JURNALTATSQIF
Jurnal Pemikiran dan Penelitian Pendidikan
Volume 22, No. 1 (June) 2024
Site: http://journal.uinmataram.ac.id/index.php/tatsqif Email: jurnaltatsqif@uinmataram.ac.id
P ISSN: 1829-5940
E ISSN: 2503-4510

THE EFFECTIVENESS OF GO-LAB BASED INQUIRY LEARNING SPACE (ILS) AS MEDIA ON SCIENCE SUBJECT FOR JUNIOR HIGH SCHOOL IN INDONESIA

Rangga Alif Faresta[1], Rizal M Suhardi[2], Mega Safana[3]
[1]Monash University, Melbourne, Australia
[2]National Sun Yat-sen University, Kaohsiung, Taiwan
[3]Universitas Negeri Yogyakarta, Yogyakarta, Indonesia
rangga211297@gmail.com

Abstract

A PISA survey in 2018 showed that Indonesian students underperformed in science results. Consequently, the rate of scientific concepts and literacy is low, especially in junior high school grades. However, Inquiry-based learning can be used to improve science concepts and literacy. One of the science tools to improve students' science concepts and literacy-based inquiry is Go-Labs. The Go-Lab provides students with an Inquiry Learning Space feature. This investigation aims to find out the effectiveness of the Go-Lab-based Inquiry Learning Space (ILS) as a medium for teaching science subjects to junior high school students in Indonesia. This systematic literature method was used to provide evidence from 21 of the literature related to Go-Lab and science literacy. This provided an overview of current knowledge of the Go-Lab's effectiveness on students' science concepts and literacy. The result is the Go-Lab can be used as an alternative media for teachers in science teaching to assist students in improving their ability in science. Go-Lab can benefit students by improving their ability in scientific concepts and improve their scientific literacy. This is because the Go-Lab is embedded with an Inquiry-based learning approach, the effectiveness of Inquiry Learning Space (ILS) in Go-Lab, and the Go-Lab's ecosystem supports the science teaching process. The implication of this investigation is to provide alternative mediums in science teaching to engage students with scientific concepts. Hence, the Go-Lab can be used as an alternative media for teachers in science teaching to assist students in improving their ability in science.

Keywords: Go-Labs, Inquiry Learning Space, Learning Media, Science Concept and Literacy

INTRODUCTION

In Indonesia, students face a challenge to get an engagement in a science context. Science engagement is described as "a multidimensional concept

that broadly encompasses three components, namely behavioral engagement, emotional engagement, and cognitive engagement" (Hampden-Thompson & Bennett, 2013, p.1327). The students tend to consider a science subject is difficult to be comprehended (Lee & Sulaiman, 2018). Moreover, since student must deal with both calculation and context comprehension, science is thought to be one of the most challenging topics in school, according to Ogunkola and Samuel (2011). For instance, mathematically challenged students would be unable to understand the material in calculation-based physics and chemistry classes (Thangjai, 2022). As a result, physics exam results at the national level, with an average score of 67.43, are classified as category C, according to the High School National Examination Results report (Hikmawati et al., 2020). This data shows a low achievement in science education. Thus, the low score in science subject indicates that students have a lack engagement in science. Science teaching method can be stated as one of factors that make student restricted engaging in science. In Indonesia, teacher commonly deliver the science teaching process through conventional method, which remain teacher-cantered (Febriani et al., 2019). As a result, many students have difficulty in building their own knowledge in using science concepts in a meaningful way (Adriani et al., 2021).

Additionally, students often adhere to teachers' instructions in science classrooms where direct instruction is the primary pedagogy to comprehend the pre-defined scientific topics. Thus, students do not have a chance to engage in science practice and thereby increase their scientific literacy (Liu et al., 2022). This method does not involved students in learning process, so that they cannot play an active role in science teaching (Afriani & Agustin, 2019). Whereas the student can get an engagement in science learning process if there is involvement of students in it, such as carrying out science investigations (Septiani & Susanti, 2021). Another study also revealed that because students are exposed to more lectures during learning activities than other types of content, the learning process is still primarily focused on the

teacher and contributes to students' poor levels of scientific literacy (Andriani et al., 2021).

Consequently, Indonesia scored poorly in science performance in the Program for International Student Assessment (PISA) survey in 2018 (OECD, 2018). The survey revealed that the average student score is 371 for reading comprehension, 379 for math aptitude, and 396 for science aptitude. This achievement score is still below the 79 test-taking countries' averages for reading ability, math ability, and science ability, which are 487 and 489, respectively (OECD, 2019). Based on these statistics, students in Indonesia have not been able to apply science concept and analyze to solve a problem. Science concept relates to a student's belief that she or he can easily understand and learn science (Grabau & Ma, 2017). This implies one indication that there is an issue with the low score in science education that Indonesia received in the PISA results in 2018 (Putri et al., 2020). These findings may perceive that science teaching method is a matter for student to engage in scientific ability.

