

DEVELOPMENT OF ICT-BASED WORKSHEET ON STEM-INTEGRATED TO INCREASE KNOWLEDGE, DATA LITERACY, AND TECHNOLOGY LITERACY OF HIGH SCHOOL STUDENTS

Mutiara Dier¹, Asrizal Asrizal^{1*}

¹ Department of Physics, Universitas Negeri Padang, Jl. Prof. Dr. Hamka Air Tawar Padang 25131, Indonesia
Corresponding author. E-mail: asrizal@fmipa.unp.ac.id

ABSTRACT

The development of education cannot be separated from the development of the current Industrial Revolution 4.0. One of the chops that can answer the industrial revolution is data literacy and technological literacy. The use of ICT-based teaching materials is needed in learning in this era. Correspondingly, stem integration will improve new literacy skills. However, preliminary studies show the lack of ICT-based worksheet use in the learning process. The solution to this problem is to create STEM-integrated ICT-based worksheets. The purpose of this study is to determine the effectiveness of ICT-based worksheets in effective STEM integration work and energy teaching materials to improve students' knowledge, data literacy, and technology literacy. This type of research is Research and Development (R&D) according to the Plomp model. The data obtained from this study is the result of expert validation. Data analysis techniques using descriptive statistical analysis with Aiken's V validation. The validation results of Aiken's V stated that the average of 0.80 had a high coefficient of Aiken's V criteria. This result was obtained from an average of three expert validators. Thus, an ICT-based worksheet, STEM-integrated work, and energy material to improve the data literacy and technological literacy of SMA students are declared valid and suitable for learning. It is hoped that this worksheet can be a reference for further research to improve the quality of learning to answer the challenges of the upcoming revolution era.

Keywords: *ICT-Based Worksheet; STEM-Integrated; Data Literacy; and Technology Literacy.*



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I. INTRODUCTION

The development of education in Indonesia cannot be separated from 5the development of today's industrial revolution. The era of Industrial Revolution 4.0 is an era that requires connectivity of all things (Internet of Things) that we believe will transform our economy and quality of life in the right way [1]. This era of industrial revolution 4.0 is characterized by an increase in artificial intelligence, interaction, and the development of digital, connectivity, and virtual systems [2]. This requires the world of education to be able to keep up with the development of technology that is developing very rapidly and be able to utilize information and communication technology as a learning facility [3]. For this reason, innovation is needed in the learning process that utilizes technological developments.

The COVID-19 pandemic is attacking Indonesia's education system. Based on Decree No. 21 of 2020, specifies that learning activities will be conducted online. The shift in the online learning system requires students and teachers to be able to adjust to utilizing technology. Thus, media that can be accessed in digital form is needed.

The world of education in the use of technology demands an improvement in the quality of learning. Media in digital form will facilitate the achievement of learning objectives because the presentation of learning materials is packaged contextually that are interesting, interactive, and participatory [4]. These technological advances require learning in digital form [5]. Therefore, learning activities that still use conventional media, books, and other references must be carried out in digital form by utilizing technological developments.

The role of literacy in learning is needed to meet the challenges of the Industrial Revolution 4.0. One of the literacy skills that can meet the challenges of Industrial Revolution 4.0 is data and technology literacy. Technical

ability is the ability to understand the completeness of technology such as hardware and software [6]. Data literacy is the ability to read, analyze, and use information [7]. Therefore, learning is needed to improve data and technology literacy skills.

STEM stands for Science, Technology, Engineering, Mathematics. STEM education combines four mutually integrated disciplines and uses active learning and learning approaches [8]. STEM education is one of the concepts that can improve students' data literacy and technological literacy skills [9]. STEM education can increase individual productivity in the learning process.

One of the materials commonly used in the learning process is the student worksheet. Worksheets are learning tools that teachers use in the learning process to increase student participation in the teaching and learning process [10]. The worksheet contains information and instructions from educators to students to do a learning activity in the form of work or practice [11]. The use of digital worksheet-style materials is necessary to ensure that students understand what they are learning well [12]. Therefore, student worksheet is needed to be developed in digital form.

