Posttest	Pretest	Posttest
Mean	46.50	84.16	45.89	71.42	54.44	71.70
Maximum	70.00	100.00	75.00	95.00	75.00	95.00
Minimum	25.00	60.00	20.00	40.00	25.00	40.00
St. Deviation	12.11	9.38	16.83	12.97	14.29	11.66
Variance	146.81	88.07	283.43	168.25	204.48	136.06

The descriptive analysis in Table 5 shows a significant improvement in average scores after the intervention. The experimental group's mean score rose by 37.66, while control class 1 increased by 25.53 and control class 2 by 17.26, indicating advancements in mathematical representation skills across all groups. Notably, the experimental group had the largest increase. Additionally, the highest scores improved by 30.00 for the experimental group, and 20.00 for both control classes. The minimum scores also increased, with the experimental class rising by 35.00, control class 1 by 20.00, and control class 2 by 15.00.

In addition to examining the mean value, one can also assess the improvement in the mathematical representation skills of the three sample groups through N-Gain. These values are derived from the pretest and posttest outcomes. Figure 3 illustrates the mean N-Gain for the experimental, Control 1, and Control 2 classes.

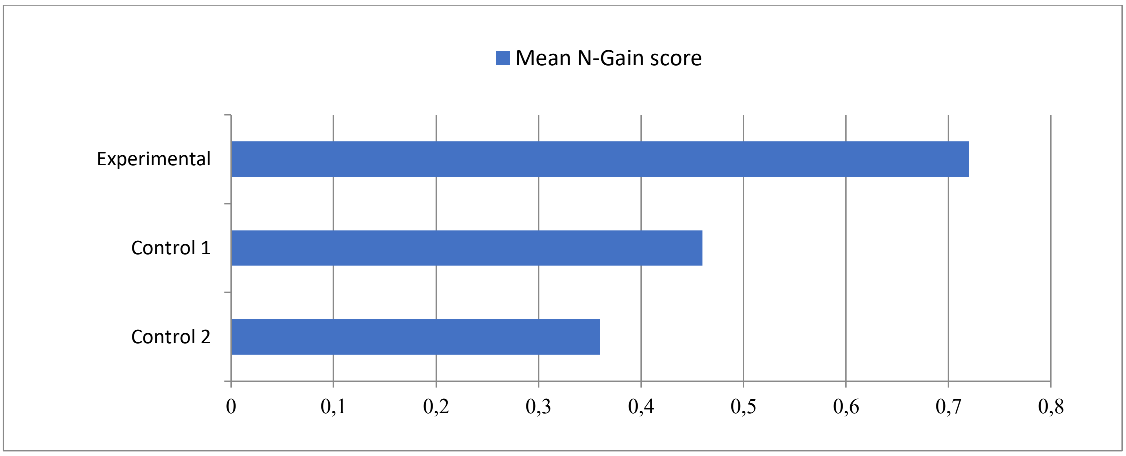

Figure 3. *Mean N-Gain score of Mathematical Representation Ability*

Figure 3 shows that the mean N-Gain scores are 0.72 for the experimental class, control classes 1 are 0.46 and control classes 2 are 0.36, respectively. This indicates a high N-Gain score for the experimental class, while both control classes are medium. The results suggest that the experimental class has superior mathematical representation skills, which involve formulating equations from problems and performing calculations. For a detailed analysis of the mean N-Gain scores for each indicator of mathematical representation ability across the three classes, see Table 8.

Table 6. Mean N-Gain score for every aspect of mathematical representation ability

No	Indicator	Average N-Gain		
		Ex	C 1	C 2
1	Determine mathematical equations based on the problems presented	0.74	0.50	0.40
2	Perform calculations to solve the problems presented	0.70	0.42	0.32

Table 6 are shown that in the experiment class, control 1 class, and control 2 class, the mean N-Gain score for indicator 1 (Determining mathematical equations based on the problems presented) is higher than that of indicator 2 (Performing calculations to solve the problems presented). In the experiment class, the mean N-Gain score for indicator 1 was 0.74, while for indicator 2 it was 0.70. In control 1 class, the mean N-Gain score for indicator 1 was 0.50, whereas for indicator 2 it was 0.42. Similarly, in control 2 class, the mean N-Gain score for indicator 1 was 0.40, and for indicator 2 it was 0.32. Furthermore, the analysis results indicate that students' ability to determine mathematical equations is higher than their ability to carry out calculations to solve problems, as evidenced by the mean N-Gain scores for each indicator.

