Unnes.J.Biol.Educ. (2) (2022)

Journal of Biology Education

http://journal.unnes.ac.id/sju/index.php/ujbe

E-Module of Human Circulatory System through Levels of Inquiry-Based to Improve Students' Science Literacy

Mariny Soraya Raupu, Masra Latjompoh[1]✉, Margaretha Solang[2]✉

[1]Biology Department, Pascasarjana, Universitas Negeri Gorontalo, Indonesia

Article Info

Article History:

Received : July 2022

Accepted : July 2022

Published : August 2022

Keywords:

Human sirculatory system, Levels of Inquiry, Scientific literacy

Abstract

This study aims to analyze the E-module validity and practicality of the human circulatory system through levels of inquiry based to improve the students' science literacy. It used Research and Development model with the stages of research, including needs analysis, product design, prototyping, validation, testing, and revision. Validation sheets, observation sheets of learning implementation, student response questionnaire, and the science literacy tests were used in data collection techniques. The validity test results showed that this e-module is included in the very valid criteria with an average presentation value of 96% validity. The practical test results show that this is the very practical criteria of e-module with an average presentation of teacher activity implementation of 83,3%, while the average presentation of student activity implementation of 79,17%, and the value of student response of 83,96%. The effectiveness test used one group pretest-posttest design which obtained the average pretest value of 34,2 and the average post-test value of 70,83. There is an increase in the ability of students' science literacy with an n-gain of 0,56 (medium category). Based on the results of the study, it is found that the e-module of the human circulatory system based on levels of inquiry is valid, practical, and effective to be used in improving students ' science literacy.

✉ Correspondence Address:
Jl. Jendral Sudirman No. 6 Kota Gorontalo - Indonesia
E-mail: marinysoraya@gmail.com masralatjompoh@ung.ac.id
martasolang@yahoo.co.id

p-ISSN 2252-6579

e-ISSN 2540-833X

INTRODUCTION

Comprehension of science concepts by the scientific process is expected to improve students ' scientific literacy skills so that they can be used in solving problems in daily life. In fact, science learning at the junior high school level is still focused on knowledge competence only, while the efforts to familiarize the scientific process that affects the ability of students with science literacy are still rarely to be implemented. Science literacy is the knowledge of science concepts, understanding the science process behind science content, and the meaning of science concepts and processes in their implementation in various aspects of life (Rohmi, 2017). Good science literacy skills can be identified through three competencies according to the PISA recommendations, namely 1) explaining phenomena scientifically, 2) evaluating and designing scientific investigations, 3) interpreting data and evidence scientifically (Pantiwati, 2017).

The problem of low ability of students' science literacy is still experienced for a whole students at junior high school in Indonesia. Rohmi (2017) presented data on the PISA research results for three times in 2006, 2009, and 2012 that Junior High School students in Indonesia were only able to obtain an average score of 382-395 which still under the average score of the PISA which is 500. Another study conducted by Mulbar and Bahri (2021) regarding the scientific literacy ability of Junior High School students in South Sulawesi, where a sample of 235 students from 4 schools showed that the ability of scientific literacy in biology learning was still in the low category. Nur'aini et al (2018) also presented the research result on the scientific literacy skills of students in Surakarta. The instrument they used was a package of scientific literacy questions referring to the PISA 2015. According to the results obtained, they found that the ability of science literacy students in Surakarta was still relatively low.

The low ability of science literacy in Junior High School students, one of them is found in the material of the Human Circulatory System. Hasasiyah et al (2020) have conducted research on the analysis of the scientific literacy ability of Junior High School students on human blood circulation learning material. She took a sample in one of the schools located in Central Java. The results showed the average ability of students' science literacy for human blood circulation material in the low category. Not only harm in terms of competence of students, but the low students' scientific literacy related to the concept of the circulatory system also feared that it can affect their daily life. It is known that heart and blood vessel disease is very dangerous and it is the number one killer disease in Indonesia (Mandagi and Yani, 2019). Hanifah et al (2021) explained that coronary heart is a disease with a long development period so that it can be prevented by changing lifestyle early on. Therefore, it is important to strengthen the students' scientific literacy related to the efforts in maintaining the human circulatory system since junior high school level. Then, Mulbar and Bahri (2021) recommended that to train students ' scientific literacy skills, teachers should use constructivist learning methods, such as inquiry equipped with innovative media and learning resources.