Field reality does not account for the expected conditions. That said, some issues have been identified based on the results of a preliminary study of real-life situations encountered in SMAN 9 Padang, namely: 1) Lack of use of ICT-based worksheet in the learning process; 2) STEM integration in textbooks is quite sufficient; 3) students' low understanding of physics learning materials; 5) lack of performance assessment on students' data literacy and technology literacy skills. Thus, there is a need for a solution to this problem

Starting from real conditions and ideal conditions, it is hoped that there will be problems in learning physics. It is important to make efforts to overcome this problem. The solution to this problem is to create STEM-based ICT-based worksheets. This solution addresses the challenges of the Industrial Revolution 4.0 era that require digital learning.

From this solution, three theoretical studies need to be done. The first theoretical study is an ICT-based worksheet. An ICT-based worksheet is a worksheet in which there is a summary of the material, assign moments, and instructional implementation instructions containing text, audio, and audiovisual elements that can be accessed via computers or other smartphones [13]. Another definition of an ICT-based worksheet is technology as a tool for processing data, including processing, retrieving, assembling, storing, and manipulating data in various ways to produce high-quality information teaching materials to use [14].

The second theoretical study is related to STEM. STEM is an educational approach that integrates science, technology, engineering, and mathematics into the process of learning activity. In addition, STEM is a scientific discipline whose components are closely related to each other [15]. STEM is an approach that explores two or more STEM subjects and one or more subjects in school [16]. Thus, STEM can be interpreted as an approach by integrating several subjects with components that are closely related to each other.

STEM integrated development can improve student competence. The characteristic of STEM is that it integrates science, technology, engineering, and mathematics in solving real problems. How to integrate all fields in STEM needs to consider the material, media, and other factors [17]. The integration of STEM can improve literacy knowledge and skills because it can motivate students to find various cases in everyday life [18]. Quality STEM education requires programs that incorporate rigorous curriculum, instruction, and assessment, integrating technology and engineering with science and mathematics curricula, and displays that also facilitate scientific research and construction processes [19].

The third theoretical study relates to data literacy and technological literacy. Data literacy is the ability to read, analyze, and draw conclusions from data and information obtained [7]. Data literacy can also be interpreted as the ability to use information, find, evaluate, use, create and communicate content/information with cognitive and technical skills [20]. In short, data literacy is the ability to reason based on information and process information with cognitive and technical skills.

Technical literacy is the ability to understand how machines and technical applications work [21]. Technical competence is the ability to effectively, responsibly, appropriately, independently, or collaborate with others to use technological tools to obtain, manage, synthesize, evaluate, produce, and communicate information. It is the ability of an individual to work with [22]. In other words, technical literacy refers to the ability to understand how machines and technical applications for managing information work.

A previous study by Sunarti stated that teaching materials developed in the form of e-teaching materials and having STEM content characteristics which include science, technology, engineering, and mathematics were declared valid based on the validity of Aiken's V with an average validity value of 0.92 [23]. Furthermore, Pratiwi stated that the STEM-based e-book developed to train scientific literacy skills was declared very feasible with 92.56% validation results with valid criteria [24]. Research conducted by Chania stated that physics teaching

materials were categorized as suitable for use with an achievement percentage of 83.25% which was validated by experts [25].

Starting from the background of the problems that have been described, it can be stated that preliminary research to develop a STEM-based ICT-based worksheet needs to be done. This study has several differences from previous research including; 1) the teaching materials used are digital worksheet or ICT-based worksheet. The software used in making this ICT-based worksheet is Flip PDF Professional so it is more practical and interesting. 2) worksheet in this electronic form integrates STEM, and 3) the skills observed are data literacy and technology literacy. The purpose of this research is to create effective STEM-based ICT-based work and energy teaching materials to improve students' data and technology literacy.

II. METHOD

The type of research used is research and development or research and development (R&D). Research and development research is a research method that produces a specific product and tests the effectiveness of a specific product. Of course, building a product involves doing a needs analysis, testing the product's effectiveness, and making it work in the wider community [26].

