Available online at: http://journal.uny.ac.id/index.php/jpip

Jurnal Penelitian Ilmu Pendidikan, 16 (1), 2023, 72-83

Interactive video's urgency on guided inquiry laboratory to improve integrated science process skills

Ince Raudhiah Zahra*, Didi Teguh Chandra, Dadi Rusdiana
Faculty of Mathematics and Science Education, Universitas Pendidikan Indonesia
Jl. Dr. Setiabudi No 229, Bandung 40154, West Java, Indonesia
**Corresponding Author. e-mail*: raudhiahzahra@upi.edu

Abstract

This study aimed to describe the analysis phase results on the ADDIE product development method, which forms the basis for the need for interactive videos in guided inquiry laboratory learning to improve integrated science process skills. The analytical procedures used were identifying gaps in the performance of students' integrated science process skills, identifying the cause, collecting infrastructure information, and determining appropriate products. Data was collected through tests and questionnaires from 42 students and 7 middle school science teachers in West Java. The results show that students' integrated science process skills are low. The cause is the rare provision of learning that facilitates students to design experiments. Students need more intensive guidance, but teachers have limitations in facilitating all the difficulties students face when designing and conducting experiments. Based on the results of an analysis of student characteristics, teacher difficulties, and availability of infrastructure, the interactive video in guided inquiry laboratory learning is suitable for addressing issues of readiness, time management, and difficulties in guiding students so it is hoped that integrated science process skills can improve.
Keywords: integrated science process skills, guided inquiry laboratory, interactive video

Peningkatan keterampilan proses sains terintegrasi menggunakan video interaktif pada inkuiri laboratorium terbimbing

Abstrak

Penelitian ini bertujuan untuk mendeskripsikan hasil fase analisis pada metode pengembangan produk ADDIE yang menjadi dasar diperlukannya video interaktif pada pembelajaran laboratorium inkuiri terbimbing untuk meningkatkan keterampilan proses sains terintegrasi. Prosedur analisis yang digunakan adalah mengidentifikasi kesenjangan keterampilan proses sains terintegrasi peserta didik, mengidentifikasi penyebab kesenjangan, mengumpulkan informasi infrastruktur, dan menentukan produk yang sesuai. Pengumpulan data dilakukan melalui tes dan angket dari 42 peserta didik dan 7 guru IPA SMP di Jawa Barat. Hasil penelitian menunjukkan bahwa keterampilan proses sains terintegrasi peserta didik tergolong rendah. Penyebabnya adalah kurang optimalnya pemberian pembelajaran yang memfasilitasi peserta didik untuk merancang eksperimen. Peserta didik membutuhkan bimbingan yang lebih intensif, namun guru memiliki keterbatasan dalam memfasilitasi semua kesulitan yang dihadapi peserta didik saat merancang dan melakukan percobaan. Berdasarkan hasil analisis karakteristik peserta didik, kesulitan guru, dan ketersediaan sarana prasarana, video interaktif dalam pembelajaran laboratorium inkuiri terbimbing dipilih karena sesuai untuk mengatasi masalah kesiapan, manajemen waktu, dan kesulitan dalam membimbing peserta didik sehingga diharapkan keterampilan proses sains terintegrasi dapat meningkat.
Kata kunci: *video interaktif, keterampilan proses sains terintegrasi, inkuiri laboratorium terbimbing*

How to Cite (APA): Zahra, I. R., Chandra D. T. & Rusdiana, D. (2023). Interactive video's urgency on guided inquiry laboratory to improve integrated science process skills. *Jurnal Penelitian Ilmu Pendidikan, 16*(1), 46-57. doi:https://doi.org/10.21831/jpipfip.v16i1.57969
Received 15-03-2023; Received in revised from 25-03-2023; Accepted 28-03-2023

INTRODUCTION

Mastering integrated science process skills is imperative for students to meet 21st-century learning demands. It will both help to carry out valid investigations (Damopolii et al., 2018; Turiman et al., 2012) and provide the basis for various higher-order thinking skill developments such as solving problems, critical thinking, and concluding based on evidence (Ergül et al., 2011). The urgency of possessing science process skills for students is also stated in the learning outcomes of Kurikulum Merdeka and the basic competence of Kurikulum 2013 in Indonesia (Kementrian Pendidikan dan Kebudayaan Indonesia, 2018, 2021). A learning model that is suitable to foster the acquisition of these skills is inquiry-based learning (Jauhar, 2011).

Inquiry-based learning is constructivist learning and the hallmark is the nature of student inquiry in a scientific context (Anderson, 2007). Like scientists, students are directed to connect ideas and theories to understand and explain things around them related to natural phenomena (Şahintepe et al., 2020). Implementing inquiry learning effectively and efficiently in science class will reduce teacher monopoly in learning activities and increase student enthusiasm (Soewarso, 2000). One of the suitable inquiry learning spectrums that involves direct investigation in the form of experimental activities is the guided inquiry laboratory (Wenning, 2011).

