ISSN (PRINT) : 2549-9955 ISSN (ONLINE): 2549-9963
JURNAL ILMIAH PENDIDIKAN FISIKA
https://ppjp.ulm.ac.id/journals/index.php/jipf/index

The Validity of The Student Worksheet of Thermal Energy Material Based on *Science, Technology, Engineering, Mathematics* (STEM) and Local Wisdom to Enhance Scientific Literacy

***Maula Ariefianti, Arif Sholahuddin, and Mustika Wati**
Magister of Science Education Universitas Lambung Mangkurat, Banjarmasin, Indonesia
*maulaariefianti12@gmail.com

Abstract

Scientific literacy is one of the primary objectives of scientific education. Despite this, field research indicates that scientific literacy remains inadequate. The approach of Science, Technology, Engineering, and Mathematics (STEM) and local wisdom have scientifically obtained substantive supports in addressing comparable challenges. However, the STEM-based Learner Worksheet and the incorporation of local wisdom into scientific education remain underdeveloped. The purpose of this research is to describe the validity of thermal energy worksheet based on STEM and local wisdom in enhancing scientific literacy. This research and development employed the Borg and Gall model. The validation sheet used to acquire the worksheet validation data were reviewed by two practitioners and three experts. The validation data was derived by averaging the validator's scores on all assessment components, with the calculation outcomes being modified to adhere to the validity criteria. The results indicated that the validity of the worksheet based on STEM and local wisdom of thermal energy material was classified as very valid with an average score of 3.49. Therefore, the worksheet based on STEM and local wisdom regarding thermal energy materials are deemed valid and can be implemented in the subsequent phase of classroom trials.

Keywords: Local wisdom; Scientific literacy; STEM; Validity; Worksheet

Received: 4 July 2023
Accepted: 6 November 2023
Published: 31 December 2023
DOI : https://doi.org/10.20527/jipf.v7i3.9379

How to cite: Ariefianti, M., Sholahuddin, A., & Wati, M. (2023). The validity of the student worksheet of thermal energy material based on *science*, *technology*, *engineering*, *mathematics* (stem) and local wisdom to enhance scientific literacy. *Jurnal Ilmiah Pendidikan Fisika*, 7(3), 487-499.

INTRODUCTION

Scientific literacy is an essential foundational skill that every individual ought to attain. This is due to the fact that scientific literacy is intricately linked to an individual's perspective on the environment and other prevalent issues in contemporary society. Contemporary society extremely relies on technological and scientific advancements in order to elevate their own and their social sphere's standard of living (Rahayuni, 2016; Kemendikbud, 2017).

Scientific literacy becomes a primary objective of science education which comprises the development of fundamental knowledge, critical thinking skills, the application of acquired knowledge, and a comprehension of the science properties (Sutrisna, 2021). Scientific literacy, which pertains to the cosmos, is considered a fundamental ability in the twenty-first century (Kemendikbud, 2017). Scientific literacy consists of the knowledge and abilities required to identify problems and comprehend the significance of scientific issues (science process) so that individuals can make decisions based on scientific evidence (Fives, et al., 2014; Puskurbuk, 2017).

The objective of education in the twenty-first century is to prepare students to emerge as a generation that possesses the following qualities: excellence, religious, intelligence, autonomy, adaptability, competitiveness, and fortitude in the face of current obstacles (Mukminan, 2014; Daryanto et al., 2017; Hasibuan et al., 2019). The quality of science education can affect the attainment of the Indonesia’s educational objectives, which subsequently influence the progress of the nation (Bagasta et al., 2018; Pratiwi et al., 2019). It is anticipated that students' scientific literacy will increase as a result of effective science education (Khaeroningtyas, et al., 2016; Batdi et al., 2019; Rohmah, et al., 2019; Silvia, et al., 2020; Andaresta, et. al., 2021, Maksum, et al., 2022).

Indonesia's scientific literacy classification remains comparatively low in the field, as indicated by PISA 2018. Scientific literacy received a score of 396 on the PISA, placing it at position 72 out of a total of 77 participating nations (OECD, 2019). According to these findings, students' scientific knowledge or comprehension of scientific concepts remains extremely limited and can only be applied under specific conditions.

The learning report of the students of SMP Negeri 2 Salam Babaris in 2022 indicated a literacy skill score of 1.58, which falls short of the minimum competency requirement. The competency levels in information reading, information access and discovery, interpretation and comprehension, and assessment and reflection on textual content remain below the minimum competency standard. According to these findings, students' scientific knowledge or comprehension of scientific concepts remains extremely limited and can only be applied under specific conditions.