The development model in this study is the Plomp model. Plomp is a development model that produces products. The Plomp model consists of three phases: 1) a preliminary investigation phase, 2) a development or prototyping phase, and 3) an evaluation phase [27]. The initial investigation stage is the stage that includes needs analysis, literature review, and the development of a conceptual or theoretical framework. Furthermore, the development stage consists of formative evaluation and prototype revision. The last is the assessment phase, which is the stage of being tested and evaluated in practice.

In the investigative phase, researchers conducted a preliminary study on the use of ICT-based worksheet, integration of STEM in student textbooks, literature review on work and energy materials, and performance assessment of data literacy and technological literacy skills. In the development phase, researchers develop a STEM-based ICT-based worksheet which is then self-evaluated and reviewed by experts. The results of the review will be revised by researchers again to produce a good product.

There are several instruments used in this research. In the investigation phase, using observation sheets on the use of ICT-based worksheet, analysis sheets of STEM integration documents in student textbooks, and performance assessment sheets on students' data literacy and technological literacy. In the development phase using a validation sheet for STEM-based ICT-based worksheet to improve knowledge, data literacy skills, and technology literacy

The data analysis technique used descriptive statistical analysis with Aiken's V validation. Scores are given on a scale of 1 to 4. Validity results were calculated using Aiken's His V formula. The result of worksheet validation can be calculated as follows: [28] formula. Based on the evaluation interpretive criteria obtained, the value of the product validation test result is determined. Correlation coefficient criteria.

Table 1. Aiken's V Coefficient Criteria

Correlation coefficient	Interpretation Validity
$>0,80$	High
$0,60 \leq V < 0,80$	High Enough
$0,40 \leq V < 0,60$	Enough
$0 \leq V < 0,40$	Bad

(Source: Febriandi [29])

III. RESULTS AND DISCUSSION

A. Results

In the development phase using Flip PDF Professional software to convert the worksheet into an ICT-based worksheet. The ICT-based worksheet is designed using a Microsoft word application with the display shown in Figure 1.

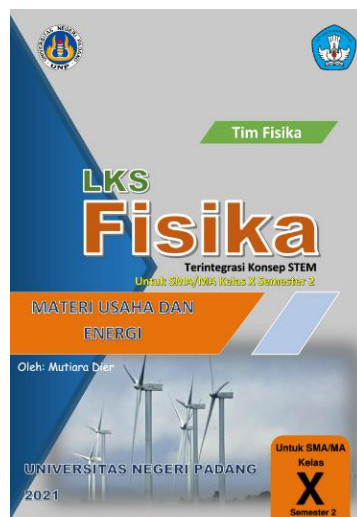


Fig 1. ICT-Based Worksheet Cover Design

After development, the STEM-based ICT-based worksheets were self-evaluated by researchers. Additionally, his STEM-based ICT-based worksheets were validated by experts conducted by three of his UNP Physics Lecturer Validators. The results of evaluation by three validators were analyzed using the Aiken-V formula and his ICT base for working and energy materials integrated with STEM to improve data and technology literacy of high school students of worksheets were determined to be valid.

1. Validity Test Results on Material Substance Components

First, go to the material sub-process component. This component consists of four metrics: 1) truthfulness, 2) completeness of the material, 3) Present, and 4) readability. Validation results analyzed using the Aiken-V formula are presented in the form of Table 2.

Table2. Analysis Results in *Aiken's V* on Components of Material Substance

Rating Indicator	Many Items	Aiken's V Score	Aiken's V Coefficient Criteria
Truthfulness	4	0.78	High Enough
Completeness of The Material	4	0.83	High
Present	3	0.93	High
Readability	2	0.89	High
Average		0.86	High

From Table 2, we can see that the average Aiken's V for the components of this material is 0.86, which is within the high standards. The current index has a high average value for Aikens V at 0.93. Current indicators include assessment points for materials presented in ICT-based worksheets for integrated STEM work and energy materials through the 2013 curriculum. The STEM integration ICT-based worksheet for work and energy contains technologies that address today's real-world conditions. The developed worksheets and energy worksheets are also digital and use modern software applications. As such, the current index has a higher Aiken's V factor criterion compared to other scoring indexes based on the fiber content of the material.