Guided inquiry laboratory learning is the most appropriate type for novice students who have not experienced inquiry learning (Blumer & Beck, 2019). Through this learning model, students gain an understanding of concepts through designing and conducting experiments with the teacher's guide based on the problems given (Afriani et al., 2019). Students who are not ready will get many benefits from the guidance provided to improve learning outcomes (Blumer & Beck, 2019). Assistance is imperative in guided inquiry learning, since the level of complexity of the abilities needed to be involved in the learning is quite high (Kaiser & Mayer, 2019). Based on previous research by Syarkowi and Malinda (2018), students find difficulties in determining variables, determining tools and materials, designing experiments, and making graphs in this learning. It happened due to students' lack of initial knowledge and readiness to take part in the learning. There is a large gap between the previous learning settings that students have received and the new learning in the form of an inquiry laboratory which leads to difficulties in adjusting (Kaiser & Mayer, 2019; Wenning, 2005). Therefore suitable instructions are needed to prepare and support students through guided inquiry learning.

Mainly, there is only one teacher who provides the instructions to facilitate all of the students in class. Therefore, it is unavoidable that teachers experience difficulties in guiding and answering any confusion experienced by each student in class, particularly in experimental-based learning. This led to low integrated science process skills achievement by Indonesian students (Fitrianingrum & Noor, 2022; Mahmudah et al., 2019; Wahyuni et al., 2020). Therefore, a learning media that helps teachers deliver these instructions effectively to students in class is needed so students can quickly adapt to guided inquiry laboratory learning and then maximize the acquisition of integrated science process skills. One of the suitable learning media for instruction delivery is a learning video.

Video is a type of learning media that has been widely used to support the implementation of inquiry learning (Afriani et al., 2019; Defianti et al., 2022; Isnayanti & Hardyanto, 2018; Kaiser & Mayer, 2019; Kant et al., 2017; Omarchevska et al., 2022; Solé-Llussà et al., 2019, 2020; Sudria et al., 2021). A video presentation can reduce students' cognitive load in learning and prepare them before learning (Devine et al., 2015). Therefore it can be used to deliver the needed instructions in guided inquiry laboratory learning. However traditional video’s characteristic which is lack of engagement is frequently criticized. Lacking variations in educational videos demotivates students (Weinert et al., 2020). While student’s engagement in watching a learning video is imperative to make them understand the video explanation. Therefore, the video should attract students’ engagement and facilitate their understanding of the video content, particularly for lower achiever students with low motivation.

Interactive video was developed to overcome the problem of using linear video which makes students become passive listeners by providing various types of interactivity (Palaigeorgiou et al., 2019). Interactive video or hyper video is a type of interactive multimedia (Balasubramanian, 2017). The difference between interactive videos and traditional videos (linear videos) lies in the presentation of the content. In traditional videos, content is presented sequentially from beginning to end. However, in interactive videos, each viewer can watch different video sequences and can repeat certain video clips according to the wishes and the options that are chosen (Papadopoulou & Palaigeorgiou, 2016). It is suitable for preparing and guiding students through guided inquiry learning since the interactivity is possible to provide embedded questions and direct feedback to engage and facilitate students' understanding of instructions explained in video content.

Despite the potential of the integration of interactive video in guided inquiry laboratory, there is limited research that has been emphasizing the importance of interactive video in guided inquiry laboratory learning to enhance integrated science process skills. Therefore, this study aims to explain the urgency of interactive videos to develop students' integrated science process skills in guided inquiry laboratory learning as a result of the analysis phase in product development using ADDIE method. The research questions in this study are: what is the profile of students' integrated science process skills?; what are the problems faced to improve the integrated science process skills?; and what learning media is most suitable to overcome these problems?. This study is important since it addresses the gap in knowledge regarding the use of interactive videos in guided laboratory inquiry and has the potential to inform instructional practices in science education.

METHOD

This research is a descriptive research that focuses on describing the results of the analysis of the first phase in the ADDIE development method. The ADDIE method is used to develop a product in the field of education. There are five phases in the ADDIE method, which are Analysis, Development, Design, Implementation, and Evaluation. The results presented in this study are the results of the analysis phase. The main objective of the analysis phase of the ADDIE method is to identify the causes of a performance gap (Branch, 2020). The analytical procedure used in this study was adopted and modified from the analytical procedure by Branch (2020), including validating performance gaps, identifying the causes of gaps, gathering information on infrastructure, and determining an appropriate product. The details of the analysis procedures can be seen in Figure 1.

Figure 1. Analysis phase procedures

The subjects of this research consisted of 42 students and 7 science teachers at junior high schools in West Java Province. The selection of this sample was carried out using a purposive sampling technique with consideration of the location of the school. There are two data collection techniques were used, namely 1) primary data from questionnaire results and the results of science process skills tests, and 2) secondary data from various literature to support primary data findings and complete the information needed in the analysis.

The used instruments to collect primary data were student questionnaires, teacher questionnaires, and students' integrated science process skills tests. Table 1 shows the aspects of asked questions in students' questionnaires, while Table 2 shows the aspects of asked questions in teacher's questionnaires. Student and teacher questionnaires were constructed in the form of open-ended and closed-ended questions. Then, the integrated science process skills test is constructed into 7 essay items. The indicators of integrated science process skills were shown in Table 3. All of the instruments have passed the validation process by two experts in the science learning field.

All the primary data is classified by the author as categorical data and analyzed using descriptive statistics. Students' answers to the integrated science process skills test were scored. Then the number of students who answer the questions for each indicator of integrated science process skills correctly and incorrectly is converted to a percentage. The percentage of students who answer correctly and incorrectly is then converted to a bar graph. A bar graph is suitable to illustrate the difference in proportions (Fraenkel et al., 2006). The primary data from the answers to the teacher and student questionnaires were analyzed based on the question type.