Implementation of the Learning Model

Observation of the learning process is conducted by an observer at every meeting during the learning process which is intended to find out whether the RPP that has been prepared has been implemented optimally or has not been implemented optimally. Observations are carried out by filling in the implementation observation sheet provided. Figure 4 presents a summary of the application of the learning model.

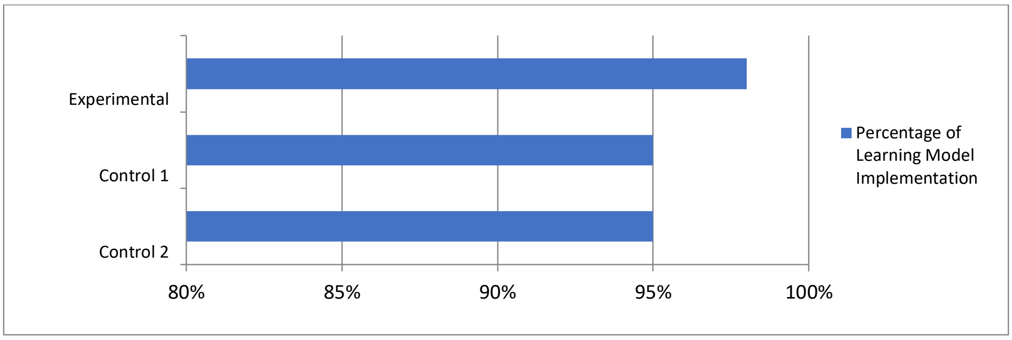

Figure 4. Percentage of Learning Model Implementation

The recapitulation results shown in Figure 4 generally show that the learning plan prepared has been implemented well. The experimental class that was given inquiry training learning treatment assisted by WhatsApp has implemented 98% of the learning plan. For control class 1, 98% has been implemented and control class 2 has been implemented 95%. This indicates that the treatment for each sample class was implemented correctly and in alignment with the learning process plan (RPP).

Discussions

The primary aim of the research is to find out the influence of learning inquiry training with WhatsApp on students' science process skills. To determine this, one can examine the average scores of each class. The analysis reveals that the scores in the experimental class surpass those in the two control classes. Specifically, there is a discrepancy of 3.18 between the experimental class and control class 1, and a difference of 6.94 between the experimental class and control class 2. The minor score difference between the experimental and control class 1 is due to their similar instructional models, while the significant advantage of the experimental class stems from using WhatsApp. Out of 20 assessed indicators of science process skills, only 3 showed improvement with WhatsApp. Consequently, it is reasonable that the score gap between the two classes is not significant. Nevertheless, these findings indicate that inquiry training with WhatsApp proves to be more successful compared to both the inquiry training and direct instruction models. Notably, the average score in control class 1 surpasses that of control class 2, highlighting the effectiveness of the inquiry training model over the direct instruction model.

The WhatsApp-assisted inquiry training has syntax that can help students develop and improve science process skills. The stages in this model are used as the basis for preparing the RPP and LKPD which are used during the learning process. The learning stages in the RPP that use the inquiry training assisted by WhatsApp and those that use the inquiry training consist of 5 phases, namely (1) Problem encounter, (2) Verification of data gathering, (3) Experimentation for data gathering, (4) Development of an explanation, (5) Examination of the inquiry process. The difference in the two RPPs lies in whether there is use of WhatsApp, namely in phases (1), (2), and (4). The steps of the inquiry training in the LKPD are phases (1), (3), and (4).

According to the earlier clarification, it is evident that the learning model employed in the experimental class and control class 1 is identical. The distinction lies in the utilization or non-utilization of media, specifically WhatsApp being utilized by the experimental class while the control class 1 does not utilize any media. WhatsApp is predominantly utilized for learning activities outside of the classroom, such as discussing lesson content, sharing and collecting assignments, and engaging in other learning-related tasks. The discussion process on WhatsApp can facilitate concluding skills for indicators of discussing experimental results with group members. Therefore, WhatsApp is the right media to use to facilitate students' science process skills.

