AL IBTIDA: JURNAL PENDIDIKAN GURU MI (2023) Vol 10 (1): 63 - 80
DOI: http://dx.doi.org/10.24235/al.ibtida.snj.v10i1.11393

Al Ibtida: Jurnal Pendidikan Guru MI
ISSN: 2442-5133, e-ISSN: 2527-7227
Journal homepage: http://syekhnurjati.ac.id/jurnal/index.php/ibtida
Journal email: alibtida@syekhnurjati.ac.id

Development of the Game-based HOTS Assessment Instrument for Measuring Science Literacy Skills of Islamic Elementary School Students

Taufiq Satria Mukti*
*Department of Madrasah Ibtidaiyah Teacher Education, Faculty of Tarbiyah and Teacher Training, Universitas Islam Negeri Maulana Malik Ibrahim Malang, Indonesia
E-mail: tsatriam@uin-malang.ac.id

Melly Elvira**
**Department of Early Childhood Islamic Education, Faculty of Tarbiyah and Teacher Training, Universitas Islam Negeri Maulana Malik Ibrahim Malang, Indonesia
E-mail: melly@uin-malang.ac.id

Zaharah Binti Hussin***
***Department of Educational Foundations and Humanities, Faculty of Education, University of Malaya, Malaysia
Email: zaharah@um.edu.my

Received: October 26th, 2022. Accepted: May 09th, 2023. Published: June 23rd, 2023.

Abstract

Science literacy is an essential ability that elementary school students must possess. Science literacy can be developed in the learning and assessment process. Science literacy assessment requires a specific measuring instrument by prioritizing the HOTS cognitive concept. The development of science literacy assessment instrument adopted from the Djemari Mardapi Model aims to obtain the reliable instrument for gauging the students' science literacy skills. Involving experts, teachers as practitioners, and essential education experts, the assessment instrument was developed in the form of a game-based multiple-choice test with Quizizz. The instrument testing was conducted in grades 4, 5 and 6 of one of Islamic Elementary School in Malang Regency, Indonesia. The analysis of the instrument consisted of content validity and test reliability. The development results revealed that the instrument met the perfect content validity and the empirical test with a very high-test reliability value (0.89). The assessment process by Quizizz game showed that the students were very enthusiastic. Despite the promising results as shown in this study, it is still necessary to enhance the science literacy skills of students by familiarizing them with HOTS-based cognitive questions.

Keywords: *science literacy, HOTS game-based assessment, empirical validity.*

Abstrak

Literasi sains merupakan kemampuan esensial yang harus dimiliki siswa sekolah dasar. Literasi sains dapat dikembangkan dalam proses pembelajaran dan penilaian. Penilaian literasi sains memerlukan alat ukur khusus dengan mengutamakan konsep kognitif HOTS. Pengembangan instrumen asesmen literasi sains yang diadopsi dari Model Djemari Mardapi bertujuan untuk mendapatkan instrumen yang handal untuk mengukur kemampuan literasi sains siswa. Melibatkan pakar, guru sebagai praktisi, dan pakar pendidikan esensial, instrumen penilaian dikembangkan dalam bentuk tes pilihan ganda berbasis permainan dengan Quizizz. Uji coba instrumen dilakukan di kelas 4, 5 dan 6 salah satu Madrasah Ibtidaiyah di Kabupaten Malang, Indonesia. Analisis instrumen terdiri dari validitas isi dan uji reliabilitas. Hasil pengembangan menunjukkan bahwa instrumen memenuhi validitas isi sempurna dan uji empiris dengan nilai reliabilitas tes sangat tinggi (0,89). Proses penilaian dengan permainan Quizizz menunjukkan bahwa siswa sangat antusias. Terlepas dari hasil yang menjanjikan seperti yang ditunjukkan dalam penelitian ini, masih perlu untuk meningkatkan kemampuan literasi sains siswa dengan membiasakan mereka dengan soal-soal kognitif berbasis HOTS.

Kata kunci: *literasi sains, penilaian berbasis permainan HOTS, validitas empiris.*

INTRODUCTION

For competing in the era of Society 5.0, the improvement of the quality of Indonesian education is of upmost importance. It can be done through reevaluating the implementation of standardized learning and assessment. In the context of the elementary school curriculum, Natural Science Education is one of the main fields of science. Science subjects are the basis for advancing science and technology. Chiappetta, Fillman, and Sethna (1991) states that science is: "a way of thinking, a way of investigating, a body of knowledge, and science and its interactions with technology and society". From the argument, it can be interpreted that science involves logical thinking. It can hone the people's skills in conducting investigations and develop their knowledge. In addition, science is a vehicle for their interaction with technology that can support human life. In the Indonesian education system, science literacy is taught in the elementary school curriculum. Science literacy includes the mastery of skills to gather comprehensive information, analyze and re-evaluate the results of information obtained, and solve problems (Fakhriyah, Mafuah, & Mardapi, 2019; Herlanti et al., 2019). Learning by continuously displaying problems is one of the strategies for honing the science literacy of students (Rusilowati et al., 2019). The students' science literacy can be enhanced through the implementation of a problem-based approach as it can lead to meaningful learning experiences. Thus, students can develop science literacy skills through mastering the ability to solve problems.

Science literacy with a problem-solving strategy requires high-level thinking to effectively explain, predict, and elaborate knowledge (Dinica et al., 2014). The students' science literacy can be honed significantly through applying thinking construction consisting of identification, classification, interpretation, analysis, and evaluation. Higher Order Thinking Skills (HOTS)-based science literacy education is essential in the current digital era, where the ability to think critically, solve problems, and solve complex problems is increasingly needed.

The ideal condition of HOTS-based science literacy is that students can master complex science concepts, use science knowledge in real situations, apply scientific methods in solving problems, and have good communication and collaboration skills (Kwangmuang et al., 2021; Putranta, 2019). The improvement of the science literacy skills can help students enhance their learning achievement. By having the science literacy skills, students can adjust to a variety of situations and conditions well, and of course, they will be more active in learning (OECD, 2017). Students should have mastered various skills, especially the science literacy skills to compete globally in the era of Society 5.0 (Fukuyama, 2018).

In fact, globally, although some countries have introduced HOTS-based science literacy in their education curriculum, many challenges still must be overcome. According to a study conducted by UNESCO in 2017, only 37% of students worldwide can reach adequate levels of science literacy (UNESCO, 2017). Meanwhile, in Indonesia, the condition of HOTS-based science literacy still needs to be improved. Based on a survey conducted by PISA (Program for International Student Assessment) in 2018, Indonesian students are at the lowest level (level 4) in the seventh rank of 15 countries. The average score of Indonesian students in science literacy only reached 396 points, below the average OECD (Organization for Economic Co-Operation and Development) of 489 points (Schleicher, 2019). In addition, only about 9% of Indonesian students reach adequate levels of science literacy. The data shows severe problems with regard to the science literacy skills of the Indonesian students.