Table 1. *Aspects Asked in Students' Questionnaire*

Aspects	Descriptions
Students' understanding of the scientific method	Students' understanding of the meaning of the scientific method Students' understanding of the steps of hypothesis testing Students understanding of the concept of controlled experiments to produce valid conclusions
Students' knowledge of hypothesis testing terms	Students' knowledge of the meaning of the hypothesis, independent variables, dependent variables, controlled variables, and operational definition terms
Experiment activity experience	Students' knowledge of the experimental activity Student's difficulties in experimental activity Students' experience in designing an experiment
Technological support	Student's ability to use gadgets Students' availability of gadgets

Table 2. *Aspects Asked in Teachers' Questionnaire*

Aspects	Descriptions
Teachers' experience in implementing guided inquiry laboratory	Profile of teachers in implementing guided inquiry laboratory including their difficulties
Teachers' experience in facilitating students to design an experiment	Profile of teachers in facilitating students to design an experiment including their difficulties
Teachers' experience in explicitly teaching method/hypothesis testing steps	Profile of teachers in teaching the scientific method/testing hypotheses to students including their difficulties
Technological support	Teachers' experience of using gadgets in class School facilities to support internet access

Table 3. *Integrated Process Skills Indicators*

Indicators	Sub indicators
Stating Hypothesis	Stating a testable hypothesis
Identifying Variables	Identifying manipulated, responding, and controlled variable in an experiment
Operationally Defining	Identifying operational definitions for the variables
Designing Investigations	Identifying suitable equipment for the experiment Determining experiment procedures
Graphing and Interpreting Data	Identifying suitable graphs to represent the experiment result Identifying variables' relationship based on experiment result

Adopted from: Burns (1985) and Rustaman (2005)

The close-ended questions answer analyzed by determining the percentage based on the chosen answers. While the answers to open-ended questions were analyzed manually in several steps: listing the answers to the questions, grouping the answers based on their similarity, giving themes for each group's answers which represent the main idea of the answers, converting the number of respondents which answer for each theme to percentage. All the primary data analysis processes were done using excel spreadsheet. Then, the secondary data are used to strengthen the findings in this study and in considering the most suitable product based on the identification of the causes of the problem.

RESULTS AND DISCUSSION

Result

Students' integrated science process skills

Students' integrated science process skills were carried out based on the results of students' answers to the test questions. Based on their answers, when a description of an experimental objective is provided, only 5% of students were able to correctly determine the suitable and testable hypothesis of the experiment. As many as 21% of students have been able to write down suitable tools and materials in experiments and 10% of them had implied implicitly in their experimental steps that there were variables that were changed, measured, and maintained unchanged. However, the steps are still written incompletely, and there are still errors in determining the variables. So overall, only 7% of students were able to write down the experimental steps correctly.

All the students cannot make line graphs correctly. As many as 10% of them have written down the X and Y axes but the determination of variables on these axes is still not appropriate. However, there were already 30% of students who were able to make the right conclusions based on the experimental data presented in the questions. The data obtained based on students' answers to essay questions of the integrated science process skills test can be seen in Figure 2.

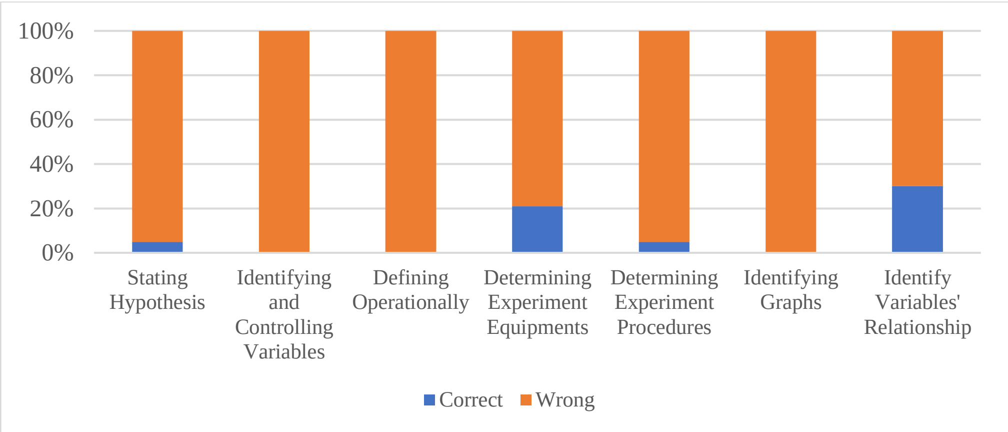

Figure 2. Percentage of students who answered correctly per integrated science process skills indicators.

Students' prior knowledge of experimental activity and their experience

Based on the questionnaire answers, 93% of students said they had done experimental activities before. However, they do not fully understand what experimental activity is. Only 7% of students said that experimentation was an activity to try something out. While the majority said that experimental activities were related to observing something (12%), practicing something (7%), activities to help understand science (7%), activities using laboratory equipment (5%), activities that produced something (7%), the activity of mixing chemical substances (7%) and the rest did not write down anything about the experiment.

