JPPIPA 9(5) (2023)

Jurnal Penelitian Pendidikan IPA

Journal of Research in Science Education

http://jppipa.unram.ac.id/index.php/jppipa/index

Empirical Validity and Reliability of the Scientific Literacy Assessment Instrument Based on the Tornado Physics Enrichment Book

Venny Mulyana[1], Desnita[1*]

[1] Magister of Physics Education, Faculty of Mathematics and Natural Sciences, Universitas Negeri Padang, Indonesia

Received: Februari 27, 2023
Revised: May 18, 2023
Accepted: May 29, 2023
Published: May 31, 2023

Corresponding Author:
Desnita
desnita@fmipa.unp.ac.id

DOI: 10.29303/jppipa.v9i5.3290

Abstract: Scientific literacy is one of the most important skills and should be strengthened by students. Students with scientific literacy skills will be able to apply the knowledge learned to solve problems in their everyday lives. This study aims to disclose the empirical validity and reliability of the scientific literacy assessment instrument. It is necessary to use an assessment tool that can measure all aspects of scientific literacy when evaluating students' levels of scientific literacy. This was research and development using the ADDIE model. The stages of the ADDIE model are analysis, design, development, implementation, and evaluation. To gather information on the trial's empirical validity and reliability, a total of 26 students participated. The outcome demonstrates that 21 instrument items were reliable in the high category with a coefficient value of 0.89 and valid with r > 0.388. This implies that assessment instrument can be used to assess students' scientific literacy.

Keywords: Physics Enrichment Book; Reliability; Scientific Literacy; Validity

Introduction

Due to increased understanding of the nature of science and 21st-century citizenship, definitions of scientific literacy are evolving (Li & Guo, 2021). It takes people who are knowledgeable about current technological issues and the sciences in the twenty-first century (Dewi & Rahayu, 2022). Students need to possess scientific literacy, which is the capacity to evaluate and apply scientific ideas to problems encountered in daily life (Jufrida et al., 2019). In recent years, science's importance has greatly increased (Kähler et al., 2020). Due to scientific and technological advancements, the world is changing quickly, as evidenced by environmental issues or technological advancements. Scientific literacy is required to comprehend and deal with these changes (OECD., 2018)

Scientific literacy is defined by the PISA framework from the (OECD., 2018) as the capacity to apply scientific knowledge to societal issues, explain scientific phenomena, assess and design scientific investigations, and draw conclusions based on evidence in order to comprehend and make decisions about nature and its changes as a result of human activity so that society becomes reflective. People who are scientifically literate are therefore more likely to be open to participating in scientific communication about science and technology, which calls for knowledge and skills in scientific explanation of phenomena, evaluation and design of scientific investigations, and scientific interpretation of data and evidence (OECD, 2018). Everyone will benefit from having a critical understanding of science to help them address issues as they arise, especially those that concern science and technology (Novitasari, 2018).

PISA identifies scientific literacy as having four interconnected aspects: context, knowledge, competence, and attitude (OECD, 2018). The context aspect, which includes personal, local/national, and global issues, both current and historical, necessitates some understanding of science and technology (OECD, 2018). Science competence is divided into three categories: scientific phenomena, design and evaluation of scientific research, and interpretation of scientific data and evidence (Wen et al., 2020). The knowledge of

How to Cite:
Mulyana, V., & Desnita, D. (2023). Empirical Validity and Reliability of the Scientific Literacy Assessment Instrument Based on the Tornado Physics Enrichment Book. *Jurnal Penelitian Pendidikan IPA*, *9*(5), 3961–3967. https://doi.org/10.29303/jppipa.v9i5.3290

science aspect of scientific literacy includes those facts, concepts, principles, laws, hypotheses, theories, and models of science necessary for a scientifically literate individual (Lasminawati et al., 2023; Pagan et al., 2023). Attitude aspect is a set of attitudes towards science indicated by an interest in science and technology;valuing of scientific approaches to inquiry, where appropriate, and a perception andawareness of environmental issues (Ardiyanti et al., 2019; Cansiz & Cansiz, 2019).