The main problem faced by Indonesian students in learning science is the lack of critical and analytical thinking skills, as well as a lack of collaboration and communication skills (Agnes, 2022; Nasution et al., 2022; Sari & Prasetyo, 2021). In addition, many students need to be more skilled in applying science concepts in real situations and using scientific methods to solve problems. Almost in the entire learning process that takes place, students use basic concepts more dominantly (Wahyuni, Aziz, Wargadinata, & Efiyanti, 2021). Students only develop knowledge based on memorization, not as the results of experience. It hinders their motivation to be involved in the learning process (Wahyuni, Indrawati, Sudarti, & Suana, 2017). Supporting the statement, several studies (Apriyani, Ramalis, & Suwarma, 2019; Güner & Erbay, 2021; Akben, 2020) conducted on primary and secondary education levels have shown that solving problems with questions only uses memorization. In terms of measuring the students' science literacy skills, such questions only employ basic concepts (Lower Order Thinking Skills).

The science literacy skills will be optimal if students can analyze, evaluate, and obtain accurate solutions to problems. Although in reality, improvements to the science literacy skills are more challenging than turning the palm. It is influenced by various factors that cause the problems. There are gaps between ideals and reality with regard to the implementation of HOTS-based science literacy both globally and in Indonesia, including the lack of quality human resources in the fields of science and education (Suparya et al., 2022), the educational curriculum that does not support the development of HOTS skills (Rahardjo, 2019), and the learning methods that are still too theoretical and less applicative (Widyandini, 2021). Students do not possess the experience of learning in different conditions, and they do not understand the core of the problems given (Dinica, Dinescu, Miron, & Barna, 2014). As well, students are less able to translate qualitative problems into quantitative (Zhou, 2017). In

addition, there is a lack of support from the government and the community (Safrizal et al., 2020; Suparya et al., 2022).

Science literacy skills are interrelated with the experience of thinking in solving problems during the learning process. The students' ability to think for solving problems is in line with their maturity, as well as their development of knowledge and experience (Ibda, 2015). Learning with basic concepts and teacher-centered learning can be minimized in several ways, including the use of an exciting game strategy (Alfiani, 2015) or the application of edutainment (Febriyanti & Mustadi, 2020). The use of a game-based approach can also increase the students' interest and motivation in learning science (Fitrianingsih et al., 2022; Tong et al., 2022).

In addition, several other studies use games as a tool for science literacy assessment. It is expected to improve student learning outcomes. Assessment with the game platform can be done with several options such as using Kahoot in the HOTS assessment process (Sartono, Sukowati, & Soleha, 2021) and developing game-based assessment (Yeni & Kurniawati, 2022). It is not an easy job to administer the assessment with HOTS-type questions. The presence of game-based assessments allows students to have a comfortable feeling during the process assessment. Preliminary studies have shown that the assessment of science literacy skills with the use of HOTS-based instruments in games can improve the students' high-level thinking skills (Huang et al., 2022; Kurnia et al., 2022). In addition, HOTS instruments in games are also effective in increasing the students' interest in learning science (Fitrianingsih et al., 2022; Tong et al., 2022; Yolanda et al., 2023). Studies have shown that the use of science literacy test instruments can provide a clear picture of the students' ability to understand the concept of science and apply it in real situations (Rini et al., 2021; Sutrisna, 2021; Winarni et al., 2020). The findings of those studies indicate that the use of HOTS instruments in games and science literacy tests can provide a comprehensive picture of the students' science literacy skills and enhance their interest in learning science.

Based on previous studies, the researchers have yet to find an assessment instrument for gauging the students' science literacy that meets the specific standards, including the quality of the test content and the empirical testing. The empirical testing will obtain the reliability value of the test. It proves that the instrument of the test can accurately estimate the science literacy skills through the construction of the students' HOTS. Therefore, to support the development of science literacy for elementary school students, the researchers developed the HOTS-based science literacy assessment instrument implemented in the form of a game. The analysis on the development of the instrument focuses on the quality of the assessment instrument with the Item Approach, which consists of the reliability of the test, as well as the analysis of the test results based on the classical response of the theory of the ability of students in specific samples.

Therefore, this study focuses on the development of science literacy assessment instrument with specific standards that can gauge the students' ability to understand the concept of science and apply them in real situations. Inspired from the results of previous studies, the researchers develop the science literacy assessment instrument with the game-based HOTS construction. The researchers develop instruments and use the Quizizz platform during the assessment process. Quizizz has a beautiful appearance, with a feature that can display the answer score of the participants during the test. It can also display the highest

score, as well as the accuracy and speed in answering the question. In addition, this platform is easy to use (user-friendly) and can be accessed freely by anyone.

The novelty of this study lies in the development of a game-based science literacy assessment instrument called Quizizz for *Madrasah Ibtidaiyah* students in Indonesia. Employing a game-based approach, the instrument is designed to measure the students' ability to understand the concept of science and their ability to develop HOTS. Therefore, this study can contribute in developing the effective and innovative science literacy assessment instrument, especially in the educational environment of *Madrasah Ibtidaiyah* in Indonesia.

METHODS

Using a quantitative approach, the development of the instrument was carried out to obtain authentic evidence in the form of content validity (Aiken Index) and the reliability value. Empirical tests were administered to ensure the accuracy of the instrument in gauging the science literacy skills of *Madrasah Ibtidaiyah* students. The instrument was also developed based on the High Order Thinking Skills (HOTS) construction. The students did not merely give a response to the instrument item. They were expected to be able to gain new knowledge by explaining scientific phenomena, drawing conclusions based on facts, understanding the characteristics of science, and being aware of how science and technology can support life, intellectual, and culture. They were also encouraged to have willingness to be involved in the issues related to science.

The instrument used in this study was a science instrument of science literacy in the form of multiple-choice questions based on HOTS. This instrument aimed to measure the literacy capabilities of elementary school students using the Quizizz game media. The development of science literacy instruments adopted the method by Mardapi (2012) that includes: 1) determining the measurement objectives, 2) determining the indicators and learning objectives, 3) developing items, 4) testing the validity of the instrument, 5) conducting instrument tests, 6) analyzing measurement results, and 7) interpreting the measurement results (Mardapi, 2012).