Inquiry is a learning model where students are facilitated to build science knowledge through investigation activities. The scientific process carried out by students during learning process supports the strengthening of process skills and scientific literacy. Fahmi et al (2018) presented the results of their research that inquiry learning is effective in improving the skills of science processes and learning outcomes for Junior High School students. Another research result by Wen et al (2020) stated that guided inquiry with simulation could support science achievement and science literacy of Junior High School students. Guided inquiry learning applied to students of SMAN 11 Tangerang had also effectively proven in improving the scientific literacy of students in the medium category (Pujiastuti, 2020).

The inquiry learning model is divided into several levels by Wenning in Zulaichah et al (2019) based on the level of thinking that students experienced and the control center of learning activities. This distribution includes levels of inquiry (LOI) consisting of discovery learning, interactive demonstration, inquiry lesson, inquiry laboratory, real-word applications, and hypothetical inquiry. The inquiry level implementation in learning is still rarely done because it is constrained by the guidance of learning activities that can be used by teachers and students. The existence of appropriate guidance and learning resources are expected to increase the effectiveness of the levels of inquiry implementation in learning activities. Muskita and Subali (2022) said that student worksheets which are based on levels of inquiry the ones they develop are effective in improving critical and creative thinking skills. Related to efforts in improving science literacy, a complete guide in the form of modules can be a good choice, considering that the module elements at least contain material and

instructions for learning steps. Therefore, electronic modules (e-modules) can be the right choice, especially in the era of digital learning. Maison and Wahyuni (2021) revealed that the development of e-module in Natural Science lesson based on guided inquiry has the potential to improve students ' science literacy.

Based on the description of these ideas above, the authors conducted an e-learning research development module for the human circulatory system based on levels of inquiry to improve the ability of science literacy in Junior High School students. The difference between this study and previous research is that the e-module development is carried out to support the application of inquiry levels that can have an impact on improving students ' scientific literacy on the human circulatory system material lesson. This study aims to analyze the validity, practicality, and effectiveness of the e-module of the human circulatory system based on levels of inquiry in improving students ' scientific literacy.

RESEARCH METHOD

This research was conducted at SMP Islam Cendekia, Bolaang Mongondow regency, the province of North Sulawesi. The research model used Research and Development which includes 6 stages, namely 1)needs analysis, 2)product design, 3)prototyping and validation, 4) initial revision, 5)limited scale trials, and 6)final revision. The resulting product is an e-module of the human circulatory system based on levels of inquiry.

The data collection were include the validity, practicality, and effectiveness of the product. Validity was measured using expert validation sheets. The product practicality was measured using teacher activity observation sheets, student activity observation sheets, and response questionnaires. The effectiveness of the module was measured using a science literacy-based test with a one-group pretest post-test design, then analyzed using the n-gain formula.

RESULTS AND DISCUSSION

Validity Analysis Of E-Module the Human Circulatory System Levels of Inquiry Based to Improve the Students' Scientific Literacy

Validation was carried out by three expert validators, consisting of material experts and media experts who were lecturers in the Department of Biology Education, Gorontalo State University. Validity test results can be seen in Figure 1