Scientific literacy is one of the most important skills and should be strengthened by students. One of the common aims of education systems is to achieve scientific literacy among pupils (García-Carmona & Acevedo-Díaz, 2018). According to Queiruga-Dios et al. (2020), scientific literacy means that a person knows and understands conceptual ideas, is capable of using information in a procedural way, and has values and principles that align with an affective dimension. Scientific literacy is understood to be a process that allows students to face relevant problems that require the recollection of the scientific knowledge they have learned (Glaze, 2018). Students with scientific literacy skills will be able to apply the knowledge learned to solve problems in their everyday lives (Jufrida et al., 2019). Scientific literacy is a person's ability to use scientific knowledge and processes to make decisions related to the universe (Ajayi, 2018). Thus, scientific literacy is an important thing that needs to be developed for students in every country.

Physics is included in the scope of scientific literacy (Mukharomah et al., 2021). Physics is a branch of science that investigates natural phenomena, including disasters (Yani & Wahyono, 2020). One method for integrating natural phenomena into physics learning is to integrate them into physics enrichment books. This integration aids in contextualizing learning.

Enrichment books are defined as books that contain material that can enrich and increase mastery of science, technology, and art, as well as skills in shaping the personalities of students, educators, education managers, and other communities. Enrichment books contain certain discussions in the broader and/or deeper curriculum. This book is not entirely structured on the basis of a good curriculum in terms of objectives, subject matter, and method of presentation. This book is not required to be used by students but is useful for students who have difficulty understanding certain subjects in the main subject textbooks (Alfarisi & Suseno, 2019).

One of the enrichment books that has been developed is the tornado physics enrichment book, which integrates natural disasters into learning physics. This enrichment book is expected to increase students' scientific literacy. To see how students achieve scientific literacy after using this enrichment book, it is necessary to do an assessment.

Assessment activities are an important and integral component in teaching and learning activities (Bariah, 2019). Assessment is an evaluation to find out improvements or progress, deficiencies, obstacles and results that have been achieved in a learning process (L. Indrawati et al., 2020; Sari, M. P. et al., 2017). Simply put, assessment in learning activities is defined as the process of measuring what students know and what they do (Rafiqoh, 2020). The results of the assessment in education show the quality of the knowledge possessed and the skills that have been achieved (M. D. Indrawati, 2018). To obtain information about the achievement of the results of the learning process of students in accordance with the goals set, an assessment is carried out. In the assessment process an assessment instrument is needed that can measure all aspects of scientific literacy.

In order to complete academic requirements, instruments are tools that are used to measure an object (Dachliyani, 2019). The fact that the instrument is a crucial component of the assessment process supports the validity of the assessment design. In order to gather accurate and trustworthy information, instruments are essential. If the quality of the instrument used is good, then the data obtained follows the facts because the instrument functions by expressing facts into data.

Chasanah et al. (2022) carried out one of the studies that produced scientific literacy instruments, creating a valid and reliable science literacy assessment instrument to assess students' scientific literacy abilities. The study conducted by (M. D. Indrawati, 2018b) resulted in the development of an instrument for evaluating students' knowledge of sound waves in physics. These studies indicate that no scientific literacy asssment instruments based on the tornado physics enrichment book have yet been created. In light of this statement, it is crucial to develop scientific literacy assessment instruments based on physics enrichment books.

Based on the description above, it is necessary to develop a scientific literacy assessment instrument. The scientific literacy assessment instrument was developed based on the tornado physics enrichment book. The instrument was created with four components in mind: context, competence, knowledge, and attitude toward science, and it will be tested for validity and reliability.

Method

This was a research and development. The product developed is a scientific literacy assessment instrument based on the Tornado Physics Enrichment Book consisting of four aspects: Context, Competencies, Knowledge, and Attitudes. The ADDIE model was used in this research. The phases of the ADDIE model are Analyze, Design, Develop, Implement, and Evaluate. These phases are sequential; each depends upon the

successful completion of the preceding stage. Moreover, the ADDIE model is an iterative feedback model, which means the results of the evaluation phase are returned to the feedback, closing the loop and facilitating further refinement of the learning product.