The initial stage in determining the measurement objectives involved the analysis of learning objectives in determining the HOTS skills that would be measured through multiple choice questions. This stage identified the concept of science literacy to be taught. The concept of science literacy was adjusted to the students and the applicable curriculum. The next stage was determining the indicators and learning objectives to be achieved. It helped determine the type of questions to be developed. The concept developed was the main predictor of questions that functioned as stimulation. Stimulation in the perspective of cognitive concepts was developed based on the ability to think of the high level (HOTS) as stated by Bloom (1956) dan Krathwohl (2010). The indicators of science literacy assessment instrument developed are as Tabel 1:

Table 1: Indicators of Science Literacy Assessment Instrument

Science Literacy	Cognitive Concepts	Subject Indicators
The Knowledge of science	Understanding	Students are able to understand human movement.
	Interpreting	Students are able to interpret energy transfer.
	Showing	Students are able to show environmental preservation attitudes.
Way of investigating	Sorting	Students are able to sort the process of digestion of food.
	Concluding	Students are able to conclude good food for health.
		Students are able to conclude changes in the form of objects.
	Classifying	Students are able to group the shape of objects based on their forming substances.
	Comparing	Students are able to compare the process of form change.
Way of thinking	Analyze	Students are able to analyze daily events about the work of the heart organ.
	Reasoning	Students are able to reason from water pollution events.
	Linking	Students are able to link heat transfer in the process of daily life.
	Evaluate	Students are able to judge by behaving from the air pollution event.
Interaction of science, technology, and society	Recommend	Students are able to recommend the activities that can maintain the health of the gestures.
	Respond	Students respond to good waste management.

Based on indicators above, the test items were developed. Items were developed on the basis of indicators of essential materials for science for the fourth, fifth, and sixth grades. The third stage was to design multiple-choice questions. The designed questions were expected to be able to evaluate the ability of students to apply HOTS skills. The question indicators used in the problem included the ability in observing, analyzing, problem-solving, high-level reasoning, critical thinking skills, being creative and communicating. In HOTS-based science literacy, the students were expected to be able to solve problems and find answers not merely by memorizing or knowing the facts. Therefore, the questions were designed to make students think of high levels and required the students to think critically and creatively. The questions also connected the concept of science with real situations.

One indicator of the questions developed in this instrument was the ability to analyze facts based on reality. Students were asked to be able to analyze daily events about the work of the heart organ. Students were expected to be able to answer and analyze facts about the mechanism of work of the heart through activities. Through such problems, the teacher could measure and improved the science literacy skills of students effectively. The process of

designing multiple choice questions can be observed through the flow diagram in Figure 1 below:

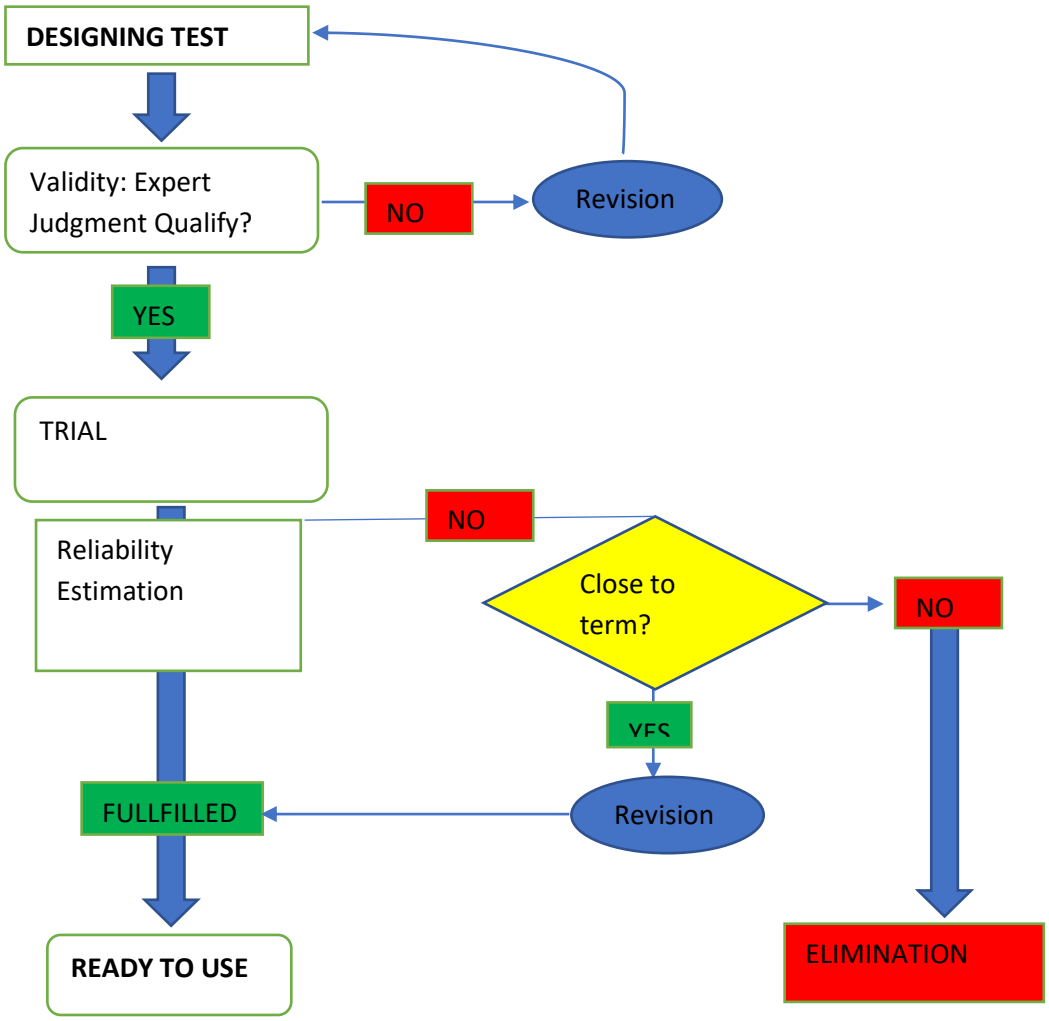


Figure 1: The Flow Chart of Instrument Development

Before measuring the students' science literacy skills, the instrument was first validated by experts. In this stage, the test questions were validated by three experts, namely practitioners/teachers, essential education experts, and learning technology experts. The validation was to ensure that these questions were relevant to the learning objectives and could measure the science literacy skills of the students. The instrument validity was tested using the content validity test, which included the checking of the compatibility of the test content and the construction and language used in the instrument. Content validity was carried out using the Aiken approach (1985). Content validity with the Aiken index analyzed the suitability of the indicator of the instrument item developed. Valid instruments could be used for the empirical test stage using a game-based application, namely Quizizz.

The next stage was an empirical test on elementary school students in grades 4, 5, and 6 at MI Raudlotul Ulum Karangploso. This stage involved the implementation of the problem in the Quizizz game media. The multiple choice questions validated were included in the Quizizz game so that the students could test their HOTS-based science literacy skills through games. The problem test stage was carried out to test the validity and reliability of the

questions. Questions were tested on students in grades 4, 5, and 6, with 127 students representing the population.