A lack of facilities that support the science learning process, such as learning resources in the form of worksheet, is one of the contributing factors to students' low scientific literacy (Pertiwi et al., 2018; Pratiwi et al., 2019; Rohmah et al., 2019; Putri, 2021; Sutrisna, 2021). The prevailing junior high school science worksheet typically comprises a synopsis of the subject matter and a set of assessment tasks that require students to respond to the questions in the form of descriptions, brief answers, or multiple-choice responses. Few of the worksheet is devoted to experimental work and illustrative instances of AKM question items presented in the form of literacy and numeracy on each chapter. Additionally, the use of digital technology in the form of barcode scanning to provide students with additional information regarding YouTube links or articles has been linked to worksheet in the schools. As the school's worksheet consists of a compilation of questions that do not direct students towards a particular learning approach, it is suboptimal for enhancing scientific literacy.

STEM is one approach for enhancing the scientific literacy and academic performance of students (Khaeroningtyas et al., 2016; Batdi et al., 2019; Rohmah et al., 2019; Silvia et al., 2020). STEM-based learning can enhance students' understanding of the environment and encourage group projects to design technology products, which fostering a strong sense of community, facilitating productive ideation, encouraging higher levels of agency, and providing students with evidence of their level of engagement in the design of their STEM projects (Hong et al., 2018). The STEM approach can be applied through the cooperative learning, PBL, PjBL, and Enquiry (Murphy et al., 2015; Afriana et al., 2016). To accomplish these objectives, each component of the STEM approach incorporates or demonstrates the application of scientific literacy skills. Consequently, it is anticipated that students will possess the capacity to establish significant correlations between the knowledge they acquire and their prior experiences (Rohmah, et al., 2019).

Some of the learning theories supporting the learning based on STEM and local wisdom are constructivism and meaningful learning. The theory of constructivism demonstrates that a learning approach should emphasize the students construct new knowledge and information by building upon previously acquired experience and knowledge, which can generate an effective science learning (Nira, 2018). Ausubel's meaningful theory demonstrates that for the learning process to be meaningful, the teacher must establish a connection between the subject matter and pertinent concepts in the students' cognitive structures (Joyce et al., 2003).

Research of the implementation of local wisdom-based learning to enhance scientific literacy was presented in a study by Setiawan et al. (2017). An educational approach grounded in local wisdom comprises a learning process encouraging the students to obtain the knowledge through tangible concepts that they frequently encounter or discover (Daniah, 2016). Utilizing this local wisdom approach enables students to identify, comprehend, and analyze technologically evident local products of their region in a manner that is relevant to their daily lives. Certain studies related to issues grounded in local wisdom include *Hanoman hadrah* (Sudirman et al., 2018), wetlands (Ridho et al., 2020), and coastal communities of Puger beach (Sakdiyah, et al., 2021).

A worksheet is utilized as one of the learning facilities. The development of worksheet can effectively support the learning process (Setiani et al., 2021; Maharani 2018; Sari et al., 2019; Arifuddin et al., 2019). Scientific literacy can be enhanced through STEM-based learning aided by the worksheet (Khaeroningtyas et al., 2016). The researchers express interest in integrating local wisdom and the STEM approach as a means to enhance students' scientific literacy, as indicated by the provided description.

A quality development product must satisfy the validity criteria before being utilized by the students (Ridho et al., 2020). The developed product must satisfy the validity requirements at minimum. Product validation is typically conducted by subject matter experts, senior educators, or educational practitioners (Sudirman et al., 2018; Mahjatia et al., 2021; Sakdiyah et al., 2021). The objective of this research is to describe the validity of the worksheet based on STEM and local wisdom.

METHOD

This research employed the Borg and Gall (1983) development model, in which the stages are depicted in Figure 1. The stages of development consist solely of the following: research and information colleting, planning, develop preliminary form of product, preliminary field testing, main product revision, main field testing, operational product revison.

The stage being comprehensively discussed in this research is the stage of developing preliminary form of product.