Based on those issues that appear in the science teaching and learning process, a learning media incorporated with inquiry-based learning is needed to overcome the issues. A broad definition of media learning is any method, physical or virtual, that teachers utilise to make learning more successful and efficient for their students (Musfiqon, 2019). Learning media can be seen as a piece of hardware or software that helps teachers distribute materials to students during the learning process (Puspitarini & Hanif, 2019; Musfiqon, 2019). According to Sardiman (2012), utilising a variety of educational media will help students develop active attitudes and can inspire them to learn. In addition to that, an inquiry learning model is one where all students are fully allowed to uncover and research concepts and their links with one another (Zaini, 2018). The effectiveness of inquiry learning model can be used to deliver science material. The benefit of inquiry learning is effective to develop students' science process ability seen from the improvement of the

students' test result (Hidayah, 2018). Therefore, these findings suggest that media learning integrated with inquiry- based learning could improve students' engagement in science education and provide an alternative way for the teacher in science teaching from teacher-cantered to student-cantered.

As mentioned above, one of online media that embedded inquiry learning model on its features is the Go-Labs. The Go-Lab is a significant research endeavor funded by the European Commission that examines federated online labs (Labs) for STEM instruction in schools (Gillet et al., 2013). Based on that meaning, the Go-Lab is online media-based laboratory to provide student with Science, Technology, Engineering and Mathematics (STEM) engagement. The Go-Labs also known as virtual or remote laboratories and data sets, provide teachers with the chance to integrate these online labs into inquiry learning spaces (ILSs) and pedagogically organized (de Jong et al., 2014; de Jong et al., 2021). The Go-Labs features provide the chance for student from 10 to 18-years old to explore scientific phenomena (Gillet et al., 2013). Moreover, Gillet et al. (2013) explained that student can conduct individualized scientific experiments with Go-Lab in pedagogically organized and scaffolded learning environments that are further enhanced with social communication tools. The Go-Lab has grown globally with 37,000 registrations and 440,000 visitors. These statistics indicate the widespread use of Go-Lab as media for inquiry-based learning in science education. Go-Lab has shown a positive impact and can improve learners' science concepts and literacy (Fang et al., 2016; Keselman, 2003; Linn et al., 2006; Minner et al., 2010). In their study, Gillet et al. (2013) stated that the Go- Labs enable students to engage in science inquiry-based learning, which encourages the development of extensive conceptual domain expertise and inquiry abilities and points them in the direction of careers in science. The inquiry-based learning approach that used in Go-Lab is called Inquiry Learning Space (ILS). Inquiry learning spaces are online and virtual spaces where learners engage

with the learning materials, including other multimedia tools and virtual labs and (de Jong et al., 2021). This feature is only in the Go- Labs which make it special. According to de Jong et al. (2021), these virtual laboratories are enhanced with tools (apps) to provide the inquiry process, such as those that assist students in formulating hypotheses or research design.

Regarding the advantages of using the Go-Labs as a learning media, this research investigation question is to what extent is Go-Lab based Inquiry Learning Space (ILS) effective as a media for teaching science subjects to junior high school students in Indonesia? The aim of this investigation is to explore the benefits of using Go-Lab as teaching media and its possibility to assist student in enhancing their science engagement that contribute to science concept and literacy. A thoughtful citizen who understands science concepts and related issues is said to possess scientific literacy (OECD, 2018). Moreover, Fives et al. (2014) defined scientific literacy as the ability way on a regular basis to work and grasp with scientific information in a practical. Equally important, in their study, Steinmayr et al. (2012) looked at the importance, intrinsic task value, and utility as aspects of the science self-concept. This study will be helpful to teachers in integrating Go-Lab into science instruction, enhancing students' scientific literacy through inquiry-based learning, and offering understanding on how to effectively digitize a teaching practice. Therefore, focusing on using the Go-Lab as media in science teaching is an alternative way to deliver science material to student effectively. The Go-Lab integrated with inquiry-based learning is an effective way and contribute to positive impact for student in science learning. This will lead to an improvement in science concept and science literacy of student.

METHOD

To answer our research question, we conducted a systematic literature review of discussing the advantages of Go-Lab for student in science subject

studies. This provided an overview of current knowledge of effective media of science teaching and the Go-Lab and insight into the methodological developments in this field of research. A systematic review has as the advantage that it surpasses the methodological limitations of single studies, thus providing more robust information for future research, and evidence-informed policy and practices (Newman & Gough, 2020). A systematic literature review is a research method for locating, evaluating, and interpreting significant research findings connected to research questions, specific topics, or phenomena (Kitchenham,2004; Prasetiyo et al., 2021; Suprapto et al., 2020).