The data obtained from the trial questions were used to conduct statistical analysis, namely the analysis of items and the reliability analysis. It was used to evaluate the effectiveness of multiple-choice questions based on HOTS in measuring the science literacy skills of elementary school students. It helped improve the quality of the questions and identify areas that needed improvement. The analysis of measurement results included the analysis of student science literacy skills, instrument reliability, and instrument items through the Item Response Theory (IRT) approach using quest software. The quest output related to the analysis of the items was grouped into four categories, namely very low, low, high, and very high, based on the opinion of Mardapi (2018). Grouping categories with a specific range of values was then carried out by calculating the ideal average formula obtained through the average value of the test population. The score range based on the ideal average value is presented in the following table:

Table 2: Category of Science Literacy Skills

Achievement Score	Category
≥ 80	Very High
60-79	High
40-59	Low
≤ 39	Very Low

Categorizing the quest output from a logit scale to a score of 0-100 was carried out through two stages: calculating the logit scale, converting the logit scale and providing categorization of capabilities. The logit scale measures the students' ability to solve HOTS-based questions. The logit scale was in the range of values of -4 to 4. The higher the logit scale value, the higher the ability of students to solve HOTS-based questions. The logit scale was converted into a score of 0-100 needed to provide categories to students' skills. Furthermore, the students' skills were grouped into four categories, namely very low, low, high, and very high, based on a predetermined range of scores.

In measuring the science literacy skills of students, the reliability of this instrument was related to the reliability and consistency of the instrument. The estimated reliability of this instrument was carried out with the estimated reliability of Alpha Cronbach's reliability coefficient of the quest output. The category of empirical testing on test reliability values (Adams & Khoo, 1996) is presented in Table 3:

Table 3: The Range of Test Reliability Value

Reliability Interval	Level
0,81 – 1	Very High
0,6 – 0,8	High
0,41 – 0,59	Medium
0,21 – 0,4	Low
0 – 0,2	Very Low

If the instrument had a high level of reliability, then the results of the measurement of the students' science literacy skills obtained were more reliable and consistent. Conversely, if

the instrument had a low level of reliability, the results of the measurement of the students' science literacy skills obtained cannot be relied upon or were inconsistent.

RESULTS AND DISCUSSION

Science literacy is the ability of individuals to understand, use, and interpret scientific information in everyday life. In science literacy, four main cognitive concepts include science knowledge, science thinking, how to investigate, and interaction between science, technology, and society. The science literacy skills include analysing, reasoning, linking, and assessing scientific information. The measurement of the skills can be done by giving students some information related to something, then they are asked to identify and analyze it.

The development of science literacy assessment instrument began by determining the instrument's objectives and designing problems to measure the ability of HOTS-based science literacy students. All the questions developed were adjusted to the indicators of the science literacy skills put forward by Chiappetta et al. (1991, 1993) as shown in Table 1. One of the efforts was to ensure that the questions had an adequate quality. Thus, it was necessary to take several vital steps in making and developing questions. First, it was necessary to analyze the skills of the expected science literacy in students. This stage was done through literature studies and observations with education experts or practitioners competent in science literacy. Second, the validity test of the previously developed questions was carried out.

The development of the science literacy assessment instrument was carried out by involving three experts. Instrument validity test results generally showed a value of 0.86. The items of the instrument was valid and can be used for trials. Although some questions still received advice and input from the experts. Based on expert reviews, of the 28 items arranged, six items had minor revisions. According to the input from the experts, the revised items still needed improvement in terms of the language. In addition, the aspects of construction were also still needed to be improved, for questions 2, 8, 13, 17, 18, and 26. Input from experts was then used to improve questions in terms of construct, content, or language.

The substance aspect of the instrument developed was the suitability of the questions to the science literacy skills. The instrument developed should have met the substantial aspects of the item. It is in line with the statement (Mardapi, 2012) that the substance aspects consist of: 1) no SARA and PPPK (ethnicity, religion, race, between groups, pornography, politics, propaganda, and violence), 2) materials following the aspects of the science literacy skills at elementary school, 3) choices of homogeneous answers and logical, and 4) only one answer key. One item was still not considered to measure the science literacy skills of students. The item included indicators of science capabilities with cognitive concepts of interpreting. Based on the advice of expert input, the item can be revised again so that it can be used.

In aspects of construction, readability tests and ease of grain were understood and used in estimating the science literacy skills of students (Mukti & Istiyono, 2018). The readability of the instrument items was considered to have fulfilled several elements of the provisions set by the 2019 Education and Culture Education Assessment Center (Abduh, 2019) namely: 1) the subject matter is the statement needed, 2) the subject matter does not answer critical instructions, 3) the subject matter does not use a double negative statement, 4) the Image/graph/table/table is clear and functioning, 5) length of Answers, 6) do not use the

answer choices "All Right Answer Options" or "All Answer Options False", 7) answer choices in the form of numbers or time are arranged based on the size of the numbers or chronological events, and 8) items do not depend on the answers to the previous question. Some questions were improved by experts related to the choice of answers that still used "all correct answers" and the choice of answers that were still not relatively the same.

In terms of the language aspect, the items have used language following the rules of writing Indonesian grammar, based on enhanced spelling (PUEBI), and using communicative language. The concurrent language was not using the language that applied in a place (regional language) (Istiyono, 2017). Almost all validators have given a good assessment of the language aspects of the items compiled. All items followed the rules of Indonesian grammar writing.

The multiple-choice items declared valid by experts were then used in the game Quizizz application (https://quizizz.com). The grains used were 15 grains representing each essential science material indicator according to Table 1. Anyone could use this Quizizz without requiring open access. Quizizz was also easy to use (user-friendly) and could be designed according to the form of the assessment. The instrument design used was based on the advice of input from the validator of technology and information media experts. Some suggestions and input related to the layout and placement of images or tables were adjusted according to the needs of the questions. Thus, the appearance of the items was attractive and easy to understand for students. The following is the display of the items in the Quizizz application.