Discussions are able to increase student participation so that they become more active (Kamelsa et al., 2021). Discussions via WhatsApp are more flexible than face-to-face discussions (Agustin Mawarni et al., 2020), because learning via WhatsApp can be done in different formats. This has the potential to improve students' learning abilities in depth and enable them to build their own knowledge. The research results obtained are in line with statement (Nunaki et al., 2020), where through inquiry learning students have personal experience of the scientific search process in order to find knowledge so that it provides meaningful perceptions and can grow their science process skills. The research findings are also consistent with the results (Solikin et al., 2020) and (Darma et al., 2022), It is widely recognized that inquiry training is an effective method for enhancing students' science process skills. Using WhatsApp can enhance the development of these skills. Students with advanced science process skills often exhibit increased engagement in the learning process. This is in line with (Astalini et al., 2023) and (Inayah et al., 2020) which reveal that science process skills can facilitate students to develop curiosity and make them active. In contrast, students engaging in direct instruction may lack firsthand exposure to the scientific inquiry process due to the teacher-centered nature of the learning approach. Consequently, their proficiency in science process skills tends to be inferior to that of peers utilizing the inquiry training with WhatsApp support.

The second research objective examines the impact of WhatsApp-facilitated inquiry-based training on students' mathematical representation skills, assessed through pretest and posttest scores from three classes. Pretest scores showed no significant differences: the experimental class scored 46.50, control class 1 scored 45.89, and control class 2 scored 54.44, indicating comparable skills before intervention. However, posttest results revealed significant improvements, with the experimental class scoring 84.16, while control class 1 and control class 2 scored 71.42 and 71.70, respectively. Mean N-Gain scores further highlight these differences: the experimental class had a high mean N-Gain of 0.72, while control class 1 had a medium score of 0.46, and control class 2 scored 0.36. This comparison demonstrates that WhatsApp-supported inquiry training is more effective in enhancing students' mathematical representation skills than the other instructional models.

The inquiry training assisted by WhatsApp offers syntax that enables students to enhance and refine their mathematical representation skills. This stage is located in the fourth phase (formulation of an explanation). During this phase, the teacher guides students to process experimental data by first writing down the correct equation and then carrying out mathematical calculations to obtain the value of the quantity sought. Apart from that, in online learning via WhatsApp the teacher gives students individual assignments and then asks them to submit them via WhatsApp within a predetermined time limit. Students have the opportunity to ask questions regarding the material and assignments given. After the time limit ends, the answer key for the assignment is distributed and then the teacher asks students to match their respective answers according to the answer key. The activities above are proven to be able to be used to hone students' mathematical representation skills. Problems in electricity often have to be solved quantitatively using a mathematical modeling approach (Srinivasan et al., 2023). Therefore, it is important to have or master these abilities in learning at vocational school (Wahyudi, 2021).

In classes that were given treatment in the form of an inquiry training learning model without the help of any media, mathematical representation abilities were only facilitated in phase 4, because learning was only carried out during the available lesson hours and not outside of them. As for classes that were given treatment in the form of a direct instruction model, apart from processing experimental data, mathematical representation abilities were also facilitated when the teacher provided example questions or gave practice questions. However, the limited time available is not as much as learning via WhatsApp.

Thus, it can be concluded that WhatsApp is the right media to combine with the inquiry training learning model in terms of facilitating students' mathematical representation abilities. During the learning process using the inquiry training, most of the time is allocated to practice conducting investigations, so that the time available for delivering material or discussions related to learning material is very limited (Pratikno et al., 2020; Suryono et al., 2023). This is in line with (Mulyono et al., 2021) which states that time limitations can be overcome through online learning using WhatsApp. Choosing the right model and media can make learning of higher quality so that it can facilitate students' hidden potential. (Matitaputty & Sopacua, 2023) revealed that the effectiveness of learning cannot be separated from good learning models and media. This is because media and learning models play an important role in the learning process (Irvy, 2020). Based on what has been discussed, inquiry training learning with WhatsApp has the potential to serve as an alternative educational approach in vocational schools to enhancing students' proficiency in science process skills and mathematical representation so that it can be applied to different subjects and grade levels.

Conclusion

The recapitulation results show that both the experimental class using WhatsApp-assisted inquiry and control class 1 achieved a 98% compliance rate with the learning plan, while control class 2 had a 95% compliance rate. This indicates effective implementation of the instructional treatment. The study found that WhatsApp-assisted inquiry training significantly improves students' science process skills. The experimental group scored an average of 84.16, outperforming those taught through traditional methods. They excelled across all five indicators of science process skills, demonstrating that this approach is more effective than conventional teaching. Moreover, the WhatsApp-assisted inquiry model also enhanced students' mathematical representation skills, with the experimental class achieving a high N-Gain of 0.72, compared to the other teaching methods. This evidence supports the effectiveness of WhatsApp in improving both science process skills and mathematical representation in vocational education.