Reviewers use selection criteria to determine which research studies to include in their review. These criteria establish guidelines for the review process, ensuring transparency and consistency. Systematic reviews emphasize making these restrictions transparent across studies. The selection criteria are shaped by the review question and conceptual framework, specifying factors such as participants, country, and language. Overall, selection criteria play a crucial role in ensuring a systematic and objective approach to reviewing research studies (Newman & Gough, 2020). There were 21 articles that met the eligibility criteria as a final database. The stages of this research apply the scheme of Bettany-Saltikov (2012) presented in Figure 1.

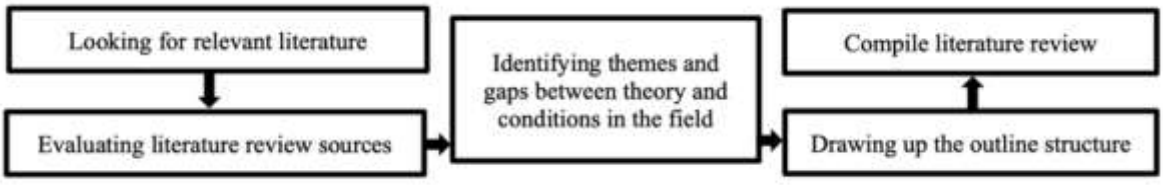

Figure 1. Bettany-Saltikov's literature review step

RESULTS AND DISCUSSION

Since students need to act like a scientist, they need to have more understanding of scientific concepts and literacy. Based on the literature

review that has been done, many studies revealed that the Go-Lab incorporated with inquiry-based learning model is effective to increase student engagement in science learning process. The section below describes about supporting point of using Go-Labs as media in science subject to tackle the issue regarding to a low of science engagement and science teaching method.

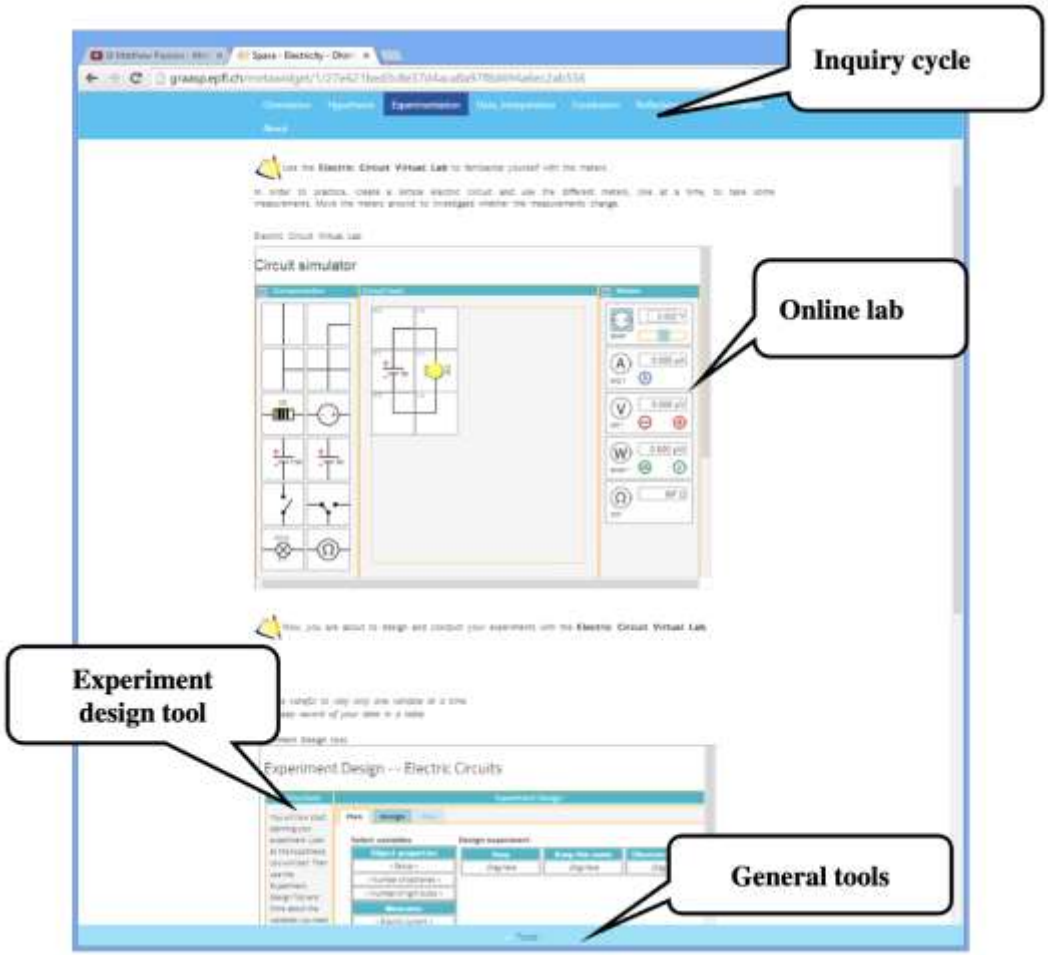

Figure 2 Go-Lab Inquiry Learning Space

The Go-Labs integrated with inquiry learning model can be an alternative of learning media. The inquiry learning model will be an intervention for students to be involved in science. According to Creagh & Parlevliet (2014), if the instructor can foster creative thinking in the classroom, inquiry-oriented learning will give students a lot of possibilities to get involved in solving challenges related to science learning. What makes the Go-Lab unique