The first step is analysis. Activities carried out at this stage are e collecting information related to the instrument to be developed. Based on observations and interviews conducted with physics teachers, it was found that scientific literacy instruments are not available at schools, so measurement of scientific literacy has not been carried out. The second analysis is curriculum analysis. There are several competencies related to tornadoes. The results of this analysis provide an opportunity to develop instruments related to the topics contained in these competencies.

The second stage is design. The activity at this stage is the instrument's design to be developed. This stage's goals are grids of scientific literacy instruments. The grids are made based on the scientific literacy aspect. The aspects used are Context, Competencies, Knowledge, and Attitudes.

The third stage is development. The activities carried out were instrument writing, internal validation, expert validation, and product revision. This expert validation was carried out to validate the content, material, and language used in the instrument.

The fourth stage is implementation. At this stage, trials of the scientific literacy assessment instruments that have been developed are being carried out to test their quality. Instrument trials to obtain data on the empirical validity, reliability, and practicality of the instruments that have been developed. The trial was conducted with a total of 26 students. Empirical validity was measured using the product-moment correlation equation:

$$r_{xy} = \frac{N\sum XY - (\sum X)(\sum Y)}{\sqrt{[(N\sum X^2 - (\sum X)^2][N\sum Y^2 - (\sum Y)^2]}} \quad (1)$$

Information :

r_{xy} = correlation coefficient between variables X and Y
N = Number of Respondents
X = item score
Y = Total score

Items are said to be valid if the value of rh > rt, so that from the calculation of the formula above, it can be known whether or not the questions contained in the instrument are valid. If the level of validity is high, then the question can be accepted; if the validity is low, it will not be used or used with a revision first. The test data also tested reliability using the Cronbach Alpha Formula as Equation 2.

$$r_{11} = \left(\frac{n}{n-1}\right)\left(1 - \frac{\sum s_i^2}{\sum s_t^2}\right) \quad (2)$$

Information:

r_{11} = The reliability coefficient
N = The number of items
$\sum s_i^2$ = The total variance score of each item
$\sum s_t^2$ = The total score variance

to find the variance using the Equation 3.

$$s_i^2 = \frac{\sum x^2 - \frac{\sum x_i^2}{n}}{n} \quad (3)$$

Reliability criteria are determined based on the following Table 1.

Table 1. Instrument Reliability Criteria

Correlation Coefficient	Criteria
0.90 < r ≤ 1.00	Very High
0.70 < r ≤ 0.90	High
0.40 < r ≤ 0.70	Medium
0.20 < r ≤ 0.40	Low
r < 0.20	Very Low

The last stage is the evaluation stage. This stage consists of formative evaluation and summative evaluation. Formative evaluation is carried out at each stage of ADDIE development which consists of the analysis stage, design stage, development stage, and implementation stage. The summative evaluation aims to see the achievement of the overall instrument development. In this article, we present data on the empirical validity and reliability of trials that have been conducted.

Result and Discussion

A scientific literacy assessment tool based on the tornado physics enrichment book was created as a result of this research. The developed instrument consists of four aspects of scientific literacy with a total of 21 items: context (2 items), competence (5 items), knowledge (8 items), and attitude (6 items) toward science. Essay tests were developed to measure context, competency, and knowledge, while self-assessment questionnaires were used to measure attitudes toward science. The instrument items are displayed using scientific discourse, whether it takes the form of phenomena, pictures, graphics, or other representations.

The first step is analysis. Based on observations and interviews conducted with physics teachers, it was found that scientific literacy instruments are not available at schools, so measurement of scientific literacy has not been carried out. The second analysis is curriculum analysis. There are several competencies related to tornadoes. The results of this analysis is shown in Table 2.