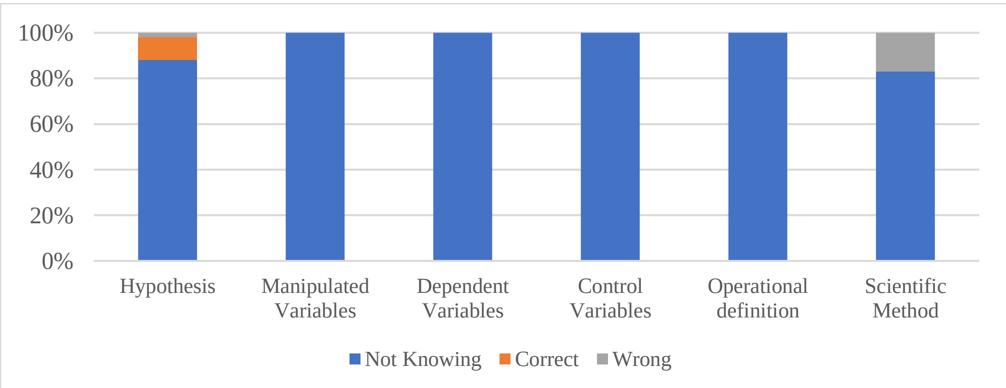

Figure 3. Learners' knowledge of the term's hypotheses, variables, operational definition, and scientific method

43% of students said they had learned to design experiments. However, it turns out that there are still many participants who are not familiar with various terms in hypothesis testing such as the term hypothesis, independent variable, dependent variable, control variable, operational definition, and scientific method (see figure 3). Only 12% of students claimed that they knew the term hypothesis, 10% of them said the hypothesis was a prediction from the results of an experiment or conjecture, while 2% of students understood the hypothesis inaccurately by saying the hypothesis was a description of something. All the students did not know the terms independent variable, dependent variable, control variable, and operational definition. As many as 81% of students did not know the term scientific method. According to those who claim to know the term, the scientific method is the same as experimentation (10%), the scientific method is related to how to do things (5%), and the scientific method is a step to produce a scientific solution (2%). 38% of students claimed to know the requirements for producing valid experimental conclusions. However, none of the students mentioned the concept of controlling variables in their questionnaire answers.

In addition, 88% of students did not know the steps of the scientific method. According to 12% of students who claimed that they knew the steps of the scientific method, 10% only mentioned that preparing material tools was one of the steps, then 2% of them were inaccurate by stating that finding out something and doing something was one of the steps of the scientific method.

Teachers' profile in facilitating experimental activity and inquiry learning

To consider the appropriate product in solving the gap, teachers' experiences including their difficulties in facilitating experimental activity and inquiry learning are identified. Based on the results of the questionnaire, it turns out that teachers also have problems teaching scientific method steps to students. The teacher needs to do the explanation of scientific method steps repeatedly thus it takes a lot of time and effort. Each student has different prior knowledge and pace so the teacher has difficulty providing explanations that can reach all students. The teacher explained that it was difficult to teach students to identify independent, dependent, and controlled variables in experiments. In fact, in experimental activities where the experimental steps have been given through worksheets, students are still difficult to guide because students tend not to read the directions given on worksheets.

Teacher difficulties are also found in implementing guided inquiry learning. As many as 100% agree that they have difficulties in guiding and facilitating students. As many as 25% of teachers experience difficulties in time management. Based on the results of the questionnaire obtained, as much as 50% of teachers had never implemented guided inquiry laboratory learning in science learning. The reason is due to limited learning time, concerns about the lack of responsiveness of students, and limitations of teachers in understanding and implementing the learning model itself.

Infrastructure survey results

The results of the questionnaire show that 100% of students have smartphones and 100% are used to accessing the internet using cell phones. The results of the teacher questionnaire also show that 86% of teachers are accustomed to integrating internet-based learning in their classes. Internet access in learning is supported by the existence of WIFI facilities in schools and can be obtained with student personal data packages.

Discussion

Based on the identification of students' integrated science process skills, it can be concluded that their skills are still low. Most students are not familiar with the terms in the scientific method and the concept of controlling variables. Although there have been some students who have shown controlling variables in their experimental steps, the determination of the variables is not precise, and the steps written have not been coherent and clear. Likewise, when interpreting data, only a few students can make conclusions containing the relationship between the independent variable and the dependent variable. All students have not been able to make line graphs. These findings were also found by Syarkowi and Malinda (2018) where students also still have difficulties in determining tools and materials, determining variables, designing experiments, and making graphs based on experimental results. Also, these finding supports previous study that show Indonesian students has a low integrated science process skills (Fitrianingrum & Noor, 2022; Mahmudah et al., 2019; Wahyuni et al., 2020)

The cause of the performance gap is identified from teachers' and students' answers to questionnaires. Based on the analysis, students have low integrated science process skills because they are not familiar with designing experiments. Therefore, it can be improved by giving students chance to design and conduct their experiment in an inquiry learning. One of the inquiry learning spectrums that are suitable for novices to improve their integrated process skills is the guided inquiry laboratory (Blumer & Beck, 2019). However, the implementation of guided inquiry learning also needs to consider the characteristics of students, teachers' limitations, and the availability of facilities. Therefore, further literature analysis was done to determine an appropriate product as a solution for more suitable guided inquiry learning implementation.

The need of preparation students for guided inquiry learning

Based on students' prior knowledge and their experience with experimental activity, students have a low understanding of experimental activities and the scientific method. Therefore, this certainly needs to be anticipated by introducing it before guided inquiry laboratory learning is carried out. According to Ausubel's theory of meaningful learning, before the teacher delivers learning material, they should provide directions on how to organize the information to be provided (advanced organizer). The advanced organizer can be in the form of an explanation regarding the relationship between the material to be studied and the previous material. It also can be in the form of explaining the things that need to be considered before delivering the material (Widodo, 2021). It is hoped that by providing initial conditioning for all students, students can be more prepared to take part in the new series of learning.