References

Agustin Mawarni, I. T., Ratnasari, N., Handayani, A. N., Muladi, M., Aji Wibowo, E. P., & Sri Untari, R. (2020). Effectiveness of Whatsapp in Improving Student Learning Interests During The Covid-19 Pandemic. *2020 4th International Conference on Vocational Education and Training (ICOVET)*, 248–252. https://doi.org/10.1109/ICOVET50258.2020.9230031

Ahmad, K., Nurkhin, A., Muhsin, M., & Pramusinto, H. (2020). Problem-Based Learning Strategy: Its Impact on Students' Critical and Creative Thinking Skills. *European Journal of Educational Research*, *9*(3), 1141–1150. https://doi.org/10.12973/eu-jer.9.3.1141

Amaliyah, A., Agusmiati, S., Zakiyah, B., Ummah, W. K., Hasanah, U., Baini, & Abdullah, D. (2021). Accelerated e-Learning Implementation through Youtube Videos Using Smartphones. *Journal of Physics: Conference Series*, *1899*(1), 012155. https://doi.org/10.1088/1742-6596/1899/1/012155

Anisa, R., Cahyono, E., & Sumarni, W. (2021). *IMPLEMENTASI DESIGN BASED LEARNING UNTUK MENINGKATKAN KETERAMPILAN PROSES SAINS DASAR MATERI ELEKTROKIMIA*.

Astalini, A., Darmaji, D., Universitas Jambi, Indonesia, darmaji@unja.ac.id, Kurniawan, D. A., Universitas Jambi, Indonesia, dwiagus.k@unja.ac.id, Wirayuda, R. P., Universitas Jambi, Indonesia, pwricky27@gmail.com, Putri, W. A., Universitas Jambi, Indonesia, witaardinaputri09@gmail.com, Rini, E. F. S., Universitas Jambi, Indonesia, endahfebri9@gmail.com, Ginting, A. A. Br., Universitas Jambi, Indonesia, agnesss.gintingmunthe@gmail.com, Ratnawati, T., & Universitas Jambi, Indonesia, triratnawati2312@gmail.com. (2023). Impact of Science Process Skills on Thinking Skills in Rural and Urban Schools. *International Journal of Instruction*, *16*(2), 803–822. https://doi.org/10.29333/iji.2023.16242a

Berewot, J., & Fibra, A. (2020). Whatsapp Messenger Among Higher Education Students: A Study on Whatsapp Messenger Usage for Project Learning. *Journal of Physics: Conference Series*, *1477*, 042018. https://doi.org/10.1088/1742-6596/1477/4/042018

Bonfield, C. A., Salter, M., Longmuir, A., Benson, M., & Adachi, C. (2020). Transformation or evolution?: Education 4.0, teaching and learning in the digital age. *Higher Education Pedagogies*, *5*(1), 223–246. https://doi.org/10.1080/23752696.2020.1816847

Darma, S., Nasution, I. S., Fadli, H., & Natalia, P. (2022). *The Effect of Inquiry Training Instructional Models Using Phet Media and Motivation toward Students Science Process Skill Junior High School Labuhan Deli Satu Atap Academic in 2022/2023*.

Durgungoz, A., & Durgungoz, F. C. (2022). "We are much closer here": Exploring the use of WhatsApp as a learning environment in a secondary school mathematics class. *Learning Environments Research*, *25*(2), 423–444. https://doi.org/10.1007/s10984-021-09371-0

Dyan Wulan Sari Hs & Agus Kistian. (2020). PERBEDAAN SIKAP ILMIAH SISWA MENGGUNAKAN MODEL PEMBELAJARAN INQUIRY TRAINING DENGAN MODEL PEMBELAJARAN DIRECT INSTRUCTION. *Jurnal Tunas Bangsa*, *7*(2), 174–188. https://doi.org/10.46244/tunasbangsa.v7i2.1160

Fadilla, N., Nurlaela, L., Maspiah, & Nur, M. (2019). Analysis of Student Science Process Skills in Faculty of Engineering State University of Surabaya. *Proceedings of the 1st Vocational Education International Conference (VEIC 2019)*. Proceedings of the 1st Vocational Education International Conference (VEIC 2019), Semarang, Indonesia. https://doi.org/10.2991/assehr.k.191217.036