Table 2. Tornado integration matrix

Grade	Basic Competencies	Essential concepts
X	BC 3.9 Analyzing the concept of energy, work (work), business relations (work) and energy changes, the law of conservation of energy, and its application in everyday events	Energy
XI	BC 3.4 Applying fluid dynamic principles in technology	Speed, Pressure, Flow rate, Bernoulli's principle, Density
	BC 3.5 Analyzing the effect of heat and heat transfer which includes the thermal characteristics of a material, capacity, and heat conductivity in everyday life	Heat, Heat transfer, Heat capacity
	BC 3.12 Analyzing the symptoms of global warming and its impact on life and the environment	Heat
XII	BC 3.11 Analyzing limited energy sources and their impact on life	Energy

Table 2 demonstrates how physics and tornadoes are closely related. Since every mass-moving object has kinetic energy, the concept of energy exists in a tornado. Due to convectional heat transfer, temperature differences in a high area are what cause tornadoes to form. Because of global warming, there will be more chances for tornadoes to form.

The second stage is design. The activity at this stage is the instrument's design to be developed. The grids are made based on the scientific literacy aspect. The grids is shown in Table 3.

Table 3. The grids of scientific literacy assesment instrument

Scientific Literacy Aspects	Indicator	Sum
Context	Identify local issues Identify global issues	2
Compentencies	Explain phenomena scientifically Interpret data and facts scientifically	5
Knowledge	Fact Theory concept Principle Law	8
Attitudes	Interest in science Concern for resources and the environment	6
	Sum	21

The third stage is development. The activities carried out were instrument writing, internal validation, expert validation, and product revision. Internal validity is a team effort to improve the assessment instrument. A good instrument is inseparable from several aspects of its preparation, namely the material, construction, and language aspects (Retnawati, 2016). The expert validation was carried out to validate the content, material, and language used in the instrument. Determination of the value of expert validity using Aiken's V equation shows that the results of content validity are 0.81, construct validity is 0.86, and language validity results are 0.89. The average validity of the critical thinking instrument is 0.85, so it can be said that the scientific literacy instrument is valid.

The fourth stage is implementation. The implementation stage is carried out after the product developed is valid, and revised according to the validator's suggestions. At this stage, product evaluations are being done to determine the reliability and empirical validity of the scientific literacy assessment instruments. A group of 26 students was used to test the instrument. Using the Pearson Product Moment equation, empirical validity is assessed. The following Table 4 shows the results of the empirical validity analysis for each item.

Table 4. The empirical validity of each item.

Scientific Literacy Aspects	Item No.	r_t	r	Criteria
Context	1	0.388	0.652	valid
	2	0.388	0.473	valid
Compentencies	3	0.388	0.482	valid
	4	0.388	0.427	valid
	5	0.388	0.389	valid
	6	0.388	0.598	valid
	7	0.388	0.419	valid
Knowledge	8	0.388	0.44	valid
	9	0.388	0.617	valid
	10	0.388	0.437	valid
	11	0.388	0.533	valid
	12	0.388	0.56	valid
	13	0.388	0.494	valid
	14	0.388	0.658	valid
	15	0.388	0.571	valid
Attitudes	16	0.388	0.882	valid
	17	0.388	0.534	valid
	18	0.388	0.691	valid
	19	0.388	0.669	valid
	20	0.388	0.716	valid
	21	0.388	0.761	valid

Empirical validity was obtained from Pearson's correlation analysis. Pearson correlation is used because the instrument presents a linear relationship between the criteria presented (Santoso et al., 2017). The r-table value with a 95% confidence interval for n = 26 is 0.388. If r > 0.388, the item is considered to be valid. The overall

results can be interpreted to show that the statements are simple to comprehend and respond to without losing their intended meaning or purpose, making the 21 statement items suitable for assessing students' scientific literacy. This is in line with what (Marselina et al., 2021) stated: that an instrument that has been tested for validity can measure what is to be measured, and the results of this empirical validity will show the level of validity or accuracy of each existing item and are based on empirical facts.

The valid instrument then calculated its reliability coefficient. The Cronbach's Alpha statistical test was used in this study's reliability test. The results of the Cronbach's alpha test indicate the reliability of the questionnaire. Since the Cronbach's Alpha value must be greater than 0.7 for an instrument to be considered reliable, the developed assessment instrument must meet very stringent reliability standards. This criterion is based on Guilford's reliability coefficient criteria, which ranges from 0.80 to 1.00 (Prajoko et al., 2021).