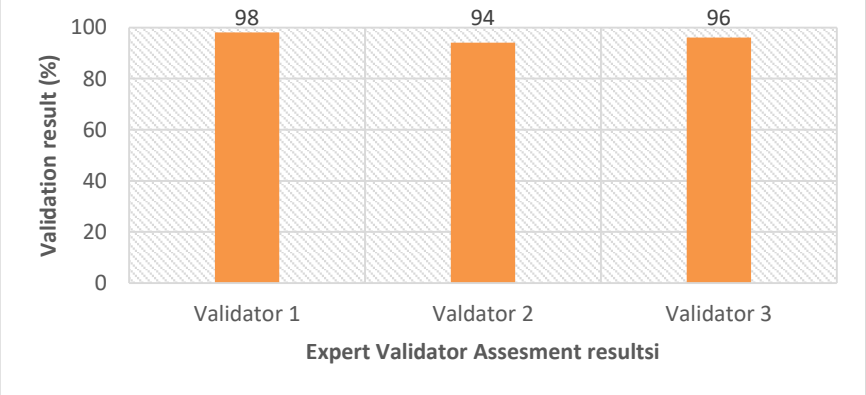
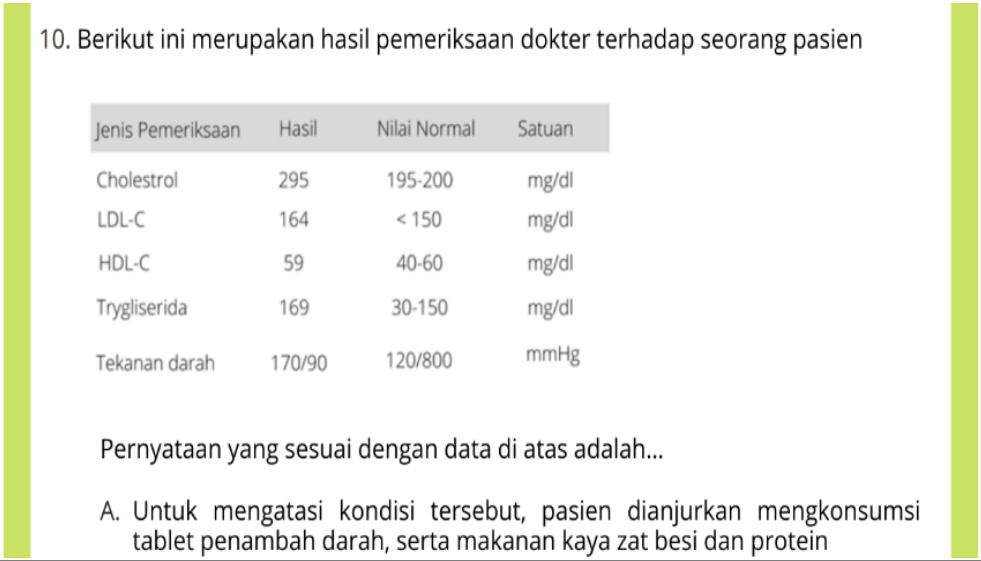


Figure 1 Assessment results of e-module validity

The Data in Figure 1 shows that the product validation results of all validators have a very good value. Validator 1, as a material expert, evaluates that the e-module content in terms of material have fulfilled the elements of feasibility of completeness, width, depth of material, concepts accuracy, images, diagrams and illustrations, clarity of terms and language use, suitability of content with learning levels of inquiry based,

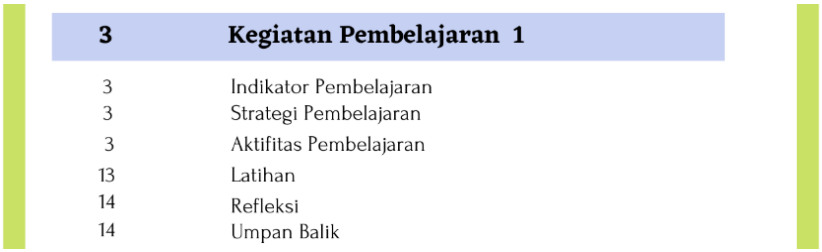
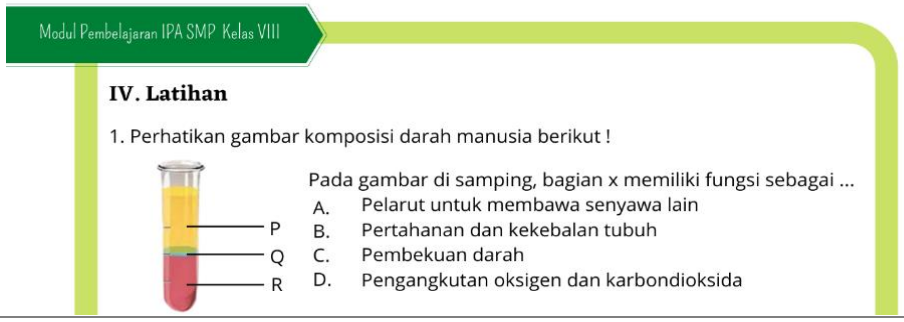
the content of scientific literacy and accuracy of the items questions/evaluation. Improvement of the e-module contents based on expert advice material is in the evaluation section as shown in Table 1.