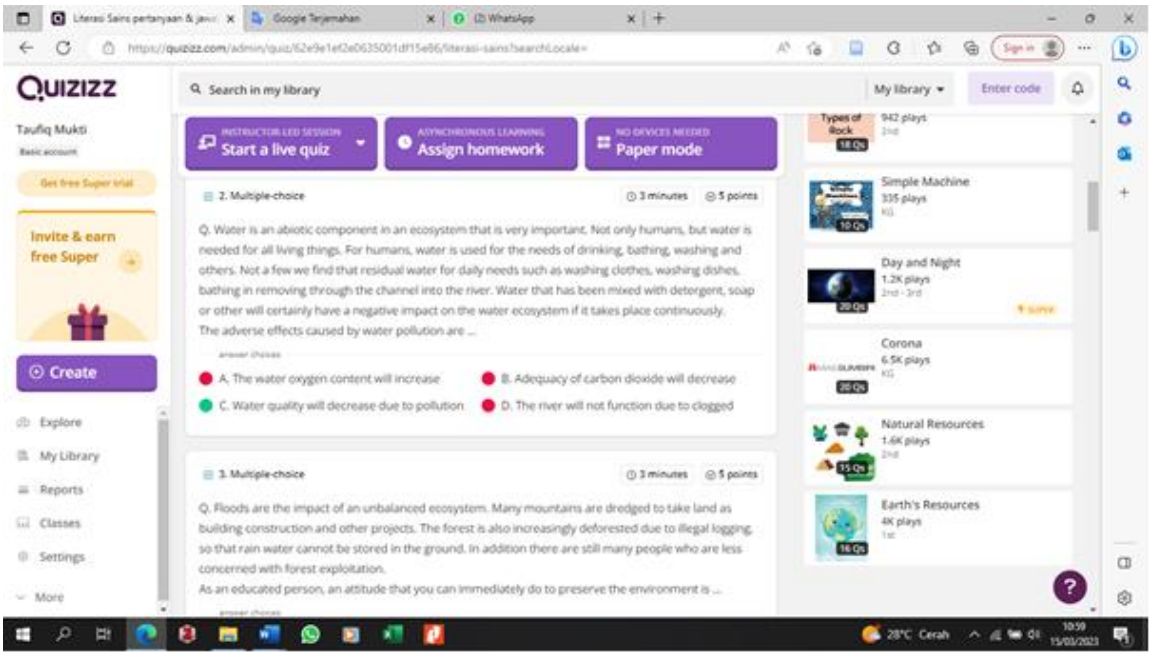
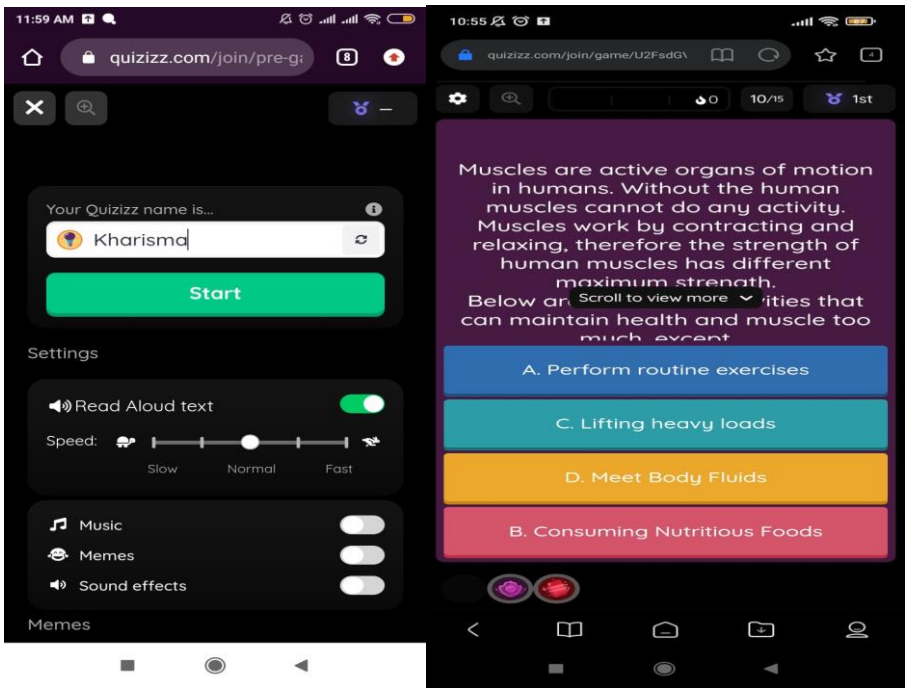


Figure 2: Quizizz Worksheet

The picture above shows the worksheet on the Quzizz application. The items on the worksheet include the writing points on each question and the order of the question number. It shows that Quizizz is a user-friendly application. The highest score criteria for each item is based on the accuracy of the answers and the speed of time answering (Salsabila, Habiba, Amanah, Istiqomah, & Difany, 2020). At this stage, each item that has been valid can be written.



A Figure 4: Start Quizizz B

Figure 4 shows the display of the user/test participant on the initial Quizizz (A) before the quiz starts, and (B) the display of the item when the quiz takes place is beautiful. The quiz will be set by the operator (quiz maker) to get a link (https://quizizz.com/join?gc=550324&source=lvedashboard) to join the game. The test participants can join at the link by entering their name and post-applicable name at a specific time (550324). Figure 5 is the display when students answer each item. If the answer is correct (A), a kind of stimulant game will appear (B), and when the answer is wrong, then the answer justification will appear (C).

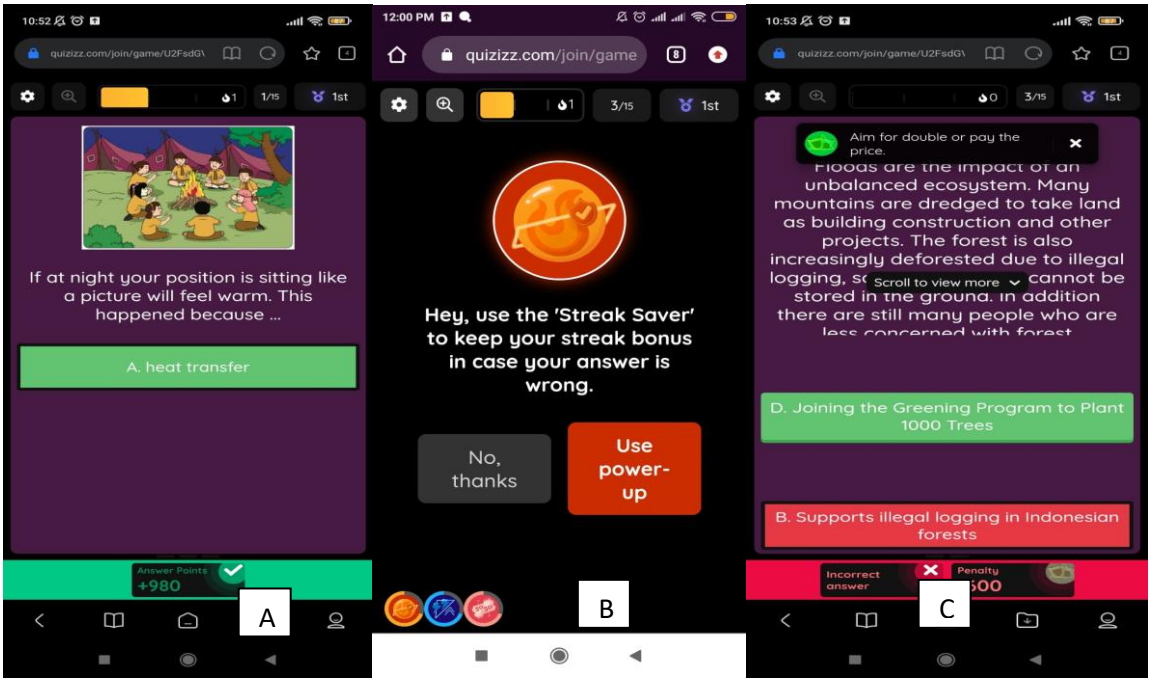


Figure 5: Running Game

Quizizz can also be set as needed when the questions or answers require a more detailed explanation, this explanation will appear after the answers to the questions come out as shown in Figure 6:

Figure 6: Additional Explanation

The trials conducted using the Quizizz application ran smoothly. The measurement process was administered with fun. Students were very enthusiastic. They could understand the instructions well so that they could answer the questions smoothly. Game stimulants that appeared when successfully answering correctly would be varied and would appear several times when the game took place. It could undoubtedly be enjoyable in the process of measurement of the students' science literacy skills.