Table 5. The Reliability Statistics

Cronbach's Alpha	N of Items
0.81	21

Table 5 shows that the developed scientific literacy assessment tool is trustworthy, scoring a reliability coefficient value of 0.89 in the high category. Even when used for multiple measurements with the same subject, a reliable instrument (having a high reliability coefficient) will produce data that is largely the same (Febrianawati, 2018). Additional studies show that tests using reliable instruments on the same group of individuals at different times produce the same outcomes (Arum et al., 2022).

Measurement error and reliability are closely related. A low error rate in obtaining measurement results is indicated by high reliability. The measurement error is smaller for instruments with higher reliability, and the measurement results are better for instruments with lower reliability scores. Measurement errors can be due to a variety of factors, such as the characteristics of the instrument used alone, the preparation and implementation of measurements that do not follow standard rules, the quality of the items in the instrument, cooperation during the administration of the test or completion of the instrument, uncertain instrument items, and the circumstances participants are in while responding to the instrument, such as participants who are fatigued (Retnawati, 2016). Although the instrument's reliability coefficient was quite high, this does not imply that the instrument's reliability value is always the same. In order to be able to alter the reliability coefficient's value in the subsequent data collection, this reliability is tested by collecting data only once.

Conclusion

The assessment instrument developed based on the Tornado Physics Enrichment Book can be declared valid and reliable. The Pearson Correlation Test was used to determine the construct validity of 21 instrument items that were deemed valid with a value of $r > 0.388$. Additionally, the Cronbach's Alpha statistical test was used to test the reliability of 21 statement items, and the results showed that the 21 instrument items were reliable. The coefficient value is 0.89 in the high criteria. This indicates that the developed assessment instrument is feasible for use in assessing students' scientific literacy.

Author Contributions

Conceptualization ideas, prepare designs, and draft articles by Venny Mulyana and Desnita. Desnita designed a scientific literacy instrument. Venny Mulyana conducted research on the development of scientific literacy assessment instruments in high schools.

Funding

This research was independently funded by Desnita.

Conflicts of Interests

No conflicts of interest.

References

Ajayi, V. O. (2018). *Scientific literacy*. Benue State University.

Alfarisi, R. S., & Suseno, S. (2019). Pengembangan Buku Pengayaan Menulis Teks Anekdot Bermuatan Cinta Tanah Air. *KREDO: Jurnal Ilmiah Bahasa Dan Sastra*, *3*(1), 102–115. https://doi.org/10.24176/kredo.v3i1.3950

Ardiyanti, Y., Suyanto, S., & Suryadarma, I. G. P. (2019). The role of students science literacy in Indonesia. *Journal of Physics: Conference Series*, *1321*(3), 32085. https://doi.org/10.1088/1742-6596/1321/3/032085

Arum, A. E., Khumaedi, M., & Susilaningsih, E. (2022). Pengembangan Instrumen Penilaian Domain Afektif (Sikap) Kepercayaan Diri pada Siswa. *Jurnal Basicedu*, *6*(3), 5467–5474. https://doi.org/10.31004/basicedu.v6i3.3203

Bariah, S. K. (2019). Rancangan pengembangan instrumen penilaian pembelajaran berbasis daring. *Petik: Jurnal Pendidikan Teknologi Informasi Dan Komunikasi*, *5*(1), 31–47. https://doi.org/10.31980/jpetik.v5i1

Cansiz, N., & Cansiz, M. (2019). Evaluating Turkish science curriculum with PISA scientific literacy framework. *Turkish Journal of Education*, *8*(3), 217–236. https://doi.org/10.19128/turje.545798

Chasanah, N., Widodo, W., & Suprapto, N. (2022).