Table 1. Revision based on expert assessment of the material

No.	Material Expert Assesment
1	The patient's identity in the question stimulus is removed to maintain ethics and train the character of students Before assesment  10. Berikut ini merupakan hasil pemeriksaan dokter terhadap seorang pasien Laboratorium Klinik Sehat Alamat. Jl. Kartini Kotamobagu, Sulawesi Utara Nama Pasien : Ny. Siti Alamat : Kotamobagu No Telepon : 085212345678 Jenis Pemeriksaan / Hasil / Nilai Normal / Satuan Cholestrol 295 195-200 mg/dl LDL-C 164 < 150 mg/dl HDL-C 59 40-60 mg/dl Trygliserida 169 30-150 mg/dl Tekanan darah 170/90 120/800 mmHg Dari gambar tersebut, kriteria yang cocok dengan pasien adalah... After Assesment  10. Berikut ini merupakan hasil pemeriksaan dokter terhadap seorang pasien Jenis Pemeriksaan / Hasil / Nilai Normal / Satuan Cholestrol 295 195-200 mg/dl LDL-C 164 < 150 mg/dl HDL-C 59 40-60 mg/dl Trygliserida 169 30-150 mg/dl Tekanan darah 170/90 120/800 mmHg Pernyataan yang sesuai dengan data di atas adalah... A. Untuk mengatasi kondisi tersebut, pasien dianjurkan mengkonsumsi tablet penambah darah, serta makanan kaya zat besi dan protein

The media expert assessment results (validators 2 and 3 in Figure 1) show that e-module is very good in terms of module size, letters and spaces, completeness of elements, layout, attractiveness, clarity of activity instructions and each inquiry level. Minor revision are carried out based on the media expert suggestion shown in Table 2.

Table 2. Revision based on media expert assessment

No.	Media Expert Assessment
1	Added practice questions Before assesment  3 Kegiatan Pembelajaran 1 3 Indikator Pembelajaran 3 Strategi Pembelajaran 3 Aktifitas Pembelajaran 10 Refleksi 11 Umpan Balik After assesment  3 Kegiatan Pembelajaran 1 3 Indikator Pembelajaran 3 Strategi Pembelajaran 3 Aktifitas Pembelajaran 13 Latihan 14 Refleksi 14 Umpan Balik  Modul Pembelajaran IPA SMP Kelas VIII IV. Latihan 1. Perhatikan gambar komposisi darah manusia berikut ! P Q R Pada gambar di samping, bagian x memiliki fungsi sebagai ... A. Pelarut untuk membawa senyawa lain B. Pertahanan dan kekebalan tubuh C. Pembekuan darah D. Pengangkutan oksigen dan karbondioksida

The validation results show that e-module produced has fulfilled the characteristics of self-instructional and adaptive. Self-instructional in the meaning of e-module can be used by the students to learn independently because it is supported by the completeness of the module elements. These elements include material based on the indicators of competence, including illustrations and supporting images, discussion questions, learning activity guides according to the level of inquiry, and practice questions and evaluation. E-module adaptive has adapted to the development of science and technology. The e-module contents are equipped with a choice of supporting material links accompanied by QR-codes that make the students are easier to access them through mobile devices. In addition, each learning activity and questions in the e-module is started with a stimulus in the form of new pieces images or event data related to the human circulatory system that is being discussed today. It is considered that having good correlation with the level of inquiry and indicators of science literacy.

The conclusion from the validation results of the material and media experts indicated that the e-module developed is feasible to use with an average validity value percentage by the three expert validators is

96% with very valid criteria. This result is supported by Wahyuni's research (2021) that the development of natural science modules using a guided inquiry model has a positive impact on the ability of science literacy. Results of similar research were also presented by Auilia et al (2018) that inquiry-based natural science teaching materials are effective in improving students ' science literacy ability.

E-Module Practicality Analysis Of the Human Circulatory System Levels of Inquiry Based to Improve Students' Science Literacy

The practicality test was conducted through observation of the learning implementation calculated using observation sheets of student and teacher activities. It was done in the learning activities of the human circulatory system using an e-module based on *levels of inquiry*. The result is presented in Figure 2.