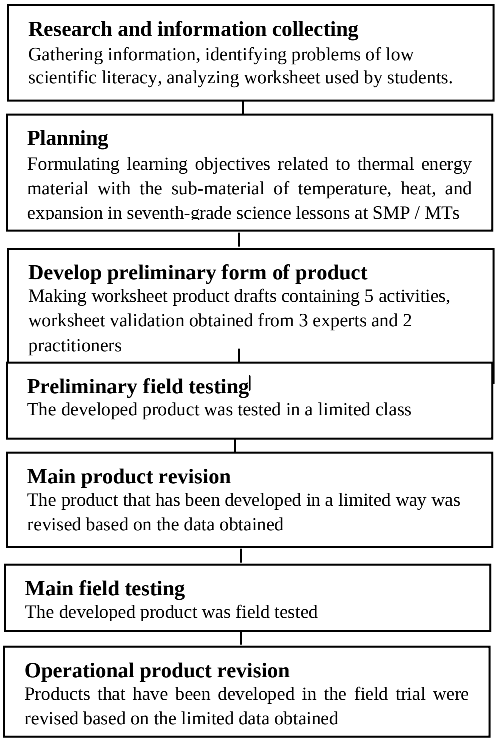

Figure 1 Development stages

The developed product was the worksheet based on STEM and local wisdom to enhance scientific literacy. The relevant local knowledge consists of *rimpi*, *kacang jaruk*, and *parang* construction. Three experts conducted the validation process: lecturers specializing in science education at the master's level, two practitioners who are science teachers at SMPN 1 Hatungun, and physics teachers at SMAN 1 Binuang. An evaluation of the accuracy or soundness of a product constitutes validity (Plomp et al., 2013). The validity of the worksheet is assessed across multiple aspects, including format, language, and content. Table 1 presents the instrument synopsis that was employed.

Table 1 The worksheet validation instrument

Aspect	Indicator
Format	• The format of the indicators or objectives of the worksheet is clear • Appropriate font size and type • Appropriate layout • Presents activity procedures • The answer column provided is in accordance with the answer key
Language	• Indonesian language used is in accordance with the grammar • The language used is simple and easy to understand • The sentences do not cause double meaning
Content	• In accordance with the Merdeka curriculum • contains STEM and local wisdom • Relevant to STEM learning and local wisdom to improve scientific literacy • The truth of the concept and material of thermal energy in everyday life • Systematic worksheet filling procedure • Motivate students to improve the scientific literacy

The data derived from the worksheet assessment outcomes was computed by averaging the validator's scores against the worksheet validity criteria outlined in Table 2.

Table 2. The validity criteria of the worksheet

Interval	Category
$X > 3,4$	Very Valid
$2,8 < X \leq 3,4$	Valid
$2,2 < X \leq 2,8$	Fairly Valid
$1,6 < X \leq 2,2$	Less Valid
$X \leq 1,6$	Invalid

(Widoyoko, 2016)

Description:

$\overline{Xi}$ = ideal average

= 1/2 (max score + min score)

sb_i = ideal standard deviation
= 1/6 (skor max – skor min)
X = empirical score

If the product developed is tested valid, the data that has been obtained are tested for the reliability using the following formula.

$$R = 100\left(1 - \frac{A - B}{A + B}\right) \quad \ldots(1)$$

Description:
R = Reliability
A = The high validator's score
B = The low validator's score

The instrument assessment criteria have a good level of reliability if the reliability is ≥ 75% (Borich, 1994).

RESULT AND DISCUSSION

The developed worksheet is based on STEM and local wisdom regarding thermal energy materials. This worksheet is developed in accordance with the Merdeka curriculum for SMPs/MTs in the seventh grade. In order to align with the practical experiences of students, this worksheet incorporates scientific literacy indicators and STEM stages. By participating in this worksheet, students are anticipated to acquire a comprehensive understanding of scientific concepts through the study of relevant materials, apply technology by utilizing designed basic tools around them, refine their numerical abilities, and develop a deep appreciation for their local culture. The practical issues related to the local wisdom of the South Kalimantan region are the construction of housing/*tungku rimpi*, *kacang jaruk* production, and *parang* model creation. The worksheet comprises five distinct categories of scientific literacy indicators: 1) identify, apply, and generate explanations accompanied by descriptions and examples; 2) formulate predictions and statements; 3) recognize enquiries in scientific lessons; 4) transform data from one format to another; and 5) analyze and interpret data to draw scientific conclusions, beginning with the identification of responses, evidence, and rationales in science that are pertinent to the text.

The worksheet design comprises the following sections: front cover, preface, introduction, table of contents, STEM, scientific literacy, worksheet instructions, worksheet I senses as a method for measuring the hot/cold temperature of objects, worksheet II thermometer working principles, worksheet III heat, worksheet IV heat transfer, worksheet V expansion of solids, glossary, author bio, and back cover. The worksheet is developed with the intention of enhancing students' scientific literacy.

The front cover of the worksheet got revision. The revised and unrevised covers are illustrated in Figures 2 and 3.

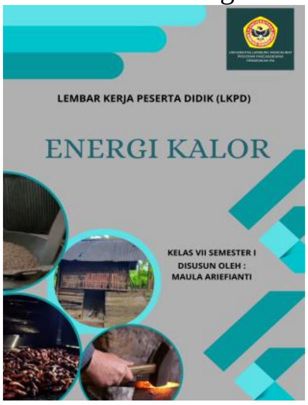

Figure 2 Cover before revision

Figure 3 Cover after revision

This worksheet explains the meaning of STEM which is explained at the beginning section. The STEM explanation in the worksheet is presented in Figure 4.