compared to other learning media is that Go-Lab provides teachers to make inquiry-based activities into an online platform (Tamami et al., 2022). This online activity can be incorporated with any learning resources. Tamami et al. (2022) in their study produced lesson plans, syllabus, and problem solving and creativity ability instruments that integrated with the Go-Labs and obtained 75% of validity scores. Because of this, teachers using the Go-Lab ecosystem can integrate online labs, multimedia material, and learning apps to enhance students' inquiry-based learning process (de Jong et al., 2021). Additionally, teachers can trust and integrate Inquiry based learning into their practice (Rodriguez-Triana et al.,2021). So that these findings suggest that science teaching method problems that decrease students' science engagement can be tackled by using the Go-Labs inquiry-based learning. Not only learning material can relate to inquiry learning in Go-Labs but also, based on evidence, inquiry-based learning combined with virtual labs can create a more engaging and meaningful online learning experience for students (Putri et al., 2021). This indicates that students have an opportunity to develop their idea and knowledge in scientific concept. It is because in inquiry learning model students get involved in learning process meaningfully. Inquiry-based learning encourages students to address problems by conducting the appropriate research (Wood, 2013). As a result, inquiry-based learning promotes the growth and use of higher-order thinking skills such as search, question, critique, correlation, and analysis (Hofstein & Lunetta, 2004).

Moreover, for students, the Go-Labs embedded with inquiry learning allow them to work collaboratively through participating in educational activities with their peers, which helps children develop qualities like listening to others and being open to other viewpoints (Korkman & Metin, 2021). Another study conducted by Zulaichah et al. (2021) suggested that through inquiry-based learning, students can learn like a scientist namely through investigation and experiment activities. By treating students like

scientists and using a methodical procedure that includes performing studies, inquiry learning emphasizes learner-centered learning (Abdurrahman, 2017; Putri et al., 2021; Ramdani & Artayasa, 2020). According to Nel-Ekici (2017), inquiry learning is a lifelong ability that enables pupils to learn things meaningfully and permanently through investigation and questioning. These findings may result in enhancing students' engagement that will contribute to science concepts and literacy.

However, there are several drawbacks to inquiry learning that have been discovered via research, one of which is that it takes a lot of time (Rosmala, 2021). Additionally, teachers continue to struggle with creating teaching materials, such as the way they offer questions on scientific literacy and the subpar way they incorporate technology into science lessons (Andriani et al., 2021). In contrast to what has been said, research has demonstrated that The Go-Lab can provide teachers with all the apps and laboratories they need to construct a classroom. Virtual laboratories have been developed for instructors with an overarching pedagogical organize (scenario) in which teachers can assemble the lab(s) and apps provided (de Jong et al., 2021). Moreover, these flaws can be fixed by creating guided inquiry-based learning material that teachers can utilize to assist students' learning as well as to educate and enhance their scientific literacy abilities (Andriani et al., 2021). Although, there are several challenging for teachers in applying the Go-Lab based inquiry learning, it can be solved by using the Go-Labs features and teachers can create guided inquiry learning material.

The possibility for teachers to design specific inquiry learning spaces is one of the features that distinguishes Go-Lab from other online repositories (de Jong et al., 2014). In addition to that as opposed to alternative lab approaches using cookbook procedures or discovery methodologies, the inquiry strategy has been shown to be more successful (de Jong et al., 2013). This evidence showed that only the Go-Lab provided by a feature called Inquiry Learning Space (ILS) and its main domain is physics (de Jong et al.,

2021). According to de Jong et al. (2014), inquiry learning space is the components that come together in Go-Lab to create a learning space. Through the ILS, the teacher can make a supportive collaboration and adjust the lesson. de Jong et al. (2021) described that teachers can collaborate with peer teachers or experts to create and modify inquiry learning phases and guidance in an ILS. In addition, the ILS is created by emphasizing individualization and collaboration using a particular social media platform for STEM in the classroom (Gillet et al., 2013).

Besides that, teachers are supported by associated default ILSs and scenarios that can be used as a starting point for development (de Jong et al., 2014). These studies indicate that teacher can use ILS as a tool in developing their lesson plan and any resource material related to science subjects.
Additionally, teachers have a flexible way to use the ILS, whether they want to use a default or existing ILS or create new ILS in developing their learning space and material. A further explanation is that the Go-Lab portal contains lesson plans and ILSs that teachers can choose to continue using. When a teacher is done with a self-written ILS or lesson plan, they can publish it to the portal with a creative commons license so that other teachers can use it (de Jong et al., 2014). For student, In ILS, the Go-Lab is enhanced with tools (apps) to support the inquiry process, such as those that assist students in formulating hypotheses or designing experiments, and with those that teach twenty-first century skills like teamwork and reflection (de Jong et al., 2021).