Fathiya, Johar, R., Ahmad, A., & Annisa, D. (2020). The mathematics learning based on realistic mathematics to improve the mathematical representation ability in elementary school. *Journal of Physics: Conference Series*, *1460*(1), 012025. https://doi.org/10.1088/1742-6596/1460/1/012025

Fitriani, Harahap, M. B., & Bukit, N. (2020). Integrated Science Learning Development of Model Inquiry Training Based on Comics. *Journal of Physics: Conference Series*, *1428*(1), 012045. https://doi.org/10.1088/1742-6596/1428/1/012045

Fitriyanti Zulaikha, Z., Hariri, H., Faculty of Teacher Training and Education, Universitas Lampung, Indonesia, Rini, R., Faculty of Teacher Training and Education, Universitas Lampung, Indonesia, Sowiyah, S., & Faculty of Teacher Training and Education, Universitas Lampung, Indonesia. (2021). Analysis of vocational education curriculum in ASEAN Economic Community: A literature review. *Journal of Social, Humanity, and Education*, *1*(3), 157–170. https://doi.org/10.35912/jshe.v1i3.357

Goos, M., & Kaya, S. (2020). Understanding and promoting students' mathematical thinking: A review of research published in ESM. *Educational Studies in Mathematics*, *103*(1), 7–25. https://doi.org/10.1007/s10649-019-09921-7

Gunawan, G., Harjono, A., Hermansyah, H., & Herayanti, L. (2019). GUIDED INQUIRY MODEL THROUGH VIRTUAL LABORATORY TO ENHANCE STUDENTS' SCIENCE PROCESS SKILLS ON HEAT CONCEPT. *Jurnal Cakrawala Pendidikan*, *38*(2), 259–268. https://doi.org/10.21831/cp.v38i2.23345

Hassan, R. H., Hassan, M. T., Naseer, S., Khan, Z., & Jeon, M. (2021). ICT Enabled TVET Education: A Systematic Literature Review. *IEEE Access*, *9*, 81624–81650. https://doi.org/10.1109/ACCESS.2021.3085910

Inayah, A. D., Ristanto, R. H., Sigit, D. V., & Miarsyah, M. (2020). Analysis of Science Process Skills in Senior High School Students. *Universal Journal of Educational Research*, *8*(4A), 15–22. https://doi.org/10.13189/ujer.2020.081803

Irvy, I. I. (2020). Understanding the Learning Models Design for Indonesian Teacher. *International Journal of Asian Education*, *1*(2), 95–106. https://doi.org/10.46966/ijae.v1i2.40

Kailani, A., & Rafidiyah, D. (2020). OPPORTUNITIES AND CHALLENGES IN THE IMPLEMENTATION OF TEN REVITALIZATION STRATEGIES OF VOCATIONAL SCHOOLS IN INDONESIA: SCHOOL PRINCIPALS' VOICES. *International Journal of Educational Best Practices*, *4*(2), 60. https://doi.org/10.31258/ijebp.v4n2.p60-77

Kamelsa, L. P., Ristiono, R., Alberida, H., Yogica, R., & Zulyusri, Z. (2021). *Literature Study on the Application of the Talking Chips Learning Model to the Learning Competency of High School Students*. *5*.

Krismadinata, K., Verawardina, U., Jalinus, N., Rizal, F., Sukardi, S., Sudira, P., Ramadhani, D., Lubis, A. L., Friadi, J., Arifin, A. S. R., & Novaliendry, D. (2020). Blended Learning as Instructional Model in Vocational Education: Literature Review. *Universal Journal of Educational Research*, *8*(11B), 5801–5815. https://doi.org/10.13189/ujer.2020.082214

Mahmudah, F. N., & Putra, E. C. S. (2021). Tinjauan pustaka sistematis manajemen pendidikan: Kerangka konseptual dalam meningkatkan kualitas pendidikan era 4.0. *Jurnal Akuntabilitas Manajemen Pendidikan*, *9*(1), 43–53. https://doi.org/10.21831/jamp.v9i1.33713

Matitaputty, J. K., & Sopacua, J. (2023). The Effectiveness of the Learning Cycle 5E Learning Model in an Effort to Improve Learning Outcomes of History. *Jurnal Ilmiah Mahasiswa Pendidikan Sejarah*, *8*(2), 740–747. https://doi.org/10.24815/jimps.v8i2.24816