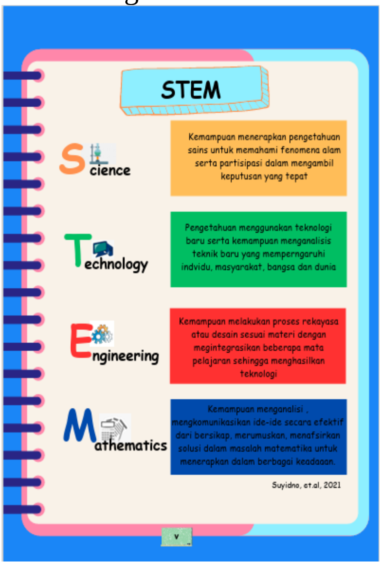

Figure 4 Explanation of STEM

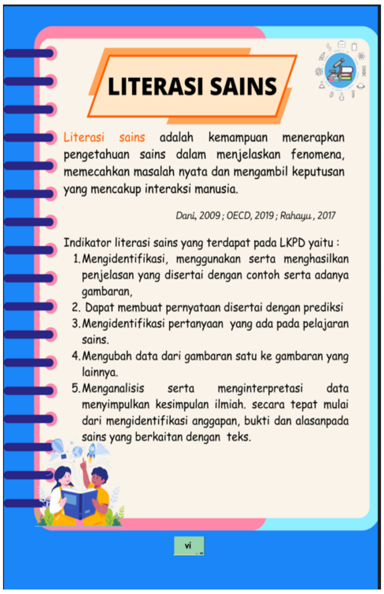

Figure 5 Explanation of scientific literacy

This worksheet has instructions for use which are arranged after the STEM explanation. The instructions are presented in Figure 6.

Figure 6 Instructions for use of the worksheet

The final part of the developed worksheet is a glossary that comprises the meaning of terms or keywords contained in the worksheet.
The glossary on the worksheet is presented in Figure 7.

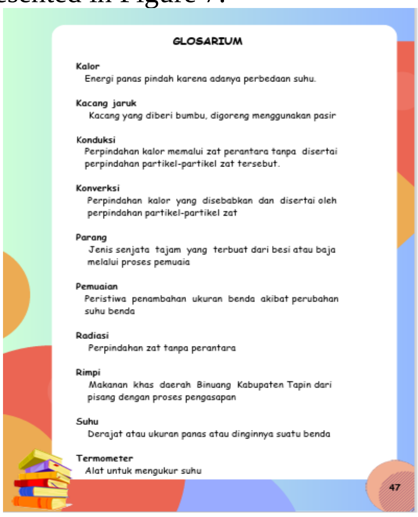

Figure 7 The worksheet glossary

The initial part of each worksheet topic contains the title of the material topic, learning objectives, and STEM indicators. An example of the initial part for each worksheet material title is presented in Figure 8.

Figure 8 The worksheet initial part on each material topic

Students are guided to understand natural phenomena related to science concepts at the Science stage in the worksheet by answering questions about science. The concepts that students must understand in the material of thermal energy contain the concepts of temperature, heat, and expansion. Examples of Science stages and scientific literacy indicators of identifying, applying, and generating explanations accompanied by examples and images are presented in Figure 9.

Figure 9 Example of Science stage and scientific literacy indicator 1) identify, apply, and generate explanations accompanied by examples and images

Students are guided to recognize and understand technology in everyday life at the Technology stage. An example of the Technology stage is presented in Figure 10. In this section, a QR code is provided for students to find information related to technology.

Figure 10 Example of the technology stage

Students are guided to design or make simple designs at the Engineering stage, such as making simple thermometers, *tungku rimpi*/houses, and simple *parang* designs. An example of the Engineering stage in the worksheet is presented in Figure 11.

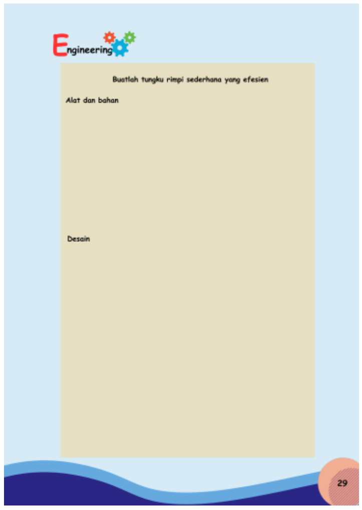

Figure 11 Example of the Engineering stage in the worksheet

Students write the numbers of observations in the table in the developed worksheet, compare and sort the temperature of objects, and convert the temperature from Celsius to Reamur. An example of the Mathematics stage in the worksheet is presented in Figure 12.