Evidence that the instrument developed and tested has met the reliable criteria can be expressed through the validity and empirical tests with the item response theory (IRT) analysis. The empirical test from the instrument test results was carried out, and a measurement of students' science literacy skills with Quizziz application. Analysis based on CRT was carried out on 127 elementary school students in grades 5 and 6. The analysis of the responses of empirical test results was carried out with quest application software. Reliable instruments must meet the elements of the reliability value tested empirically. This reliability criterion was conveyed by Wright & Stone (1999) that should at least meet the reliability value of 0.7. The minimum limit can be used as a reference that the quality instrument can be used accurately in estimating the science literacy skills and also obtaining authentic evidence, and that the instrument can be used anytime, anywhere, and by anyone (Mardapi, 2012). The instrument reliability value in this study can be shown in Figure 7:

```
----------------------------------------------------------------------------------------------------------
Item Estimates (Thresholds)                                                          15/ 8/22 9:25
all on all (N = 127 L = 15 Probability Level= .50)
----------------------------------------------------------------------------------------------------------

Summary of item Estimates
-------------------------

Mean                          .00
SD                           1.58
SD (adjusted)                1.49
Reliability of estimate       .89
```

Figure 7: Reliability Value

Analysis of the instrument reliability in the empirical test obtained a value of 0.89. The reliability value was expressed as a very high value, this can also be observed in Table 3 (Adams & Khoo, 1996). It can be interpreted that the instruments developed have met high quality. Thus, the results obtained in estimating the science literacy skills of students can be accounted for.

The results of science literacy skills students show that 70.96% of respondents have good science literacy skills. It can be proven by the acquisition of the scores. 12.9% of the students got a score of science literacy skills of more than 80. Meanwhile, 58.06% of students got a score of 60-79. Half of that number obtained a score of more than 70, and the other half gained less than 70. Based on the CRT analysis, the results of student science literacy skills are presented in Table 4 as follows:

Table 4: Results of Science Literacy Skills

Achievement Score	Category	Student Achievement (%)
≥ 80	Very High	12,90
60-79	High	58,06
40-59	Low	25,81
≤ 39	Very Low	3,23

Although in all respondents, the achievement of science literacy is in a suitable category. 29.04% of the students still need to enhance their science literacy skills. It shows that there are still students who still need to have a high level of thinking ability, so it becomes the input for teachers to continue making improvements. These findings are in line with the results of research conducted by Susapti and Istiqlal (2021) that most of the HOTS abilities in elementary school students are still relatively low and must be improved. Some cognitive concepts that still need to be improved are the concept of reasoning, linking and implementing. The students' ability related to cognitive concept still needs to be improved.

The improvement of the students' science literacy can be done in various ways. Teachers are one of the main factors and actors in increasing science literacy in classroom learning. They must be able to present a real context and always link lessons with daily life so that students can more easily understand the various context of the problem and its solutions (Busyaeri, Udin, & Zaenudin, 2016). Teachers can also implement relevant learning strategies and models in addition to the teaching materials. Such effort can thus increase the student motivation and also improve the quality of learning in class to achieve good literacy (Ramadhani, Kenedi, Helsa, Handrianto, & Wardana, 2021).

The development of science literacy assessment Instrument with game-based HOTS construction through the Quizizz application can enhance the students' motivation in the assessment process. In addition, other advantages of developing this game-based assessment can be significantly reversed for anyone. The ease of use is also shown by its flexible settings. However, elementary school students require intensive assistance during the assessment process. The Quizzaz application can be ultimately used along with the use of the mobile phone.

CONCLUSION

The assessment of science literacy skills through HOTS cognitive concepts for elementary school students can be done using the game-based assessment (Quizizz). Based on the development and results of the instrument trials, the instrument based on the Quizizz game met good qualifications and fulfilled the elements of content and empirical validity, in the form of very high-reliability values of 0.89. The results of the measurement of the students' science literacy skills are obtained at a reasonable level. However, it needs to be improved in the learning and assessment processes that support cognitive development. Thus, the output of science literacy can be more optimal. The implications of this study include several aspects: First, in the process of developing the instrument, it is necessary to test the validity and reliability to ensure that the instrument can accurately measure the science literacy skills of students. Second, through attractive and interactive media, students are expected to be more interested and motivated in learning science. In addition, the developed HOTS-based science literacy assessment instrument can also help teachers develop more effective and efficient learning.

REFERENCES

Abduh, M. (2019). Panduan Penilaian Tes Tertulis. *Pusat Penilaian Pendidikan: Kementerian Pendidikan dan Kebudayaan*, 129.

Adams, R. J., & Khoo, S. T. (1996). *Quest: The interactive test analysis system version 2.1*. Australia: The Australian Council for Educational Research Ltd.

Agnes, P. (2022). *Pengaruh Model Pembelajaran Active Learning Tipe Quiz Team Terhadap Kemampuan Berpikir Kritis Peserta Didik Ditinjau dari Keaktifan Belajar*. UIN Raden Intan Lampung.

Aiken, L. R. (1985). Three Coefficients For Analyzing The Reliability And Validity Of Ratings. *Educational and Psychological Measurement*, *45*(1), 131–141. https://doi.org/10.1177/0013164485451012

Akben, N. (2020). Effects of the Problem-Posing Approach on Students' Problem Solving Skills and Metacognitive Awareness in Science Education. *Research in Science Education*, *50*(3), 1143–1165. https://doi.org/10.1007/s11165-018-9726-7

Alfiani, D. A. (2015). Penerapan Metode Role Playing Dalam Meningkatkan Motivasi Belajar Anak Usia Play Group. *Al Ibtida: Jurnal Pendidikan Guru MI*, *2*(1). https://doi.org/10.24235/al.ibtida.snj.v2i1.174

Alonso-Fernández, C., Calvo-Morata, A., Freire, M., Martínez-Ortiz, I., & Fernández-Manjón, B. (2019). Applications of data science to game learning analytics data: A systematic literature review. *Computers & Education*, *141*, 103612. https://doi.org/10.1016/j.compedu.2019.103612

Apriyani, R., Ramalis, T. R., & Suwarma, I. R. (2019). Analyzing Student's Problem Solving Abilities of Direct Current Electricity in STEM-based Learning. *Journal of Science Learning*, *2*(3), 85–91. https://doi.org/10.17509/jsl.v2i3.17559

Bahri, S., Mutaleb, A., Gunawan, T., & Zainuddin, Z. (2021). *Implementasi Game Quizizz Sebagai Media Evaluasi Pembelajaran Daring Menyenangkan Di Masa Pandemi Covid-19*.