On the other hand, there are several obstacles for teacher in using ILS. Firstly, teachers using Go-Lab faces challenges in adopting educational technology, particularly in creating well-designed inquiry environments (de Jong et al., 2021; de Jong et al., 2014). Secondly, due to the Go-Lab as an online media laboratory compared to physical lab, students can learn actual laboratory skills using physical laboratory such as troubleshooting machinery. (de Jong et al., 2013). Moreover, student t can experience like scientists when designing experiments that call for meticulous equipment

setup and prolonged observations through physical lab (de Jong et al., 2013). The last point is that the ease of experimenting in the Go-Lab may also result in less structured student inquiries, as Renken and Nunez (2013) recently discovered in an environment lacking experimental guidance. Despite these claims, there are evidence suggest that the Go-Lab as a virtual media often take less time to set up and deliver results of extensive studies instantly, they are more efficient than real experiment (Zacharias et al., 2008). This finding proved that online learning media can overcome any issue related to the limitation of using the Go- Lab in science learning process. Another study also revealed that using online labs to learn is frequently superior to learning in actual laboratories for gaining conceptual knowledge (de Jong et al., 2013). This conceptual knowledge would benefit for student that giving them more time to experience an experiment and focus on its conceptual aspects. In addition to that, for teachers and students who face a difficulty in using the Go-Lab because they have less technological proficiency, with an overall pedagogical structure (scenario) in which teachers can assemble the lab(s) and apps given, the Go- Lab has been created for teachers (de Jong et al., 2021). To conclude, the Inquiry learning space (ILS) in the Go-Lab gives benefits for teachers in managing and arranging the class virtually by using any resources from the ILS particularly in science. This will contribute to improve student engagement science learning process.

The Go-Lab ecosystem offers the teacher or instructor many types of help, with the current focus being on the design process (de Jong et al., 2021). These types of assisting can help teacher in designing the learning journey for students. Every component (labs and apps) required for creating ILSs is provided to teachers (de Jong et al., 2021). As a result, teacher can be easier to provide any material related to science. this activity will lead to an opportunity for student to gain an understanding of scientific concepts, problem-solving, and engagement in science through inquiry-based learning. (de Jong et al., 2014; Fang et al.,2016). The participatory design, responsive

design, and privacy-by-design approaches were used to construct the Go-Lab ecosystem (de Jong et al., 2021). Based on data in 2019, Golabz had 614 labs, most of which were in physics, mathematics, biology, astronomy, technology, environmental education, and engineering (de Jong et al., 2021). One of Go-Lab ecosystem is Go-Lab Portal. The main content of this feature is repository of online material that can be set up as a metadata for example to science curricula. In addition, the Go-Lab portal will provide several extra features, including a booking system, a bartering platform (which facilitates the trading of skills and services), and access to the Go-Lab community (de Jong et al., 2014). Another element is called apps. Most of these apps relate to Go-Lab inquiry cycle learning processes and can be incorporated into an ILS to aid students in their inquiry process (de Jong et al., 2021). In addition, according to de Jong et al. (2021), for more precise design choices, the sharing and assistance website Golabz provides a bigger collection of design principles (tips & tricks).

On the other hand, according to Puspitarini and Hanif (2019), many teachers who have not utilized the technology in the learning process optimally because of the lack of knowledge and ability from the use of technology as a medium of learning. Furthermore, teachers are not adequately trained in the use of online labs since they hardly ever put activities into practice in class unless they are comfortable with the procedure and are able to handle issues (Gillet et al., 2013). However, to refute these claims, other studies revealed that teacher will be able to use and modify their inquiry-learning environments via the Go-Lab Portal (Frontend), which will provide a simple to use platform (Gillet et al., 2013). In addition, the Go-Lab portal will provide several extra features, including a booking system, a bartering platform (which facilitates the trading of skills and services), and access to the Go-Lab community (de Jong et al., 2014). Furthermore, the Go-Lab ecosystem provides educational resources (also known as ILSs, or inquiry learning spaces) that support inquiry learning and

contain online laboratories as their primary component (de Jong et al., 2021) These results show that, despite teachers limited technological proficiency, Go- lab may be built using user-friendly tools. In other word, teacher can tackle the issue by using the Go-Lab ecosystem to develop the science course for students.