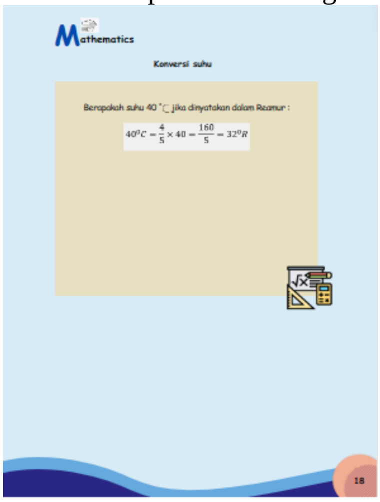

Figure 12 Example of the Mathematics stage in the worksheet

Scientific literacy indicators are inserted in the STEM stages of the worksheet. Examples of scientific literacy indicators on the developed worksheet are presented in Figures 13, 14, 15, and 16 respectively.

Figure 13 Scientific literacy indicator 2) making statements and predictions

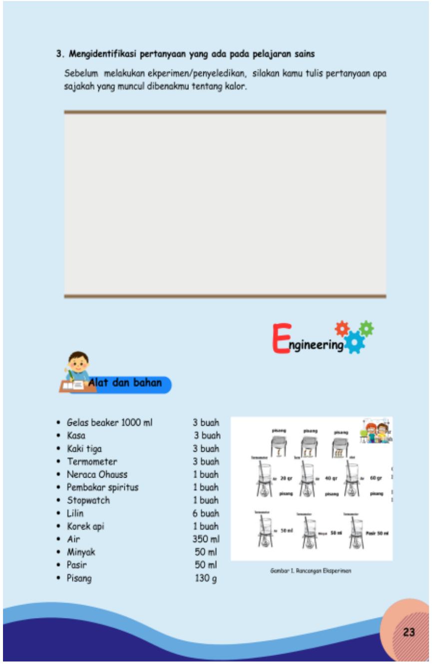

Figure 14 Scientific literacy indicator 3) identifying questions in science lessons

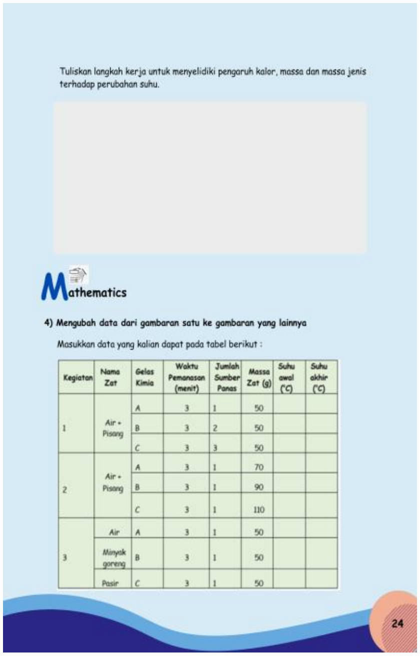

Figure 15 Scientific literacy indicator 4) transforming data from one representation to another.

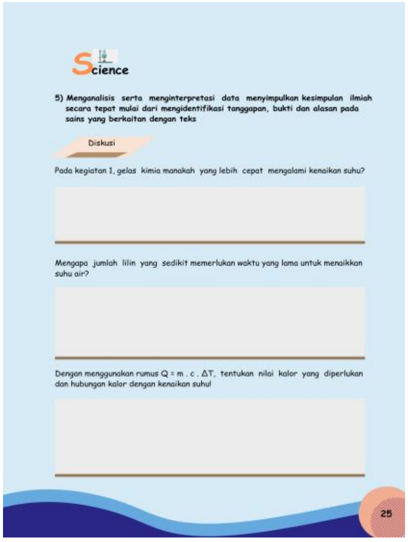

Figure 16 Scientific literacy indicator 5) analyzing and interpreting data to draw scientific conclusions, beginning with the identification of responses, evidence, and rationales in science related to the text

Validity is the soundness or accuracy of a product (Plomp & Nieveen, 2013). Subsequent trials may utilize the development product that satisfy validity criteria or meet validity standards (Nurhusain et al., 2021). One of the criteria utilized to assess the quality of a product is validation (Violadini et al., 2021). Table 3 displays the validation results as provided by three experts and two science teachers.