Students potentially have several risks when adjusting to guided inquiry laboratory learning. Some students who have high learning achievements in traditional learning will feel challenged and worried about the constructivist approach. This is because they are used to getting the right answer right away. Whereas in constructivist learning there is a process that they need to go through to understand it. Some students will also lack initiative in carrying out assignments and wait for other students to start or even wait for directions from other students (Wenning, 2005).

Barriers that students potentially must adapt in guided inquiry laboratory learning can be anticipated by classroom climate setting. This intervention requires 2 main components, which are the role of the teacher and the role of the students. In this setting, teachers need to help students understand the differences between inquiry learning and traditional learning. Teachers need to emphasize that the role of the teacher and the role of students change. The role of students is to talk more, ask questions, and be responsible for their learning. They can gain knowledge from their own experience. Giving climate settings can be done at the beginning of learning, or it can even be emphasized continuously so that students understand their role in inquiry learning (Wenning, 2005).

Based on several considerations above, to prepare students before guided inquiry learning, a brief introduction to the experimental activity, scientific method, and guided inquiry learning characteristics should be given to the students. Hopefully, by giving this explanation, students will understand what is expected from them and have a hint of what they will be doing in the learning. Therefore, they are expected to be able to understand the flow of learning and increase their enthusiasm for completing assignments given by the teacher.

The need for guiding students during guided inquiry laboratory

There are five learning steps in guided inquiry laboratory learning, namely observation, manipulation, generalization, verification, and application (Wenning, 2011). At observation step, the teachers will direct the students to propose an experimental question based on observed phenomena. Afterward, at the manipulation step, the teacher will facilitate students to design their experimental activity in their group. Then, the students will interpret the data and make a conclusion in generalization step. In verification step, the result of the experimental activity is communicated to the class, before finally in application step, the students will solve everyday problems related to the concept they constructed from the experimental activity.

The result from the students' questionnaire shows that students have a low understanding of scientific method steps. Whereas, knowing the scientific method is a good introduction before direct experience with experimental activities (Emden, 2021). The scientific method needs to be taught to students because the steps are easy to follow and simple (Ioannidou & Erduran, 2021). Therefore, it is important to teach students how to apply the scientific method during guided inquiry learning.

The solution that can be given is giving direct instructions about scientific method steps on guided inquiry laboratory learning. Based on a literature review, direct instruction helps students to know what they should do to complete a task. By providing the necessary information, it is hoped that student performance can be better and achieve maximum learning outcomes. Learning combined with detailed guidance will make students adapt to scientific investigation activities and improve their scientific reasoning abilities (Schlatter et al., 2020). Direct instructions can be given at each step of guided inquiry laboratory learning. The provided direct instruction needs to be focused on maximizing the acquisition of integrated science process skills.

Referring to the indicators of integrated science process skills by Burns (1985), integrated science process skills include formulating hypothesizing, identifying and controlling variables, operationally defining, designing experiments, and interpreting data. Therefore, in particular, the integrated science process skills are trained in the manipulation and generalization stages of guided inquiry laboratory learning, which is when students plan experiments and make conclusions based on experimental results. However, as an advanced science process skill, ensuring students also practice the basic science process skills needed in a series of lessons is also necessary. Therefore, each stage has a role to improve integrated science process skills.

Interactive video to prepare and guide students in guided inquiry laboratory learning

In accordance with the results of the analysis in the previous discussion points, students need to be prepared and assisted during guided inquiry laboratory learning to maximize the acquisition of integrated science process skills. However, based on this study result, teachers have several difficulties in implementing inquiry learning such as time constraints, which is also found in a previous study by Sudria (2021). Teachers also have problems in facilitating each student and guiding them through inquiry learning and experimental activity.

Based on the results of questionnaire answers from teachers who have implemented guided inquiry laboratory learning, all of them agree that they have difficulties in guiding and directing students. The teacher needs to do the explanation of these scientific method steps repeatedly, so it takes a lot of time and effort. The teacher's difficulty in guiding students through guided inquiry laboratory learning will make it harder for the students to adapt quickly.

The problem faced is the large number of students who need to be facilitated by the teacher and the demand for skills in conducting guided inquiry laboratory learning. The time available in class is limited, so it is necessary to think about ways that can reach each student more effectively and efficiently. Then a solution arises, the delivery of instructions can be given through a video to reach each student because it can be played when needed. In addition, according to Dale's Cone of Experience theory that pictures, sounds, and text give students a level of understanding faster and last longer in their memory (Dale, 1969). This can be a solution to the limited time available.

The integration of video and direct instruction can be provided through video modeling examples. This video contains an overview of how to do the tasks the teacher wants to teach in class. Procedures are presented in easy-to-follow steps with application examples. Through this video, students' attention can be focused on completing assignments and not distracted by information that is irrelevant to the task. Self-regulation of students in completing assignments is better when video modeling examples are provided. This can trigger student responsibility to complete the experiment. Students who watch this video can plan, monitor, and evaluate the investigation process because there is a narrative explanation of the thought process shown in the video (Omarchevska et al., 2022)

The integration of video modeling examples in inquiry learning is supported by several works of literature. Kaiser and Mayer (2019) find that providing video modeling examples gives long-term effectiveness of guided inquiry because it helps students create the necessary problem-solving schemes. Learners who watch modeling example videos produce higher-quality hypotheses in training and transfer assignments and higher-quality arguments in inquiry exercises, compared to students who engage in free inquiry learning alone (Omarchevska et al., 2022). After the first training phase, students who watched modeling sample videos faced lower difficulties and demonstrated higher grades and performance on measures of the learning process than students who completed the inquiry task without modeling sample videos. Providing a video modeling example in an experiment helps students build their basic cognitive schemes (Kant et al., 2017).