Pengembangan Instrumen Asesmen Literasi Sains Untuk Mendeskripsikan Profil Peserta Didik. *PENDIPA Journal of Science Education*, *6*(2), 474–483. https://doi.org/10.33369/pendipa.6.2.474-483

Dachliyani, L. (2019). Instrumen yang Sahih: Sebagai Alat Ukur Keberhasilan Suatu Evaluasi Program Diklat. *MADIKA: Media Informasi Dan Komunikasi Diklat Kepustakawanan*, *5*(1), 57–65. https://ejournal.perpusnas.go.id/md/article/view/721

Dewi, C. A., & Rahayu, S. (2022). Pentingnya mengoptimalkan literasi kimia melalui pembelajaran berbasis isu-isu sosiosaintifik di abad ke-21. *Proceeding Seminar Nasional IPA*, 348–359. https://proceeding.unnes.ac.id/index.php/snipa/article/view/1371

Febrianawati, Y. (2018). Uji validitas dan reliabilitas Instrumen penelitian kuantitatif. *Jurnal Tarbiyah: Jurnal Ilmiah Kependidikan*, *7*(1), 17–23. https://doi.org/10.18592/tarbiyah.v7i1.2100

García-Carmona, A., & Acevedo-Díaz, J. A. (2018). The nature of scientific practice and science education: rationale of a set of essential pedagogical principles. *Science & Education*, *27*(5–6), 435–455. https://doi.org/10.1007/s11191-018-9984-9

Glaze, A. L. (2018). Teaching and learning science in the 21st century: Challenging critical assumptions in post-secondary science. *Education Sciences*, *8*(1), 12. https://doi.org/10.3390/educsci8010012

Indrawati, L., Mashudi, M., & Hartoyo, A. (2020). Keterampilan Berpikir Tingkat Tinggi Dalam Pembelajaran Berbasis Proyek Berintegrasi Science Technology Engineering And Mathematics. *Jurnal Pendidikan Dan Pembelajaran Khatulistiwa (JPPK)*, *9*(7). Retrieved from https://jurnal.untan.ac.id/index.php/jpdpb/article/view/41491

Indrawati, M. D. (2018a). Pengembangan instrumen penilaian literasi sains fisika peserta didik pada bahasan gelombang bunyi di SMA Negeri 1 Gedangan Sidoarjo. *Inovasi Pendidikan Fisika*, *7*(1). https://doi.org/10.26740/ipf.v7n1.p

Indrawati, M. D. (2018b). Pengembangan instrumen penilaian literasi sains fisika peserta didik pada bahasan gelombang bunyi di SMA Negeri 1 Gedangan Sidoarjo. *Inovasi Pendidikan Fisika*, *7*(1). Retrieved from https://ejournal.unesa.ac.id/index.php/inovasi-pendidikan-fisika/article/view/22244/20389

Jufrida, J., Basuki, F. R., Kurniawan, W., Pangestu, M. D., & Fitaloka, O. (2019). Scientific Literacy and Science Learning Achievement at Junior High School. *International Journal of Evaluation and Research in Education*, *8*(4), 630–636. https://eric.ed.gov/?id=EJ1238303

Kähler, J., Hahn, I., & Köller, O. (2020). The development of early scientific literacy gaps in kindergarten children. *International Journal of Science Education*, *42*(12), 1988–2007. https://doi.org/10.1080/09500693.2020.1808908

Lasminawati, E., Pangesti, N. A., & Jumadi. (2023). Scientific literacy competency analysis of edmodo-based learning materials about simple machine. *AIP Conference Proceedings*, *2556*(1), 60003. https://doi.org/10.1063/5.0115689

Li, Y., & Guo, M. (2021). Scientific literacy in communicating science and socio-scientific issues: prospects and challenges. *Frontiers in Psychology*, *12*, 758000. https://doi.org/10.3389/fpsyg.2021.758000

Marselina, K. T., Lasmawan, I. W., & Dantes, N. (2021). Pengembangan Instrumen Kemampuan Berpikir Kritis dan Hasil Belajar IPS pada Siswa Kelas V SD. *Jurnal Penelitian Dan Evaluasi Pendidikan Indonesia*, *11*(2), 105–114. https://doi.org/10.23887/jpepi.v11i2.620