Table 3 The results of the worksheet validation

Assessment Aspect	Average	Category
Format	3.64	Very Valid
Language	3.27	Valid
Content	3.57	Very Valid
Average	**3.49**	**Very Valid**

The validity results indicate that the worksheet's format and content are deemed to be very valid, whereas its language is deemed to be valid. The format of the worksheet is evident in the distinct format of the indicators/objectives, the appropriateness of the font size and style, the appropriateness of the layout, the presence of activity procedures, and the alignment of the answer space with the answer key. The language aspect demonstrates that the worksheet has employed language that adheres to proper usage conventions, is straightforward, is easily comprehensible, and contains sentences that are not redundant. The content of the worksheet aligns with the Merdeka curriculum, specifically the thermal energy material in phase D. It includes STEM stages and addresses issues derived from local wisdom, such as *rimpi*, *kacang jaruk*, and *parang*. By including scientific literacy indicators in the worksheet, students are motivated to enhance their scientific literacy. The application of thermal energy material is practical in real-world scenarios, and the process of filling out the worksheet is systematic. The worksheet may be revised in accordance with validators' suggestions, including but not limited to the following: correcting typographical errors (typo writing), altering the gray background and font to one other than Times New Roman, refining the cover and preface as suggested by the worksheet, placing the bibliography on a separate page following the conclusion of the worksheet, ensuring that scientific literacy indicators are not only included in the science section but also in STEM, adding glossary and the author biography.

A worksheet is considered valid when it adheres to a systematic approach, prioritizes the process of discovering concepts, employs language that is easy to comprehend, and assesses the applicability of the cases provided alongside the material. Worksheets that are valid are organized in a systematic manner, are pertinent to the learning objectives, and facilitate the efficient execution of learning activities

(Lismidarni et al., 2020). When a development product is classified as valid and reliable, it is considered to be of high quality and practical for use (Maulana, 2022; Sudiarman et al., 2015). The subsequent step after validation is computing its reliability. The formula for determining the reliability of the worksheet assessment was derived from the Borich method (1994). Reliability results are presented in Table 4.

Table 4 The results of the worksheet's reliability

Assessment aspect	Reliability	Category
Format	94.44	Good reliability
Language	89.96	Good reliability
Content	90.57	Good reliability
Average	**91.66**	**Good reliability**

The results of the worksheet's reliability analysis indicate that all three aspects namely format, language, and content obtain scores greater than 75%, indicating that the worksheet has good reliability in every aspect. The worksheet, in its entirety, exhibits high validity and reliability, thereby satisfying one criterion for the worksheet's feasibility.

CONCLUSION

The research results indicated that the worksheet based on STEM and local wisdom regarding thermal energy materials is deemed to be very valid and has good reliability. In order to enhance scientific literacy at the junior high school or MTs level, the worksheet can be implemented in the subsequent phases: validity and reliability, limited trial, product revision, field trial, and product revision. The utilization of the worksheet based on STEM and local wisdom of the South Kalimantan community enables students to gain an understanding of the processes involved in the construction of banana *rimpi*, *kacang jaruk*, and *parang/mandau*. The construction procedure necessitates thermal energy, which can be associated with materials studied in junior high or middle school pertaining to thermal energy. By promoting local wisdom, students are better able to comprehend the thermal energy material and develop a deep appreciation for the regional culture. Additional research is required through the practical application of students' skills in *rimpi* production, marketing *kacang jaruk*, and *parang* construction. These practices may be incorporated into the Pancasila Student Profile Strengthening Program's activities (P5).

REFERENCES

Afriana, J., Permanasari, A., & Fitriani, A. (2016). Penerapan project based learning terintegrasi STEM untuk meningkatkan literasi sains siswa ditinjau dari gender. *Jurnal Inovasi Pendidikan IPA*, *2*(2),202-212. https://doi.org/10.21831/jipi.v2i2.8561.

Andaresta, N., & Rachmadiarti, F. (2021). Pengembangan e-book berbasis stem pada materi ekosistem untuk melatihkan kemampuan literasi sains siswa. *Berkala Ilmiah Pendidikan Biologi (BioEdu)*, *10*(3), 635-646. https://doi.org/10.26740/bioedu.v10n3.p635-646.

Arifuddin, M., Wati, M., Miriam, S., Suyidno, S., Misbah., M., Mahtari, S., & Ridho., M. H. (2020). Pengembangan desain lembar kerja siswa (LKS) berbasis kreativitas ilmiah pada guru sains-fisika di Kalimantan Selatan. *Bubungan Tinggi: Jurnal Pengabdian Masyarakat*, *1*(2), 92-99. https://doi.org/10.20527 /btjpm.v1i2.180.