CONCLUSION

Science engagement and teaching method in science can be counted as factors that lead to low scores in science teaching performance of students in Indonesia. Science engagement is a multidimensional concept that encompasses three components: behavioral, emotional, and cognitive. In Indonesia, students face a challenge to get an engagement in science, with an average score of 67.43 being classified as category C. Another point is that science teaching method is a factor that restricts student engagement in science, as it does not involve students in the learning process, such as carrying out science investigations. This suggests that students in Indonesia have not been able to apply science concept and analyze to solve a problem. To overcome the issues, many studies have proved that inquiry learning model can be used to assist student to develop their scientific concept. Learning media integrated with inquiry-based learning is needed to improve students' engagement in science education and provide an alternative way for the teacher in science teaching from teacher-cantered to student-cantered. It is effective in developing students' science process ability and improving test results. The Go-Labs is an online media-based laboratory that enables students to engage in science inquiry-based learning, which encourages the development of conceptual domain expertise and inquiry abilities. Even teachers who lack digital proficiency can still use the media because it provides them with user-friendly tools and a pedagogically structured approach. Therefore, the Go-Lab is effective to be used as learning media because the effectiveness of the Inquiry Learning Space (ILS) in the

Go-Lab, which is integrated with an inquiry-based learning approach and the features of the Go-Lab aids in science teaching.,

ACKNOWLEDGMENT

Author thanks to the supervisor, Dr. Mariko Francis and Dr. Hongzhi Zhang who have assisted us in conducting this research. Additionally, this study discloses receiving financial support from Endowment Fund for Education (LPDP), Ministry of Finance, Republic of Indonesia.,

REFERENCES

Afriani, T., & Agustin, R. R. (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(4), 79-84. DOI: 10.17509/jsl.v2i3.15144.

Andriani, S., Sukarmin., &Masykuri, M.&. (2021). Development of Electronic Modules (E-Modules) Based on Guided Inquiry on Temperature and Heat Materials to Improve Students' Science Literacy. Jurnal Penelitian Pendidikan IPA, 7(Special Issue), 281–287. https://doi.org/10.29303/jppipa.v7iSpecialIssue.1234.

Bettany-Saltikov, J & McSherry, R. (2012). How to do a Systematic Literature Review in Nursing – A Step-by-Step Guide. McGraw-Hill Education.

Creagh, C., & Parlevliet, D. (2014). Enhancing student engagement in physics using inquiry oriented learning activities. International Journal of Innovation in Science and Mathematics Education, 22(1), 43–56. https://researchrepository.murdoch.edu.au/id/e print/22645

Febriani, S.,Taufik,M., Verawati,N. N. S. P. (2019). Pengaruh model guided discovery learning dengan metode eksperimen terhadap hasil belajar fisika peserta didik MAN 1 Mataram ditinjau dari gaya belajar VAK [The effect of the guided discovery learning model with the experimental method on the physics learning outcomes of Mataram MAN 1 students in terms of the VAK learning style]. Jurnal Pendidikan Fisika dan Teknologi, 5(1), 82-90. http://10.0.114.119/jpft.v5i1.872

de Jong, T., Gillet, D., Rodríguez-Triana, M. J., Hovardas, T., Dikke, D., Doran, R., Dziabenko, O., Koslowsky, J., Korventausta, M., Law, E., Pedaste, M., Tasiopoulou, E., Vidal, G., & Zacharia, Z. C. (2021). Understanding teacher design practices for digital inquiry–based science learning: the

case of Go-Lab. Educational Technology Research and Development, 69(2), 417–444. https://doi.org/10.1007/s11423-020-09904-z

de Jong, T., Linn, M. C., & Zacharia, Z. C. (2013). Physical and virtual laboratories in science and engineering education. Science, 340(6130), 305-308. doi:10.1126/science.1230579

de Jong, T., Sotiriou, S., & Gillet, D. (2014). Innovations in STEM education: the Go-Lab federation of online labs. Smart Learning Environments, 1(1), 1–16. https://doi.org/10.29303/jppipa.v8i4.2174

Fang, S.-C., Hsu, Y.-S., Chang, H.-Y., Chang, W.-H., Wu, H.-K., & Chen, C.-M. (2016). Investigating the effects of structured and guided inquiry on students' development of conceptual knowledge and inquiry abilities: a case study in Taiwan. International Journal of Science Education, 38(12), 1945–1971. https://doi.org/10.1080/09500693.2016.1220688

Fives, H., Huebner, W., Birnbaum, A. S., & Nicolich, M. (2014). Developing a measure of scientific literacy for middle school students. Science Education, 98(4), 549-580. https://doi.org/10.1002/sce.21115

Gillet, D., de Jong, T., Sotirou, S., & Salzman, C.(2013,March 13-March 15). Personalised Learning Spaces and Federated Online Labs for STEM Education at School.[Paper Presentation]. 2013 IEEE Global Engineering Education Conference (EDUCON).Technische Universität Berlin, Berlin, Germany. http://dx.doi.org/10.1109/EduCon.2013.6530194.