However, based on the questionnaire result, the teacher also considers the attitude of students who are felt to be less responsive during learning. This was also found in the research of Syarkowi & Malinda (2018), where teachers also have a pessimistic feeling about teaching learning using other methods than the lecture method. Therefore, instructions through modeling videos are expected not to make students bored and give them more motivation. However, some critics have faced traditional video (linear video) regarding its problem toward students' passivity. Lacking variations in educational videos demotivates students (Weinert et al., 2020). While student's engagement in watching a learning video is imperative to make them understand the video explanation. Therefore, the video should attract students' engagement and facilitate their understanding of the video content, particularly for lower achiever students with low motivation. To overcome this problem, interactive video or hyper video is introduced by providing various types of interactivities. In traditional videos, content is presented sequentially from beginning to end. While, in interactive videos, each viewer can watch a different video sequence and can repeat certain video clips according to the wishes and chosen options (Palaigeorgiou et al., 2019). For this reason, interactive videos were chosen as learning media that can assist teachers in facilitating students in guided inquiry laboratory learning to help them improve their students' integrated science process skills.

In general, there are three types of interactions in interactive videos, namely interactions among students, interactions between students and video content, and interactions between students and teachers (Weinert et al., 2020). The interactive video in guided laboratory inquiry learning can adopt the type of interactions between student and teacher as well as interactions between students and video content. The student-teacher interactions can be in the form of providing feedback videos after students choose each interactive element. This interaction can make students actively shape the learning process according to their thoughts and ideas. Meanwhile, the student-content interaction can provide various ways to understand learning content in videos such as by giving students control over their video to validate their understanding of explained content by giving some questions (Weinert et al., 2020).

One feature that plays a role in video interactivity is the hotspot feature, which is an area in the video (which can be in the form of a button or a region) that viewers can choose from. This hotspot feature gives students the freedom to choose over the video content. Differences in students' initial knowledge and their speed of understanding can be overcome by giving students control to play back certain videos that they feel need to be watched again. Giving control to students to watch videos according to their needs will facilitate independent learning which is constructivist learning. Based on a constructivist approach to learning, involving students in independent, and active learning is a form of high-quality instructional instruction (Domagk et al., 2010). Learners will remain active during learning and can reflect on themselves to re-watch the instructional videos when needed. Teachers can focus on giving other instructions that are deemed necessary without explaining repeatedly about the scientific method in guided inquiry laboratory learning.

Another advantage of the hotspot feature is that it can be used to provide embedded questions in videos. According to research by Kalthoff (2018), to increase the effectiveness of direct instruction, adding reflective questions helps students gain deeper experimentation skills. This strategy helps students to apply their procedural knowledge even in experimental activities with different contexts from the examples given. Based on the students' answers to the reflective question, feedback can be given to make students better understand the video explanation. So, it is hoped that instructions can be delivered more quickly, efficiently, and effectively to students. This type of interactivity in interactive videos has been shown to increase motivation and learning outcomes because it reduces the cognitive load that students need to process (Liao et al., 2019; Roth & Koenitz, 2019).

Based on the results of this analysis, to maximize the achievement of guided inquiry laboratory learning in training students' integrated science process skills, an interactive video can be made to introduce guided inquiry laboratory learning, experimental activities, and the scientific method, as well as guide students with scientific method steps. It is hoped that through the help of interactive videos, guided inquiry laboratory learning will be implemented more effectively and efficiently to improve students' integrated science process skills. The survey result of available facilities and infrastructure also stated that it is adequate for implementing interactive videos in guided inquiry laboratory learning.

Several implications that can be stated from the findings in this study are 1) When learning to design experiments is never done, students do not get the opportunity to develop their integrated science process skills; 2) As a learning model that facilitates students in designing and conducting experiments, guided inquiry laboratory is suitable to be implemented in class. However, the way the teacher facilitates students in this learning needs to be evaluated so that students can quickly adapt and get the maximum benefit from the learning; 3) Novice students need to be prepared before guided inquiry laboratory learning is carried out and they need guidance during learning; 4) Integration of interactive videos containing instructions needed in guided laboratory inquiry learning is possible to help the learning run more effectively and efficiently to improve students' integrated science process skills since interactivity in the form of questions given in the video and the freedom for students to repeat the video according to their understanding pace allows students to understand instructions and ultimately improve their integrated science process skills.

CONCLUSION

Based on the results of this study, it can be concluded that students' integrated science process skills are still low. The reason is that students barely know experimental activity and are inexperienced in inquiry learning. Teachers also have difficulties in directing and guiding students through guided inquiry laboratory learning or experimental-based learning. Therefore the learning outcomes gained from guided inquiry learning can not be maximized. Interactive video can be a solution as it is possible to help students be prepared before the guided inquiry learning and guiding students during the learning. The interactive video helps students prepare by providing an explanation about experimental activity, scientific method, and guided inquiry learning introduction. And also interactive video helps students during learning by providing scientific method instruction. The instruction will be easier to understand due to its interactivity possibility through embedded questions, direct feedback and control to video content.