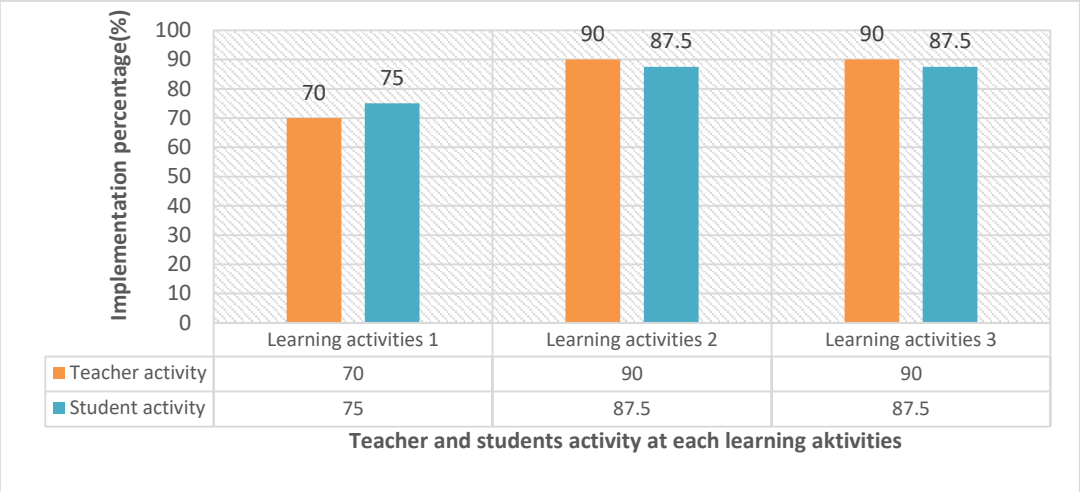


Figure 2. Assessment Results of Activity Implementation by Teachers and Students

The presented in Figure 2 shows at first meeting, the implementation of teacher activity is as much as 70%, while the implementation of student activity is as much as 75 %. In this first meeting, the constraints that occur were the students' limitations in accessing e-modules. It was caused by external factors, such as the internet network and the mobile devices' availability. So, there was a group of students who were less than the maximum in accessing the learning video link in the module. By the observer, this activity obtained enough score. According to the teacher activity at the first meeting, there were still many parts that teachers dominated in explaining both the material and learning instructions because students were not yet familiar with e-modules utilization. In the second and third meetings, the presentation of the activities implemented by teachers and students increased. Most students could carry out more independent learning activities with the e-modules assistance, and they could access links to learning materials and videos in e-modules. The students' and teachers' average activity from the first meeting to the third meeting was classified in the very good category.

Besides the learning implementation, to measure the practicality of this e-module, students' response data were collected through questionnaires. This response questionnaire contains some questions related to the students' practicality in using e-learning module of the human circulatory system levels of inquiry based during the learning activities as well as the benefits for the learners themselves. The response questionnaire results of students in limited scale trials obtained an average of 83,96% which means that the students' response in using e-module is very good.

This e-module developed showed the difference that the learning activity guide was prepared by referring to the inquiry strategy. So, in each learning activity, there were instructions for students to make a discovery process through investigation. Guide learning activities on this e-module facilitated the students to conduct experimental investigation of the effect of activity types on the heart rate frequency. It could be seen that they felt challenged and excited so that they were active in learning activities. Likewise with the teacher

activities that showed the good learning implementation because the e-module developed contains detailed instructions for each level of inquiry so making it easier for teachers to apply it in the classroom. Zainul and Cheva (2019) explained that the guided e-module based on inquiry which they developed showed practicality in improving the students' liveliness and understanding. Furthermore, the results research by Batong and Wilujeng (2018) explained that web-based inquiry training of LKPD was effective in improving science literacy.

Effectiveness Analysis of the Human Circulatory System E-module Levels of Inquiry Based to Improve the Students' Science Literacy

Effectiveness test was used to measure the extent to which of the effectiveness in e-learning module of the human circulatory system based on levels of inquiry to increase the students' science literacy. The measurement instrument used was a test instrument of multiple choice questions totalling 10 numbers with indicators used were indicators of science literacy based on the PISA recommendations in Pantiwati (2017), namely 1) explaining phenomena scientifically, 2) evaluating and designing scientific investigations, 3) interpreting data and evidence scientifically. Then, this science literacy indicator was adjusted into the indicator of basic competence achievement with a cognitive levels range at levels of C2 to C5 according to Anderson's revised Bloom taxonomy. Data on the pretest-postes results in limited scale trials are presented in Figure 3.