Batlolona, J. R., Baskar, C., Kurnaz, M. A., & Leasa, M. (2018). The Improvement of Problem-Solving Skills and Physics Concept Mastery on Temperature and Heat Topic. *Jurnal Pendidikan IPA Indonesia*, *7*(3). https://doi.org/10.15294/jpii.v7i3.12432

Bloom, B. (1956). *Taxonomy of Educational Objectives: The Classification of Educational Goals, Handbook I Cognitive Domain*. New York: Longmans, Green and Co.

Busyaeri, A., Udin, T., & Zaenudin, A. (2016). Pengaruh Penggunaan Video Pembelajaran Terhadap Peningkatan Hasil Belajar Mapel Ipa Di Min Kroya Cirebon. *Al Ibtida: Jurnal Pendidikan Guru MI*, *3*(1). https://doi.org/10.24235/al.ibtida.snj.v3i1.584

Chiappetta, E. L., Fillman, D. A., & Sethna, G. H. (1991). A method to quantify major themes of Science literacy in science textbooks. *Journal of Research in Science Teaching*, *28*(8), 713–725. https://doi.org/10.1002/tea.3660280808

Dinica, M., Dinescu, L., Miron, C., & Barna, E. S. (2014). *Formative Values Of Problem Solving Training In Physics*. 16.

Dwisetiarezi, D., & Fitria, Y. (2021). Analisis kemampuan literasi sains siswa pada pembelajaran IPA terintegrasi di sekolah dasar. *Jurnal Basicedu*, *5*(4), 1958–1967.

Fakhriyah, F., Mafuah, S., & Mardapi, D. (2019). Developing Science literacy-Based Teaching Materials to Improve Students' Computational Thinking Skills. *Jurnal Pendidikan IPA Indonesia*, *8*(4). https://doi.org/10.15294/jpii.v8i4.19259

Febriyanti, R., & Mustadi, A. (2020). Developing Edutainment-Based Comic Media in Integrative-Thematic Learning in the Elementary School. *Al Ibtida: Jurnal Pendidikan Guru MI*, *7*(2), 179. https://doi.org/10.24235/al.ibtida.snj.v7i2.6676

Fitrianingsih, M., Widiyatmoko, A., & Pamelasari, S. D. (2022). Analisis Instrumen Penilaian Hots Berbasis Game Mata Pelajaran Ipa Untuk Pembelajaran Jarak Jauh. *Proceeding Seminar Nasional IPA*, 116–126.

Fukuyama, M. (2018). Society 5.0: Aiming for a New Human-Centered Society. *Japan SPOTLIGHT*, 4.

Güner, P., & Erbay, H. N. (2021). Metacognitive Skills and Problem-Solving. *International Journal of Research in Education and Science*, 715–734. https://doi.org/10.46328/ijres.1594

Herlanti, Y., Mardiati, Y., Rahmawati, R., Putri, A. M. K., Jamil, N., Miftahuzzakiyah, M., … Sugiarti, S. (2019). Finding Learning Strategy in Improving Science Literacy. *Jurnal Penelitian Dan Pembelajaran IPA*, *5*(1), 59. https://doi.org/10.30870/jppi.v5i1.4902

Huang, Y.-M., Silitonga, L. M., Murti, A. T., & Wu, T.-T. (2022). Learner engagement in a business simulation game: impact on higher-order thinking skills. *Journal of Educational Computing Research*, *61*(1), 96–126. https://doi.org/10.1177/07356331221106918

Ibda, F. (2015). Perkembangan Kognitif: Teori Jean Piaget. *Intelektualita*, *3*, 12.

Istiyono, E. (2017). *The analysis of senior high school students' physics HOTS in Bantul District measured using PhysReMChoTHOTS*. 070008. Yogyakarta, Indonesia. https://doi.org/10.1063/1.4995184

Krathwohl, D. R. (2010). A Revision of Bloom's Taxonomy: An Overview. *Taylor and Francis*. https://doi.org/10.1207/s15430421tip4104_2

Kurnia, L. D., Haryati, S., & Linda, R. (2022). Pengembangan Instrumen Evaluasi Higher Order Thinking Skills Menggunakan Quizizz Pada Materi Termokimia untuk Meningkatkan Kemampuan Berpikir Tingkat Tinggi Peserta Didik. *Jurnal Pendidikan Sains Indonesia (Indonesian Journal of Science Education)*, *10*(1), 176–190. https://doi.org/10.24815/jpsi.v10i1.21727

Kwangmuang, P., Jarutkamolpong, S., Sangboonraung, W., & Daungtod, S. (2021). The development of learning innovation to enhance higher order thinking skills for students in Thailand junior high schools. *Heliyon*, *7*(6), e07309. https://doi.org/10.1016/j.heliyon.2021.e07309

Lai, A., Chen, C., & Lee, G. (2019). An augmented reality-based learning approach to enhancing students' science reading performances from the perspective of the cognitive load theory. *British Journal of Educational Technology*, *50*(1), 232–247. https://doi.org/10.1111/bjet.12716

Mardapi, D. (2012). *Penyusunan intrumen tes dan nontes*. Yogyakarta, Indonesia: Mitra Cendekia.

Mukti, T. S., & Istiyono, E. (2018). *Instrumen Penilaian Kemampuan Berpikir Kritis Peserta Didik SMA Negeri Mata Pelajaran Biologi Kelas X*. 6.

Nasution, T., Afrianti, D., Tukiyo, Sulistyani, & Herman. (2022). Critical Discourse Analysis in the Classroom: A Critical Language Awareness on Early Children's Critical Thinking. *Jurnal Obsesi: Jurnal Pendidikan Anak Usia Dini*, *6*(5), 4992–5002. https://doi.org/10.31004/obsesi.v6i5.2951

OECD. (2017). *OECD Skills Outlook 2017: Skills and Global Value Chains*. OECD. https://doi.org/10.1787/9789264273351-en

Pujawan, I. G. N., Rediani, N. N., Antara, I., Putri, N., & Bayu, G. W. (2022). Revised Bloom Taxonomy-Oriented Learning Activities to Develop Science literacy and Creative Thinking Skills. *Jurnal Pendidikan IPA Indonesia*, *11*(1), 47–60. https://doi.org/10.15294/jpii.v11i1.34628

Putranta, H. (2019). Synthesis of the cognitive aspects' science literacy and higher order thinking skills (HOTS) in chapter momentum and impulse. *Journal of Physics: Conference Series*, *1397*(1), 12014. https://doi.org/10.1088/1742-6596/1397/1/012014

Rahardjo, M. M. (2019). Implementasi Pendekatan Saintifik Sebagai Pembentuk Keterampilan Proses Sains Anak Usia Dini. *Scholaria: Jurnal Pendidikan Dan Kebudayaan*, *9*(2), 148–159. https://doi.org/10.24246/j.js.2019.v9.i2.p148-159