The results of this study emphasize recommendations regarding the importance of conducting empirical research to implement interactive videos in guided laboratory inquiry learning. The research should find if there is any change in students' integrated science process skills that occur after the use of the learning media. Student responses to the learning media are also needed to get comprehensive information about the impact of interactive video on the guided laboratory inquiry learning process.

REFERENCES

Afriani, T., Agustin, R. R., & Eliyawati, E. (2019). The effect of guided inquiry laboratory activity with video embedded on students’ understanding and motivation in learning light and optics. *Journal of Science Learning*, *2*(3), 79–84. https://doi.org/10.17509/jsl.v2i3.15144

Anderson, R. D. (2007). Inquiry as an organizing theme for science curricula. In *Handbook of Research on Science Education* (p. 24). Routledge.

Balasubramanian, G. (2017). *The way forward for personalised media content: Hypervideo for millennieals*. Hcltech.Com.

Blumer, L. S., & Beck, C. W. (2019). Laboratory courses with guided-inquiry modules improve scientific reasoning and experimental design skills for the least-prepared undergraduate students. *CBE Life Sciences Education*, *18*(1). https://doi.org/10.1187/cbe.18-08-0152

Branch, R. M. (2020). *Instructional design: The ADDIE approach*. Springer. https://doi.org/10.1007/978-3-319-15347-6_300893

Burns, J. C., Okey, J. R., & Wise, K. C. (1985). Development of an integrated process skill test: TIPS II. *Journal of Research in Science Teaching*, *22*(2), 169–177. https://doi.org/10.1002/tea.3660220208

Dale, E. (1969). *Audiovisual methods in teaching* (3rd Editio). Dryden Press.

Damopolii, I., Yohanita, A. M., Nurhidaya, N., & Murtijani, M. (2018). Meningkatkan keterampilan proses sains dan hasil belajar siswa melalui pembelajaran berbasis inkuiri. *Jurnal Bioedukatika*, *6*(1), 22. https://doi.org/10.26555/bioedukatika.v6i1.8029

Defianti, A., Putri, D. H., Rohayati, S., Herawati, A., & Chen, L. Y. (2022). Development of e-module guideline on basic physics practicum for science process skills in a pandemic period. *Journal of Natural Science and Integration*, *5*(1), 45. https://doi.org/10.24014/jnsi.v5i1.15595

Devine, T., Gormley, C., & Doyle, P. (2015). Lights, camera, action: Using wearable camera and interactive video technologies for the teaching & assessment of lab experiments. *International Journal of Innovation in Science and Mathematics Education*, *23*(2), 22–33.

Domagk, S., Schwartz, R. N., & Plass, J. L. (2010). Interactivity in multimedia learning: An integrated model. *Computers in Human Behavior*, *26*(5), 1024–1033. https://doi.org/10.1016/j.chb.2010.03.003

Emden, M. (2021). Reintroducing "the" scientific method to introduce scientific inquiry in schools?: A cautioning plea not to throw out the baby with the bathwater. In *Science and Education* (Vol. 30, Issue 5). Springer Netherlands. https://doi.org/10.1007/s11191-021-00235-w

Ergül, R., Şımşeklı, Y., Çaliş, S., Özdılek, Z., Göçmençelebı, S., & Şanli, M. (2011). The effects of inquiry-based science teaching on elementary school students' science process skills and science attitudes. *Bulgarian Journal of Science and Education Policy (BJSEP)*, *5*(1), 48–69.

Fitrianingrum, H., & Noor, M. F. (2022). Science process skills students on cells and tissues concept during the covid-19 pandemic: How did it achieve? *Journal of Physics: Conference Series*, *2157*(1). https://doi.org/10.1088/1742-6596/2157/1/012041

Fraenkel, J. R., Wallen, N. E., & Hyun, H. H. (2006). *How to design and evaluate research in education* (R. S. Corley (ed.); 8th ed.). McGraw - Hill.

Ioannidou, O., & Erduran, S. (2021). Beyond hypothesis testing: Investigating the diversity of scientific methods in science teachers' understanding. *Science and Education*, *30*(2), 345–364. https://doi.org/10.1007/s11191-020-00185-9

Isnayanti, R. S., & Hardyanto, W. (2018). The influence of assistance of helped guided inquiry methods tutorial video practicum on the process of student science skills. *Journal of Innovative Science Education*, *8*(1), 30–36.

Jauhar, M. (2011). *Implementasi PAIKEM dari behavioristik sampai konstruktivistik*. Prestasi Pustaka.

Kaiser, I., & Mayer, J. (2019). The long-term benefit of video modeling examples for guided inquiry. *Frontiers in Education*, *4*(October), 1–18. https://doi.org/10.3389/feduc.2019.00104

Kalthoff, B., Theyssen, H., & Schreiber, N. (2018). Explicit promotion of experimental skills and what about the content-related skills? *International Journal of Science Education*, *40*(11), 1305–1326. https://doi.org/10.1080/09500693.2018.1477262

Kant, J. M., Scheiter, K., & Oschatz, K. (2017). How to sequence video modeling examples and inquiry tasks to foster scientific reasoning. *Learning and Instruction*, *52*, 46–58. https://doi.org/10.1016/j.learninstruc.2017.04.005

Kementrian Pendidikan dan Kebudayaan Indonesia. (2018). *Kompetensi inti dan kompetensi dasar pelajaran pada kurikulum 2013 pada pendidikan dasar dan pendidikan menengah*. Kementrian Pendidikan dan Kebudayaan Indonesia.