Miller, C. J., Smith, S. N., & Pugatch, M. (2020). Experimental and quasi-experimental designs in implementation research. *Psychiatry Research*, *283*, 112452. https://doi.org/10.1016/j.psychres.2019.06.027

Moore, T. J., Brophy, S. P., Tank, K. M., Lopez, R. D., Johnston, A. C., Hynes, M. M., & Gajdzik, E. (2020). Multiple Representations in Computational Thinking Tasks: A Clinical Study of Second-Grade Students. *Journal of Science Education and Technology*, *29*(1), 19–34. https://doi.org/10.1007/s10956-020-09812-0

Mulyono, H., Suryoputro, G., & Jamil, S. R. (2021). The application of WhatsApp to support online learning during the COVID-19 pandemic in Indonesia. *Heliyon*, *7*(8), e07853. https://doi.org/10.1016/j.heliyon.2021.e07853

Mutlu, A. (2020). Evaluation of students' scientific process skills through reflective worksheets in the inquiry-based learning environments. *Reflective Practice*, *21*(2), 271–286. https://doi.org/10.1080/14623943.2020.1736999

Nunaki, J. H., Siagian, S. I. R., Nusantari, E., Kandowangko, N. Y., & Damopolii, I. (2020). Fostering students' process skills through inquiry-based science learning implementation. *Journal of Physics: Conference Series*, *1521*(4), 042030. https://doi.org/10.1088/1742-6596/1521/4/042030

Nuraini, N. L. S., Cholifah, P. S., Putra, A. P., Surahman, E., Gunawan, I., Dewantoro, D. A., & Prastiawan, A. (2020). Social Media in the Classroom: A Literature Review: *Proceedings of the 6th International Conference on Education and Technology (ICET 2020)*. 6th International Conference on Education and Technology (ICET 2020), Malang, Indonesia. https://doi.org/10.2991/assehr.k.201204.050

Pratikno, P., Suyono, S., & Agustini, R. (2020). The Validity of Student Worksheets and Student Textbooks Inquiry Training Model on The Colligative Properties of Solution. *International*

Journal for Educational and Vocational Studies, *2*(11). https://doi.org/10.29103/ijevs.v2i11.3006

Putri, S. A., & Effendi, K. N. S. (2021). Analisis Kemampuan Representasi Siswa SMK. *Jurnal Penelitian Pendidikan dan Pengajaran Matematika*, *7*(2), 69–78. https://doi.org/10.37058/jp3m.v7i2.2652

Qodr, T. S., Efendi, A., & Musadad, A. A. (2021). Opportunities for Using Smartphones in the Digital Era to Facilitate Students in Learning Sociology in High Schools. *Journal of Education Technology*, *5*(2). https://doi.org/10.23887/jet.v5i2.34806

Ramdani, A., Jufri, A. W., Gunawan, G., Fahrurrozi, M., & Yustiqvar, M. (2021). Analysis of Students' Critical Thinking Skills in terms of Gender Using Science Teaching Materials Based on The 5E Learning Cycle Integrated with Local Wisdom. *Jurnal Pendidikan IPA Indonesia*, *10*(2), 187–199. https://doi.org/10.15294/jpii.v10i2.29956

Ratumanan, T. G., Ayal, C. S., & Tupamahu, P. Z. (2022). MATHEMATICAL REPRESENTATION ABILITY OF MATHEMATICS EDUCATION STUDY PROGRAM STUDENTS. *Jurnal Pendidikan Matematika (JUPITEK)*, *5*(1), 50–59. https://doi.org/10.30598/jupitekvol5iss1pp50-59

Selvan, T. & Kalaiyarasan. (2023). *Systematic Review on Utilization of Whatsapp in Education* [Preprint]. In Review. https://doi.org/10.21203/rs.3.rs-3577406/v1

Septian, A., Darhim, & Prabawanto, S. (2020). Mathematical representation ability through geogebra-assisted project-based learning models. *Journal of Physics: Conference Series*, *1657*(1), 012019. https://doi.org/10.1088/1742-6596/1657/1/012019

snarto Isnarto, E. B. W. (2022). Mathematical Problem Solving Ability of Vocational School Students Reviewed from Self Regulated Learning in Selective Problem Solving (SPS) Assisted Learning Management System (LMS) Learning. *Unnes Journal of Mathematics Education Research*, *11*(2), 171–180.