Ramadhani, D., Kenedi, A. K., Helsa, Y., Handrianto, C., & Wardana, M. R. (2021). Mapping Higher Order Thinking Skills of Prospective Primary School Teachers in Facing Society 5.0. *Al Ibtida: Jurnal Pendidikan Guru MI*, *8*(2), 178. https://doi.org/10.24235/al.ibtida.snj.v8i2.8794

Rini, C. P., Hartantri, S. D., & Amaliyah, A. (2021). Analisis kemampuan literasi sains pada aspek kompetensi mahasiswa PGSD FKIP universitas muhammadiyah Tangerang. *Jurnal Pendidikan Dasar Nusantara*, *6*(2), 166–179. https://doi.org/10.29407/jpdn.v6i2.15320

Rusilowati, A., Astuti, B., & Rahman, N. A. (2019). How to improve student's Science literacy. *Journal of Physics: Conference Series*, *1170*, 012028. https://doi.org/10.1088/1742-6596/1170/1/012028

Salsabila, U. H., Habiba, I. S., Amanah, I. L., Istiqomah, N. A., & Difany, S. (2020). Pemanfaatan Aplikasi Quizizz Sebagai Media Pembelajaran Ditengah Pandemi Pada Siswa SMA. *Jurnal Ilmiah Ilmu Terapan Universitas Jambi|JIITUJ|*, *4*(2), 163–173. https://doi.org/10.22437/jiituj.v4i2.11605

Safrizal, S., Zaroha, L., & Yulia, R. (2020). Kemampuan Literasi Sains Siswa Sekolah Dasar di Sekolah Adiwiyata (Studi Deksriptif di SD Adiwiyata X Kota Padang). *Journal of Natural Science and Integration*, *3*(2), 215–223. https://doi.org/10.24014/jnsi.v3i2.9987

Sartono, E. K. E., Sukowati, S., & Soleha, S. (2021). The Effectiveness of Kahoot! Based on Local Wisdom to Improve Creative Thinking Skill and the Spirit of Nationality of Students in Islamic Elementary School. *Al Ibtida: Jurnal Pendidikan Guru MI*, *8*(1), 50. https://doi.org/10.24235/al.ibtida.snj.v8i1.7092

Sari, D. M. M., & Prasetyo, Y. (2021). Project-based-learning on critical reading course to enhance critical thinking skills. *Studies in English Language and Education*, *8*(2), 442–456. https://doi.org/10.24815/siele.v8i2.18407

Schleicher, A. (2019). PISA 2018: Insights and Interpretations. *Oecd Publishing*.

Susapti, P., & Istiqlal, M. (2021). The Analysis of Higher Order Thinking Skills of Islamic Elementary School Students on Science Subject. *Al Ibtida: Jurnal Pendidikan Guru MI*, *8*(2), 252. https://doi.org/10.24235/al.ibtida.snj.v8i2.8219

Sumintono, B., & Widhiarso, W. (2013). Model Rasch untuk Penelitian Sosial Kuantitatif. In *ITS Surabaya: Vol. November 2* (pp. 1–9).

Suparya, I. K., Suastra, I. W., & Arnyana, I. B. P. (2022). Rendahnya Literasi Sains: Faktor Penyebab Dan Alternatif Solusinya. *Jurnal Ilmiah Pendidikan Citra Bakti*, *9*(1), 153–166. https://doi.org/10.24815/siele.v8i2.18407

Sutrisna, N. (2021). Analisis kemampuan literasi sains peserta didik SMA di Kota Sungai Penuh. *Jurnal Inovasi Penelitian*, *1*(12), 2683–2694. https://doi.org/0.29303/jpft.v7i2.3049

Sumintono, B., & Widhiarso, W. (2013). Model Rasch untuk Penelitian Sosial Kuantitatif. In ITS Surabaya: Vol. November 2 (pp. 1–9).

Suparya, I. K., Suastra, I. W., & Arnyana, I. B. P. (2022). Rendahnya Literasi Sains: Faktor Penyebab Dan Alternatif Solusinya. Jurnal Ilmiah Pendidikan Citra Bakti, 9(1), 153–166. https://doi.org/10.24815/siele.v8i2.18407

Sutrisna, N. (2021). Analisis kemampuan literasi sains peserta didik SMA di Kota Sungai Penuh. Jurnal Inovasi Penelitian, 1(12), 2683–2694. https://doi.org/0.29303/jpft.v7i2.3049

Tong, L. C., Rosli, M. S., & Saleh, N. S. (2022). Enhancing HOTS using Problem-Based Learning and Digital Game in the Context of Malaysian Primary School. International Journal of Interactive Mobile Technologies, 16(2), 101–111. https://doi.org/10.3991/ijim.v16i02.27677

UNESCO. (2017). Education for Sustainable Development Goals: Learning Objectives. Education for Sustainable Development. The Global Education 2030 Agenda. Internasional, 10(2), 160–165

Wahyuni, E. N., Aziz, R., Wargadinata, W., & Efiyanti, A. Y. (2021). Investigation of Primary School Teacher Readiness in Online Learning during the Covid-19 Pandemic. *Madrasah*, *13*(2), 97–113. https://doi.org/10.18860/mad.v13i2.11343

Vanbecelaere, S., Van den Berghe, K., Cornillie, F., Sasanguie, D., Reynvoet, B., & Depaepe, F. (2020). The effects of two digital educational games on cognitive and non-cognitive

math and reading outcomes. *Computers & Education*, *143*, 103680. https://doi.org/10.1016/j.compedu.2019.103680

Wahyuni, S., Indrawati, I., Sudarti, S., & Suana, W. (2017). Developing Science Process Skills and Problem Solving Abilities Based on Outdoor Learning in Junior High School. *Jurnal Pendidikan IPA Indonesia*, *6*(1). https://doi.org/10.15294/jpii.v6i1.6849

Widyandini, M. W. (2021). *Implementasi Pendekatan Saintifik Kurikulum 2013 Revisi dan Peningkatan Berpikir Tingkat Tinggi (Higher Order Thinking Skills) pada Mata Pelajaran Pendidikan Agama Islam dan Budi Pekerti di SMAN 2 Ponorogo*. IAIN Ponorogo.

Winarni, E. W., Hambali, D., & Purwandari, E. P. (2020). Analysis of Language and Science literacy skills for 4th Grade Elementary School Students through Discovery Learning and ICT Media. *International Journal of Instruction*, *13*(2), 213–222. https://doi.org/10.29333/iji.2020.13215a

Wright, B., & Stone, M. (1999). Measurement Essentials 2nd Ed. *WIDE RANGE, INC*, 205.

Yeni, F., & Kurniawati, W. (2022). Efektivitas Penggunaan Aplikasi Quizizz Untuk Penilaian Pembelajaran. *Primary: Jurnal Pendidikan Guru Sekolah Dasar*, *11*(3), 915. https://doi.org/10.33578/jpfkip.v11i3.8947

Zhou, C. (Ed.). (2017). *Handbook of Research on Creative Problem-Solving Skill Development in Higher Education:* IGI Global. https://doi.org/10.4018/978-1-5225-0643-0