Mukharomah, F., Wiyanto, W., & Putra, N. M. D. (2021). Analisis Kemampuan Literasi Sains Fisika Siswa SMA Pada Materi Kinematika Gerak Lurus di Masa Pandemi Covid-19. *Journal of Teaching and Learning Physics*, *6*(1), 11–21. https://doi.org/10.15575/jotalp.v6i1.10391

Novitasari, N. (2018). Profil kemampuan literasi sains mahasiswa calon guru biologi. *Biosfer: Jurnal Tadris Biologi*, *9*(1), 36–44. https://doi.org/10.24042/biosf.v9i1.2877

OECD. (2018). *PISA for Development Assessment and Analytical Framework: Reading, Mathematics and Science*. OECD Publishing. https://doi.org/10.1787/9789264305274-en

OECD. (2018). *PISA for Development Assessment and Analytical Framework: Reading, Mathematics and Science*. OECD Publishing.

Pagan, M. M., Sarwanto, S., & Nurosyid, F. (2023). Science literacy analysis of physics textbooks in temperature heat and expansion material. *AIP Conference Proceedings*, *2569*(1), 50012. https://doi.org/10.1063/5.0112121

Prajoko, S., Anjani, A., Oktaviani, R. D., Fathimah, P., & Kamaludin, W. (2021). Development of Self-assessment Instruments to Measure Student Affective Domains on Online Biology Learning. *THABIEA: Journal of Natural Science Teaching*, *4*(2), 185–197. https://doi.org/10.21043/thabiea.v4i2.11964

Queiruga-Dios, M. Á., López-Iñesta, E., Diez-Ojeda, M., Sáiz-Manzanares, M. C., & Vazquez Dorrio, J. B. (2020). Citizen science for scientific literacy and the attainment of sustainable development goals in formal education. *Sustainability*, *12*(10), 4283. https://doi.org/10.3390/su12104283

Rafiqoh, S. (2020). Arah Kecenderungan dan Isu Dalam Pembelajaran Matematika Sesuai Pembelajaran Abad 21 Untuk Menghadapi Revolusi Industri 4.0. *Jurnal MathEducation Nusantara*, *3*(1), 58–73. https://doi.org/10.54314/jmn.v3i1.101

Retnawati, H. (2016). *Analisis kuantitatif instrumen penelitian (panduan peneliti, mahasiswa, dan psikometrian*. Parama publishing.

Santoso, B., Marchira, C. R., & Sumarni, P. (2017). Development and validity and reliability tests of professionalism assessment instrument in psychiatry residents. *Jurnal Pendidikan Kedokteran Indonesia: The Indonesian Journal of Medical Education*, *6*(1), 60–65. https://doi.org/10.22146/jpki.25369

Sari, M. P., S. P., Wibowo, Y., & Sri, N. (2017). Penerapan Model Discovery Learning Untuk Meningkatkan Keterampilan Komunikasi Lisan Peserta Didik di Kelas XI MIA 1 SMA Negeri 1 Sleman Tahun Pelajaran 2017/2018. *Prosiding Seminar Nasional Pendidikan Biologi Jurusan Pendidikan Biologi Dan Biologi, Fakultas MIPA, Universitas Negeri Yogyakarta*, 81–88. Retrieved from http://seminar.uny.ac.id/sembiouny2017/sites/seminar.uny.ac.id.sembiouny2017/files/PB 10.pdf

Wen, C. T., Liu, C. C., Chang, H. Y., Chang, C. J., Chang, M. H., Fan Chiang, S. H., Yang, C. W., & Hwang, F. K. (2020). Students' guided inquiry with simulation and its relation to school science achievement and scientific literacy. *Computers and Education*, *149*, 1–14. https://doi.org/10.1016/j.compedu.2020.103830

Yani, F., & Wahyono, U. (2020). Pengembangan Komik Mitigasi Berbasis Potensi Bencana Lokal yang Terintegrasi dalam Pembelajaran Fisika di Sulawesi Tengah. *Jurnal Pendidikan Fisika Dan Teknologi*, *6*(2), 198–205. https://doi.org/10.29303/jpft.v6i2.1874