Soelistiyono, A., & Feijuan, C. (2021). *A Literature Review of Labor Absorption Level of Vocational High School Graduate In Indonesia:* International Joint Conference on Arts and Humanities 2021 (IJCAH 2021), Surabaya, Indonesia. https://doi.org/10.2991/assehr.k.211223.155

Solikin, Derlina, & Bukit, N. (2020). Science Process Skills Improvement in Medan High School Students Through Inquiry Training Learning Model. *Journal of Physics: Conference Series*, *1485*(1), 012022. https://doi.org/10.1088/1742-6596/1485/1/012022

Srinivasan, S., Kumarasamy, S., Andreadakis, Z. E., & Lind, P. G. (2023). Artificial Intelligence and Mathematical Models of Power Grids Driven by Renewable Energy Sources: A Survey. *Energies*, *16*(14), 5383. https://doi.org/10.3390/en16145383

Suárez-Lantarón, B., Deocano-Ruíz, Y., García-Perales, N., & Castillo-Reche, I. S. (2022). The Educational Use of WhatsApp. *Sustainability*, *14*(17), 10510. https://doi.org/10.3390/su141710510

Suharno, Pambudi, N. A., & Harjanto, B. (2020). Vocational education in Indonesia: History, development, opportunities, and challenges. *Children and Youth Services Review*, *115*, 105092. https://doi.org/10.1016/j.childyouth.2020.105092

Suliyanah, Deta, U. A., Kurniawan, F. K., Lestari, N. A., Yantidewi, M., Jauhariyah, M. N. R., & Prahani, B. K. (2021). Literature Review on The Use of Educational Physics Games in Improving Learning Outcomes. *Journal of Physics: Conference Series*, *1805*(1), 012038. https://doi.org/10.1088/1742-6596/1805/1/012038

Suriani, N., Risnita, & Jailani, M. S. (2023). Konsep Populasi dan Sampling Serta Pemilihan Partisipan Ditinjau Dari Penelitian Ilmiah Pendidikan. *Jurnal IHSAN : Jurnal Pendidikan Islam*, *1*(2), 24–36. https://doi.org/10.61104/ihsan.v1i2.55

Suryani, F., & Mashuri, M. (2023). Students' Mathematical Representation Ability in Cooperative Learning Type of Reciprocal Peer Tutoring from Learning Style. *Unnes Journal of Mathematics Education*, *12*(1), 13–22. https://doi.org/10.15294/ujme.v12i1.67545

Suryono, W., Winiasri, L., Santosa, T. A., Sappaile, B. I., & Solehuddin, Moh. (2023). Effectiveness of The Inquiry Training Model to Improve Students' Critical Thinking Skills in Learning: Systematic Literature Reviews and Meta-Analysis. *Jurnal Penelitian Pendidikan IPA*, *9*(10), 947–954. https://doi.org/10.29303/jppipa.v9i10.4804

Usman, A., & Hamid, A. (2022). The Status and Challenges of Entrepreneurship Education in Vocational Higher Education Institutions in Indonesia. *Jurnal Kewirausahaan Dan Bisnis*, *27*(2), 130. https://doi.org/10.20961/jkb.v27i2.60757

Wahyudi, W. (2021). Penerapan Model Pembelajaran Project Based Learning untuk Meningkatan Hasil Belajar Fisika Materi Listrik Statis dan Listrik Dinamis. *Journal of Education Action Research*, *Volume 5*(Number 1), 57–66. https://doi.org/10.23887/jear.v5i1.31997

Widarti, H. R., Hakim, M. I., & Rokhim, D. A. (2022). The Development of a Virtual Laboratory on Qualitative Chemical Practicum Analysis. *Jurnal Ilmiah Peuradeun*, *10*(3), 783. https://doi.org/10.26811/peuradeun.v10i3.760

Wulandari, Hariadi, M. H., Jumadi, Wilujeng, I., & Kuswanto, H. (2019). Improving Mathematical Representation Ability of Student's Senior High School by Inquiry Training Model with Google Classroom. *Journal of Physics: Conference Series*, *1233*(1), 012043. https://doi.org/10.1088/1742-6596/1233/1/012043

Yuliyanto, R., & Adam Rahmanto, A. (2023). Literature Review Evaluation of Fieldwork Practice Programs in Vocational High Schools in Indonesia. *JURNAL HURRIAH: Jurnal Evaluasi Pendidikan Dan Penelitian*, *4*(4), 433–443. https://doi.org/10.56806/jh.v4i4.162