Bagasta, A. R., Rahmawati, D., Wahyuni, I. P.. &Prayitno, B. A. (2018). Profil kemampuan literasi sains peserta didik di salah satu SMA negeri kota Sragen. Pedagogia: *Jurnal Pendidikan*, *7*(2), 121-129. https://doi.org/10.21070/pedagogia.v7i2.1551.

Batdi, V., Talan, T., & Semerci, C. (2019). Meta-analytic and meta-thematic analysis of STEM education. *International Journal of Education in Mathematics, Science and Technology*, *7*(4), 382-399. EJ1232747.pdf (ed.gov)

Borg Walter R., and Gall M.D. 1983. *Educational Research: An Introduction*. New York: Longman Inc.

Borich, G, D. (1994). *Observation Skills for Effective Teaching*. Merrill : Universitas Michigan

Daniah, D. (2016). Kearifan lokal (*local wisdom*) sebagai basis pendidikan karakter pionir. Jurnal Pendidikan, 5 (2). http://dx.doi.org/10.22373/pjp.v5i2.3356.

Daryanto, K. S., & Karim, S. (2017). Pembelajaran abad ke-21. *Yogyakarta: Gava Media*.

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

Hasibuan, A. T., & Prastowo, A. (2019). Konsep pendidikan abad ke-21: kepemimpinan dan pengembangan sumber daya manusia SD/MI. *MAGISTRA: Media Pengembangan Ilmu Pendidikan Dasar dan Keislaman*, *10* (1). 26-50. http://dx.doi.org/10.31942/mgs.v10i1.2714

Hong, H. Y., Lin, P. Y., Chen, B., & Chen, N. (2019). Integrated STEM learning in an idea-centered knowledge-building environment. *The Asia-Pacific Education Researcher*, *28*(1), 63 - 76. https://doi.org/10.1007/s40299-018-0409-y .

Joyce, B., Weil, M., & Calhoun, E. (2003). *Models of teaching*. New Delhi: Prentice-Hall of India

Khaeroningtyas, N., Permanasari, A., & Hamidah, I. (2016). STEM learning in material of temperature and its change to improve scientific literacy of junior high school. *Jurnal Pendidikan IPA Indonesia*, *5*(1), 94-100. https://doi.org/10.15294/jpii.v5i1.5797.

Kemendikbud. (2017). Panduan Gerakan Literasi Nasional. Jakarta Timur: Kementrian Pendidikan dan Kebudayaan.

Lismidarni, S. (2021). Pengembangan LKPD berbasis model project based learning dengan pendekatan saintifik berbantuan aplikasi tracker pada materi kinematika gerak kelas X SMAN 3 Padang (Doctoral dissertation, Universitas Negeri Padang).

Maharani, L. (2018). Pengembangan Lembar Kerja Peserta didik Dengan Pendekatan STEM *(Science, Technology, Engineering, Mathematics)* untuk Meningkatkan Literasi Sains Siswa Pada Materi Virus ((Doctoral dissertation, UNIMED).

Mahjatia, N., Susilowati, E., & Miriam, S. (2021). Pengembangan LKPD berbasis STEM untuk melatihkan keterampilan proses sains siswa melalui inkuiri terbimbing. Jurnal Ilmiah Pendidikan Fisika, 4(3), 139. https://doi.org/10.20527/jipf.v4i3.2055

Maksum, M. (2022). Penggunaan LKPD literasi sains dalam pembelajaran tingkat SMA. *Teacher: Jurnal Inovasi Karya Ilmiah Guru*, *2*(1), 84-91.

https://doi.org/10.51878/teacher.v2i1.1106.

Maulana, A. (2022). analisis validtas, reliabilitas, dan kelayakan instrumen penilaian rasa percaya diri siswa. *Jurnal Kualita Pendidikan*, 3(3), 133-139. https://doi.org/10.51651/jkp.v3i3.331.

Mukminan. (2014). *Stategi Menyiasati Pendidikan Abad ke-21*. Yogjakarta: UNY.

Murphy, S., MacDonald, A., Danaia, L., & Wang, C. (2019). An analysis of Australian STEM education strategies. *Policy Futures in Education*, *17*(2), 122-139. https://doi.org/10.1177/1478210318774190.

Nira Nurwulandari. (2018). Pembelajaran fisika berbasis literasi sains terhadap penguasaan konsep mahasiswa pada pokok bahasan energi. *Jurnal Pendidikan : Riset & Konseptual*, 2(2),205-213. https://doi.org/10.28926/riset_konseptual.v2i2.51.

Nurhusain, M., & Hadi, A. (2021). Desain pembelajaran statistika terapan berbasis kasus berkualitas baik (valid, praktis, dan efektif) untuk mahasiswa pendidikan matematika. *Indonesian Journal of Educational Science* (IJES), 3(2),105-119. https://doi.org/10.31605/ijes.v3i2.951.