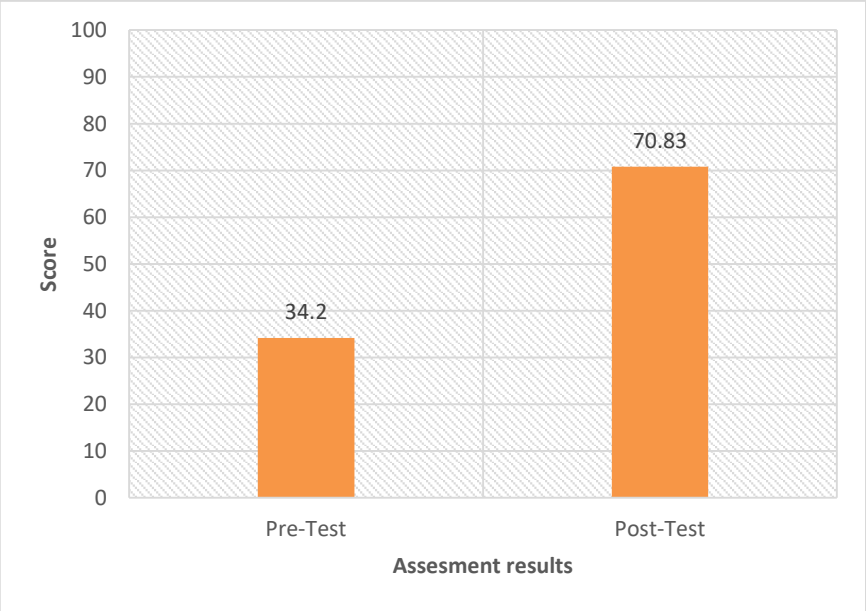


Figure 3. Students' Pre-Test and Post-Test Results

The Data presented in Figure 3 shows that the average value of students ' science literacy skills before learning activities is 34,2. In the pretest, the students' score results have low on average for all indicators. Post-test results in Table 3 shows an increase in the average score of students as much as 36,62 points. The calculating result of the n-gain as much 0,56. It was included in the medium category according to Meltzer (2002) in Fadlina et al (2021). Thus, it means that the e-module of the human circulatory system levels of inquiry based is quite effective in improving the students' science literacy. This is in line with the research by Aulia et al (2018) that the guided inquiry-based of teaching materials they developed can improve students ' science literacy skills.

The science literacy improvement that is included in the good category was found in the first indicator. It explained science phenomena and the third indicator which interpreted data and scientific

evidence. It was caused by the learning implementation using this e-module. Each level of inquiry and guidance on learning activities started with a stimulus by pieces of news or scientific data about abnormalities, diseases, or other phenomena related to the circulatory system that occurs in Indonesia. After that, there is a discussion question column. Then, the students' answers were recorded and proven through inquiry activities according to the e-module guidelines. This activity is proven to have a positive effect on the students ability to explain scientific phenomena and interpret data with scientific evidence.

Figure 4. E-module stimulus and discussion questions

The second indicator of science literacy, namely evaluating and designing scientific investigations, obtained an increase in the good enough category. In this case, it has a lower score rather than the other two science literacy indicators. This indicator was developed into 3 questions numbers, one of which is that students can determine the correct investigation hypothesis. This question was the least answered correctly by students when in the post-test session. The author analyzed that this happened because students were not familiar to carry out science activities in previous learning.

In this research, the e-module tested already contains a guideline to the students' activities in creating the correct hypothesis, particularly at the level of interactive demonstration, inquiry lesson, and inquiry laboratory, which the students were facilitated to make investigations regarding the effect of activity type on beginning heart rate frequency. The students facilitated to play the investigation variables in the form of different activity types. The observation results of students ' activities by the observer showed that most students are able to carry out this activity well. However, to train the ability in creating hypothesis and correct investigation steps, it is necessary to try getting used the process of science more often. Similar research results revealed by Mijaya et al (2019) regarding the profile of science literacy of students through the levels of inquiry

learning application. They found that after inquiry level learning implementation, the improvement of scientific literacy in the aspects of evaluating and designing scientific investigations obtained a low qualification (<g>=0.17).

CONCLUSION

The results obtained that the e-module of the human circulatory system *levels of inquiry*-based is valid, practical and effective to be used in improving students ' science literacy, with a very valid category, very practical, and increase science literacy in the medium category.