2. Validity Test Results on Visual Communication Display Components

Second, on the visual communication display component. This component consists of 6 assessment indicators, namely 1) navigation, 2) letters, 3) media, 4) color, 5) animation, and 6) layout. The results of the validity values on the assessment indicators for the visual communication display components can be described in Table 3.

Table 3. Aiken's V Analysis Results on Visual Communication Display Components

Rating Indicator	Many Items	Aiken's V Score	Aiken's V Coefficient Criteria
Navigation	2	0.78	High Enough
Letter	1	0.89	High
Media	2	0.89	High
Color	1	0.89	High
Animation	1	0.67	High Enough
Layout	1	0.67	High Enough
Average		0.80	High

Furthermore, based on Table 3, it can be seen that the average Aiken's V visual communication display component is 0.80 which is included in the high category. The indicators for the assessment of letters, media, and colors have the same average of 0.89 while the animation and layout indicators have quite high indicators of 0.67. Based on these indicators, it can be seen that ICT-based worksheet for work and energy integrated STEM in the use of written fonts are appropriate. At the point of assessment of media indicators, ICT-based worksheet for STEM integrated work and energy materials, there are pictures and sources, animations, PhET links, interactive evaluation buttons, and videos that support learning. In the navigation assessment indicator, Aiken's V assessment criteria are quite high, namely 0.78. This is because in STEM-based ICT-based worksheet there are instructions for using a worksheet that is quite clear and easy to understand. STEM-based ICT-based worksheet also contains learning instructions so that students can use this worksheet in learning well.

3. Validity Test Results on Learning Design Components

Third, on the component of learning design. The component consists of 8 assessment indicators, namely 1) title, 2) KD, 3) activity purpose, 4) materials, 5) exercises, 6) work steps, 7) compilation, and 8) references. The results of the validation analysis of the assessment indicators on the learning design components can be described in Table 4.

Table 4. Aiken's V Analysis Results on Learning Design Components

Rating Indicator	Many Items	Aiken's V Score	Aiken's V Coefficient Criteria
Title	1	0.67	High Enough
KD	1	0.67	High Enough
Activity Purpose	2	0.89	High
Materials	1	0.67	High Enough
Exercise	1	0.67	High Enough
Work steps	1	0.67	High Enough
Compilation	1	0.89	High
Reference	1	0.89	High
Average		0.75	High Enough

In Table 4, the learning design component has an average Aiken V of 0.75, a fairly high coefficient criterion. In the title index, the average Aikens V for KD, materials, exercises, and work steps is 0.67, which is a fairly high standard. In addition, the mean Aikens V for activity goal assessment, readiness, and reference indicators was 0.89, which is a high coefficient criterion. This is because the STEM-based ICT-based worksheet has learning objectives that match the KD metrics, demonstrating the benefits that can be gained from using this worksheet. This learning design component has 5 or more references to ICT-based STEM integration work and energy material worksheets.

4. Validity Test Results on Learning Software Components

Fourth, on the software components. The component consists of 4 assessment indicators, namely 1) interactivity, 2) support software, and 3) originality. The results of the validation analysis of the assessment indicators on the use of software components can be described in Table 5.

Table 5. Aiken's V Analysis Results on Software Component Usage

Rating Indicator	Many Items	Aiken's V Score	Aiken's V Coefficient Criteria
Interactivity	1	0.67	High Enough
Support Software	3	1.00	High
Originality	1	0.89	High
Average		0.85	High

Based on Table 5, the use of software components has an average Aiken's V of 0.85 and has high coefficient criteria. The supporting software indicator has the highest average of Aiken's V among the others, which is 1.00, and has a high category. This supporting software indicator has 3 assessment points. First, STEM-based ICT-based worksheet for work and energy materials use 3 or more supporting software. Second, in the STEM-based ICT-based worksheet for work materials and energy, there are main applications, namely Microsoft Office Word and Flip PDF Professional. Third, in the ICT-based worksheet for STEM-integrated work and energy materials, there is a supporting application, namely PhET as an interactive virtual lab media. In the interactivity assessment indicator, the coefficient criteria are quite high compared to the supporting software assessment indicators and originality. This is because the interactive ICT-based worksheet has not provoked questions in the learning process.