OECD. (2019). *PISA for development assessment and analytical framework: reading, mathematics and science preliminary version*. Paris: OECD Publishing

Pertiwi, K. E., Bharata, H., & Suharsono, S. (2018). Pengembangan LKPD fungsi kuadrat berbasis saintifik untuk mengembangkan kemampuan pemahaman konsep peserta didik. *Jurnal Pendidikan Matematika Universitas Lampung*, 6(2). (Doctoral dissertation, Universitas Negeri Padang)

Plomp, T. & Nieeveen (2013). *Educational design research*: An introduction. Educational design research, 11-50.

Pratiwi, S. N., Cari, C., & Aminah, N. S. (2019). Pembelajaran IPA abad ke-21 dengan literasi sains siswa. *Jurnal Materi dan Pembelajaran Fisika*, *9*(1), 34-42. https://doi.org/10.20961/jmpf.v9i1.31612.

Puskurbuk. (2017). *Literasi sains*. Jakarta : Kemendikbud.

Putri, D. V. E., & Susantini, E. (2021). Penerapan E-LKPD berbasis strategi KWL plus pada materi archaebacteria dan eubacteria untuk melatihkan keterampilan metakognitif peserta didik. *Berkala Ilmiah Pendidikan Biologi* (BioEdu), 10(2), 367-375. https://doi.org/10.26740/bioedu.v10n2.p367-375.

Rahayuni, G. (2016). Hubungan keterampilan berpikir kritis dan literasi sains pada pembelajaran IPA terpadu dengan model PBM dan STM. *Jurnal Penelitian dan Pembelajaran IPA*, *2*(2), 31-146. http://dx.doi.org/10.30870/jppi.v2i2.926.

Ridho, M. H., Wati, M., Misbah, M., & Mahtari, S. (2020). Validitas bahan ajar gerak melingkar berbasis authentic learning di lingkungan lahan basah untuk melatih keterampilan pemecahan masalah. *Journal of Teaching and Learning Physics*, *5*(2), 87-98. http://dx.doi.org/10.15575/jotalp.v5i2.8453

Rohmah, Ulfa Nadiyatur, Yoyo Zakaria Ansori, and Dede Salim Nahdi. (2019). Pendekatan pembelajaran stem dalam meningkatkan kemampuan literasi sains siswa sekolah dasar. In *Prosiding Seminar*

Nasional Pendidikan, vol. 1, pp. 471-478.

Sakdiyah, H., & Annizar, A. M. R. (2021). Pengembangan LKPD berbasis kearifan lokal masyarakat pesisir pantai Puger pada materi perbandingan. Aritmatika : . *Jurnal Riset Pendidikan Matematika*, *2*(2), 116-124.
https://doi.org/10.20527/jipf.v4i3.2055

Setiani, A., Hendri, M., & Rasmi, D. P. (2021). Persepsi peserta didik terhadap LKPD terintegrasi STEM pada materi suhu dan kalor . *Jurnal Penelitian dan Pengembangan Pendidikan*, *5*(2), 287-293. https://doi.org/10.23887/jppp.v5i2.33476.

Setiawan, B., Innatesari, D. K., Sabtiawan, W. B., & Sudarmin, S. (2017). The development of local wisdom-based natural science module to improve science literation of students. *Jurnal Pendidikan IPA Indonesia*, *6*(1), 49-54. https://doi.org/10.15294/jpii.v6i1.9595.

Sudiarman, S., Soegimin, W. W., & Susantini, E. (2015). Pengembangan perangkat pembelajaran fisika berbasis inkuri terbimbing untuk melatihkan keterampilan proses sains dan meningkatkan hasil belajar pada topik suhu dan perubahannya. *JPPS (Jurnal penelitian pendidikan sains)*, *4*(2), 658-671.
https://doi.org/10.26740/jpps.v4n2.p658-671

Sutrisna, N. (2021). Analisis kemampuan literasi sains peserta didik SMA di kota sungai penuh. *Jurnal Inovasi Penelitian*, *1*(12), 2683-2694. https://doi.org/10.47492/jip.v1i12.530.

Violadini, R., & Mustika, D. (2021). Pengembangan e-modul berbasis metode inkuiri pada pembelajaran tematik di sekolah dasar. Jurnal basicedu, 5(3), 1210-1222. https://doi.org/10.31004/basicedu.v5i3.899.

Widoyoko, S.E. (2016). *Teknik penyusunan instrumen penelitian*. Yogjakarta : Pustaka Pelajar.