Grabau, L.J., & Ma, X.(2017). Science engagement and science achievement in the context of science instruction: a multilevel analysis of U.S. students and schools. International Journal of Science Education, 39(8), 1045-1068, https://doi.org/10.1080/09500693.2017.1313468

Hampden-Thompson, G., & Bennett, J. (2013). Science teaching and learning activities and students' engagement in science. International Journal of Science Education, 35(8), 1325–1343. https://doi.org/10.1080/09500693.2011.608093

Hidayah, R. & Lailiy, N. (2018, July 21). Guided Inquiry Model To Promote Science Process Skill Students on Acid-Base.[Paper Presentation] Mathematics, Informatics, Science, and Education International Conference (MISEIC 2018), Advances in Intelligent Systems Research (AISR), 157, 96-97 .Universitas Negeri Surabaya, Surabaya, Indonesia. https://doi.org/10.2991/miseic-18.2018.23

Hikmawati, H., Kusmiyati, K., & Sutrio, S. (2020). Inquiry learning model to improve student cognitive learning outcomes in temperature and heat.

Jurnal Penelitian Pendidikan IPA, 6(1). 97-100. https://doi.org/10.29303/jppipa.v6i1.330.

Hofstein, A., & Lunetta, V. (2004). The laboratory in science education: foundation for the 21st century. Science Education, 88, 28-54. https://doi.org/10.1002/sce.10106

İnel-Ekici, D. (2017). Ortaokul öğrencilerinin bilimsel sorgulama becerileri algılarını etkileyen faktörlerin incelenmesi. [Examining the factors affecting secondary school students' perceptions of scientific inquiry skills]. Kastamonu Eğitim Dergisi, 25 (2), 497-516. https://dergipark.org.tr/en/download/article-file/302519

Keselman, A. (2003). Supporting inquiry learning by promoting normative understanding of multivariable causality. Journal of Research in Science Teaching, 40(9), 898– 921. https://doi.org/10.1002/tea.10115

Korkman, N & Metin, M. (2021). The effect of inquiry-based collaborative learning and inquiry-based online collaborative learning on success and permanent learning of students. Journal of Science Learning, 4(2),151-159. https://doi.org/10.17509/jsl.v4i2.29038

Kitchenham,B. (2004). Procedures for Performing Systematic Reviews. Keele University Technical Report [Online]. Available: https://www.inf.ufsc.br/~aldo.vw/kitchenham.pdf.

Lee, M. C., & Sulaiman, F. (2018). The effectiveness of practical work on students' motivation and understanding towards learning physics. International Journal of Humanities and Social Science Invention, 7(8), 2319-7714. https://www.ijhssi.org/papers/vol7(8)/Version-3/F0708033541.pdf

Linn, M. C., Lee, H.-S., Tinker, R., Husic, F., & Chiu, J. L. (2006). Teaching and Assessing Knowledge Integration in Science. Science, 313(5790), 1049–1050. https://doi.org/10.1126/science.1131408

Liu, C. C., Wen, C. T., Chang, H. Y., Chang, M. H., Lai, P. H., Fan Chiang, S. H., Yang, C. W., & Hwang, F. K. (2022). Augmenting the effect of virtual labs with "teacher demonstration" and "student critique" instructional designs to scaffold the development of scientific literacy. Instructional Science, 50(2), 303–333. https://doi.org/10.1007/s11251-021-09571-4.

Minner, D. D., Levy, A. J., & Century, J. (2010). Inquiry-based science instruction-what is it and does it matter? Results from a research synthesis years 1984 to 2002. Journal of Research in Science Teaching, 47(4), 474–496. https://doi.org/10.1002/tea.20347

Musfiqon. (2012). Development of learning media and sources. Prestasi Pustakaraya.

Newman, M., Gough, D. (2020). Systematic Reviews in Educational Research: Methodology, Perspectives and Application. In: Zawacki-Richter, O., Kerres, M., Bedenlier, S., Bond, M., Buntins, K. (eds) Systematic Reviews in Educational Research. Springer VS, Wiesbaden. https://doi.org/10.1007/978-3-658-27602-7_1

OECD. (2018). PISA 2018 Assessment and Analytical Framework. OECD Publishing. https://www.oecd.org/education/pisa-2018-assessment-and-analytical- framework-b25efab8-en.htm

OECD. (2019).Skills Strategy 2019 Skills to Shape a Better Future: Skills to Shape a Better Future. OECD Publishing. https://www.oecd.org/skills/oecd-skills- strategy-2019-9789264313835-en.htm

Ogunkola, B., & Samuel, D. (2011). Science teachers' and students' perceived difficult topics in the integrated science curriculum of lower secondary schools in Barbados. World Journal of Education, 1(2), 17-29. https://doi.org/10.5430/wje.v1n2p17

Prasetiyo, W.H., Naidu, N. B. M., Tan, B. P & B. Sumardjoko, B. (2021). Digital citizenship trend in educational sphere: A systematic review. International Journal of Evaluation and Research in Education (IJERE), 10(4),192–1201. doi: 10.11591/ijere.v10i4.21767.