REFERENCES

Af'idayani, N., Setiadi, I., & Fahmi, F. (2018). The effect of inquiry model on science process skills and learning outcomes. *European Journal of Education Studies*.

Aulia, E. V., Poedjiastoeti, S., & Agustini, R. (2018). The effectiveness of guided inquiry-based learning material on students' science literacy skills. In *Journal of Physics: Conference Series* (Vol. 947, No. 1, p. 012049). IOP Publishing.

Batong, J. S. T., & Wilujeng, I. (2018, September). Developing web-students' worksheet based on inquiry training for increase science literacy. In *Journal of Physics: Conference Series* (Vol. 1097, No. 1, p. 012021). IOP Publishing.

Cheva, V. K., & Zainul, R. (2019). Pengembangan e-modul berbasis inkuiri terbimbing pada materi sifat keperiodikan unsur untuk SMA/MA kelas x. *Jurnal Edukimia*, 28-36.

Fadlina, F., Artika, W., Khairil, K., Nurmaliah, C., & Abdullah, A. (2021). Penerapan Model Discovery Learning Berbasis STEM pada Materi Sistem Gerak Untuk Meningkatkan Keterampilan Berpikir Kritis. *Jurnal Pendidikan Sains Indonesia*, *9*(1), 99-107.

Haryadi, R., & Pujiastuti, H. (2020). The Science Literacy Capabilities Profile Using Guided Inquiry Learning Models. *Jurnal Penelitian & Pengembangan Pendidikan Fisika*, *6*(1), 81-88.

Hanifah, W., Oktavia, W. S., & Nisa, H. (2021). Faktor Gaya Hidup Dan Penyakit Jantung Koroner: Review Sistematik Pada Orang Dewasa Di Indonesia. *Penelitian Gizi dan Makanan (The Journal of Nutrition and Food Research)*, *44*(1), 45-58.

Hasasiyah, S. H., Hutomo, B. A., Subali, B., & Marwoto, P. (2020). Analisis kemampuan literasi sains siswa SMP pada materi sirkulasi darah. *Jurnal Penelitian Pendidikan IPA*, *6*(1), 5-9.

Mandagi, I. V., & Yani, A. (2019). penyakit jantung koroner.

Mijaya, N. P. A. P. (2021). *Pengembangan E-Modul Pembelajaran Ipa Smp Kelas Vii Berbasis Model Pembelajaran Levels Of Inquiry Untuk Meningkatkan Literasi Sains Siswa* (Doctoral dissertation, Universitas Pendidikan Ganesha).

Mulbar, U., & Bahri, A. (2021). Scientific Literacy Skills of Students: Problem of Biology Teaching in Junior High School in South Sulawesi, Indonesia. *International Journal of Instruction*, *14*(3), 847-860.

Muskita, M., & Subali, B. (2020). Effects of Worksheets Base the Levels of Inquiry in Improving Critical and Creative Thinking. *International Journal of Instruction*, *13*(2), 519-532.

Nur'Aini, D., Rahardjo, S. B., & Susanti, V. E. (2018, May). Student's profile about science literacy in Surakarta. In *Journal of Physics: Conference Series* (Vol. 1022, No. 1, p. 012016). IOP Publishing.

Rohmi, P. (2017). Peningkatan Domain Kompetensi dan Pengetahuan Siswa melalui Penerapan Levels of Inquiry dalam Pembelajaran IPA Terpadu. *EDUSAINS*, *9*(1).

Pantiwati, Y. (2017). Kemampuan literasi dan teknik asesmen literasi. *Research Report*.

Wahyuni, I. (2021, April). Guide inquiry science e-module development for improving junior high school students' scientific literacy. In *Journal of Physics: Conference Series* (Vol. 1876, No. 1, p. 012089). IOP Publishing.

Wen, C. T., Liu, C. C., Chang, H. Y., Chang, C. J., Chang, M. H., Chiang, S. H. F., ... & Hwang, F. K. (2020). Students' guided inquiry with simulation and its relation to school science achievement and scientific literacy. *Computers & Education*, *149*, 103830.

Zulaichah, S., Sukarmin, S. S., & Masykuri, M. (2019). MODEL PEMBELAJARAN LEVEL OF INQUIRY. In *Prosiding SNPS (Seminar Nasional Pendidikan Sains)* (pp. 91-99).