Kementrian Pendidikan dan Kebudayaan Indonesia. (2021). Capaian pembelajaran PAUD, SD, SMP, SMA, SDLB, SMPLB, dan SMALB pada program sekolah penggerak. In *Badan Penelitian dan Pengembangan dan Perbukuan*. Kementrian Pendidikan dan Kebudayaan.

Liao, C. W., Chen, C. H., & Shih, S. J. (2019). The interactivity of video and collaboration for learning achievement, intrinsic motivation, cognitive load, and behavior patterns in a digital game-based learning environment. *Computers and Education*, *133*(July 2018), 43–55. https://doi.org/10.1016/j.compedu.2019.01.013

Mahmudah, I. R., Makiyah, Y. S., & Sulistyaningsih, D. (2019). Profil keterampilan proses sains (KPS) siswa SMA di kota Bandung. *Jurnal Diffraction*, *1*(1), 39–43.

Omarchevska, Y., Lachner, A., Richter, J., & Scheiter, K. (2022). Do video modeling and metacognitive prompts improve self-regulated scientific inquiry? In *Educational Psychology Review* (Vol. 34, Issue 2). Springer US. https://doi.org/10.1007/s10648-021-09652-3

Palaigeorgiou, G., Papadopoulou, A., & Kazanidis, I. (2019). Interactive video for learning: A review of interaction types, commercial platforms, and design guidelines. In *Communications in Computer and Information Science* (Vol. 993). Springer International Publishing. https://doi.org/10.1007/978-3-030-20954-4_38

Papadopoulou, A., & Palaigeorgiou, G. (2016). Interactive video, tablets and self-paced learning in the classroom: Preservice teachers' perceptions. *13th International Conference on Cognition and Exploratory Learning in Digital Age (CELDA 2016), October*, 195–202.

Roth, C., & Koenitz, H. (2019). BanderSnatch, yea or nay? Reception and user experience of an interactive digital narrative video. *TVX 2019 - Proceedings of the 2019 ACM International Conference on Interactive Experiences for TV and Online Video*, 247–254. https://doi.org/10.1145/3317697.3325124

Rustaman, N., Dirdjosoemarto, S., Yudianto, S. A., Achmad, Y., Subekti, R., Rochintaniawati, D., & Nurjhani, M. (2005). *Strategi belajar mengajar biologi*. UM Press.

Şahintepe, S., Erkol, M., & Aydoğdu, B. (2020). The impact of inquiry based learning approach on secondary school students' science process skills. *Open Journal for Educational Research*, *4*(2), 117–142. https://doi.org/10.32591/coas.ojer.0402.04117s

Schlatter, E., Molenaar, I., & Lazonder, A. W. (2020). Individual differences in children's development of scientific reasoning through inquiry-based instruction: Who needs additional guidance? *Frontiers in Psychology*, *11*(May), 1–14. https://doi.org/10.3389/fpsyg.2020.00904

Soewarso. (2000). *Cara-cara penyampaian pendidikan sejarah untuk membangkitkan minat peserta didik mempelajari bangsanya*. DEPDIKNAS.

Solé-Llussà, A., Aguilar, D., & Ibáñez, M. (2019). Video worked examples to promote elementary students' science process skills: A fruit decomposition inquiry activity. *Journal of Biological Education*, *55*(4), 368–379. https://doi.org/10.1080/00219266.2019.1699149

Solé-Llussà, A., Aguilar, D., & Ibáñez, M. (2020). Video-worked examples to support the development of elementary students' science process skills: A case study in an inquiry activity on electrical circuits. *Research in Science and Technological Education*, *00*(00), 1–21. https://doi.org/10.1080/02635143.2020.1786361

Sudria, I. B. N., Yanti, N. L. G. P., Redhana, I. W., & Maryam, S. (2021). Developing worksheet assisted guided inquiry learning video. *AIP Conference Proceedings*, *2330*(March). https://doi.org/10.1063/5.0043246

Syarkowi, A., & Malinda, S. (2018). Identifikasi kendala siswa dalam proses pembelajaran bounded inquiry lab pada konsep difraksi cahaya. *Berkala Ilmiah Pendidikan Fisika*, *6*(3), 315. https://doi.org/10.20527/bipf.v6i3.5058

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

Wahyuni, S., Suhendar, S., & Setiono, S. (2020). Profil keterampilan proses sains siswa kelas X sma. *Jurnal Pelita Pendidikan*, *8*(1), 41–45. https://doi.org/10.24114/jpp.v8i1.17246

Weinert, T., de Gafenco, M. T., & Börner, N. (2020). Fostering interaction in higher education with deliberate design of interactive learning videos. *International Conference on Information Systems, ICIS 2020 - Making Digital Inclusive: Blending the Local and the Global*.

Wenning, C. J. (2005). Minimizing resistance to inquiry-oriented science instruction: The importance of climate setting. *Physics*, 10–15.

Wenning, C. J. (2011). The levels of inquiry model of science teaching. *Journal of Physics Teacher Education Online*, *6*(2), 9–16.

Widodo, A. (2021). Pembelajaran ilmu pengetahuan alam dasar-dasar untuk praktik. In *UPI Press*.