Puspitarini, Y. D., & Hanif, M. (2019). Using learning media to increase learning motivation in elementary school. Anatolian Journal of Education, 4(2), 53–60. https://doi.org/10.29333/aje.2019.426a

Putri, L. A., Permanasari, A., Winarno, N., & Ahmad, N. J. (2021). Enhancing students' scientific literacy using virtual lab activity with inquiry-based learning. Journal of Science Learning, 2021(2), 173–184. https://doi.org/10.17509/jsl.v4i2.27561

Ramdani, A., & Artayasa, I. P. (2020). Keterampilan berpikir kreatif mahasiswa dalam pembelajaran ipa menggunakan model inkuiri terbuka. [Students' creative thinking skills in science learning use an open inquiry model]. Jurnal Pendidikan Sains Indonesia, 8(1), 1–9. https://doi.org/10.24815/jpsi.v8i1.15394

Renken, M. D.,& Nunez, N.(20130. Computer simulations and clear observations do not guarantee conceptual understanding. Learning and Instruction, 23,10-23. https://doi.org/10.1016/j.learninstruc.2012.08.006

Rodríguez-Triana, M. J., Prieto, L. P., Dimitriadis, Y., de Jong, T., & Gillet, D. (2021). ADA for IBL: Lessons Learned in Aligning Learning Design and Analytics for Inquiry- Based Learning Orchestration. Journal of Learning Analytics, 8(2), 22–50. https://doi.org/10.18608/jla.2021.7357

Rosmala, A. (2021). Model-model pembelajaran Matematika. Bumi Aksara. https://books.google.com.au/books/about/Model_Model_Pembelajaran_Matemati ka.html?hl=id&id=5xwmEAAAQBAJ&redir_esc=y

Sardiman. (2012). Teaching and learning interaction & motivation. Rajawali Pers

Septiani, D., & Susanti, S. (2021). Urgensi Pembelajaran Inkuiri di Abad ke 21: Kajian Literatur. [The Urgency of Inquiry Learning in the 21st Century: Literature Review.] SAP (Susunan Artikel Pendidikan), 6(1). https://doi.org/10.30998/sap.v6i1.7784

Steinmayr, R., Dinger, F. C., & Spinath, B. (2012). Motivation as a mediator of social disparities in academic achievement. European Journal of Personality, 26(3), 335– 349. https://doi.org/10.1002/per.842

Suprapto, N. (2020). A systematic review of photovoice as participatory action research strategies. International Journal of Evaluation and Research in Education (IJERE), 9(3),675–683. doi: 10.11591/ijere.v9i3.20581.

Tamami, F., Rokhmat, J., & Harjono, A. (2022). Validation of Go-Lab Based Inquiry Learning Spaces (ILS) on Science Subject for Junior High School Student. Jurnal Penelitian Pendidikan IPA, 8(4), 1724–1729. https://doi.org/10.29303/jppipa.v8i4.2174

Thangjai, N. (2022). Developing inquiry learning characteristics of grade 7 students using integrated 5e's of inquiry-based learning and game-based learning. Journal of Educational Issues, 8(1), 137-150. https://doi.org/10.5296/jei.v8i1.19547.

Woods-McConney, A., Oliver, M. C., McConney, A., Maor, D., & Schibeci, R. (2013). Science engagement and literacy: A retrospective analysis for Indigenous and non-Indigenous students in Aotearoa New Zealand and Australia. Research in Science Education, 43(1), 233–252. https://doi.org/10.1007/s11165-011-9265-y

Xiao, Y., & Watson, M. (2019). Guidance on Conducting a Systematic Literature Review. Journal of Planning Education and Research, 39(1), 93–112. https://doi.org/10.1177/0739456X17723971

Zacharias, Z. C., Olympiou, G., & Papaevripidou, M. (2008). Effects of experimenting with physical and virtual manipulatives on students'

conceptual understanding in heat and temperature. Journal of Research in Science Teaching, 45(9), 1021–1035. https://doi.org/10.1002/tea.20260

Zaini, M. (2018). Development of Guided Inquiry Based Learning Devices To Improve Student Learning Outcomes in Science. European Journal of Alternative Education Studies, 2000, 107–117. https://doi.org/10.5281/zenodo.2261027

Zulaichah, S., Sukarmin, S., & Masykuri, M. (2021). Pengembangan modul IPA berbasis inquiry lesson pada materi usaha dan pesawat sederhana untuk meningkatkan kreativitas ilmiah siswa. [Inquiry-based science education module development lesson on work-energy material and simple machines to increase students' scientific creativity]. Edusains, 13(1), 64-72. https://doi.org/10.15408/es.v13i1.17389