5. Validity Test Results on STEM Assessment Components

Fifth, on the STEM assessment component. The component consists of 4 assessment indicators, namely 1) science, 2) technology, 3) engineering, and 4) mathematics. The results of the validation analysis of the assessment indicators on the STEM assessment components can be described in Table 6.

Table 6. Aiken's V Analysis Results on STEM Assessment Components

Rating Indicator	Many Items	Aiken's V figure	Aiken's V Coefficient Criteria
Science	2	0.67	High Enough
Technology	2	0.89	High
Engineering	2	0.78	High Enough
Mathematics	2	0.67	High Enough
Average		0.75	High Enough

Based on Table 6, the STEM assessment components have an average Aiken's V of 0.75 and have quite high criteria. The technology indicator has the highest average value of 0.89 with high criteria. Science and mathematics indicators have the lowest average value, namely 0.67 with quite high criteria. The indicators of science, technology, engineering, and mathematics each have 2 points of assessment. In science indicators, the relationship between the material presented and students' real-world situations are true and the science component can increase students' knowledge supported by experiments to improve data literacy. Technology indicators, there are examples of technology related to science and technology components that can trigger students' technological literacy. On engineering indicators, there is knowledge about the design and working principles of technology, and engineering components can trigger the emergence of data literacy and technological literacy and encourage students to design technology with simple materials. Finally, mathematical indicators, which contain the mathematical basis that underlies product design and mathematical components, can trigger the emergence of data literacy skills. The science indicator assessment is lower than the technology assessment indicator. This happens because in the assessment of the science indicators the material presented and the real-world situation have not been realized properly. contains a mathematical basis that underlies product design and mathematical components can trigger the emergence of data literacy skills. The science indicator assessment is lower than the technology assessment

indicator. This happens because in the assessment of the science indicators the material presented and the real-world situation have not been realized properly. contains a mathematical basis that underlies product design and mathematical components can trigger the emergence of data literacy skills. The science indicator assessment is lower than the technology assessment indicator. This happens because in the assessment of the science indicators the material presented and the real-world situation have not been realized properly.

6. Aiken's V Validity Test Results

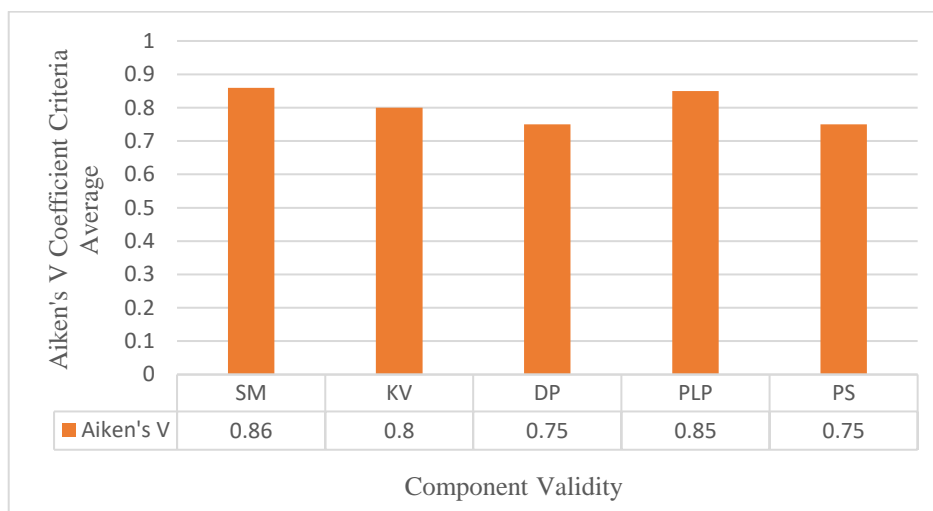


Figure 2. Aiken's V Analysis Results

From the data in Figure 1, it can be seen that all components have high Aiken's V criteria with several 0.80. The material substance component has Aiken's V coefficient criterion which is greater than the other assessed components. This suggests that STEM-based ICT-based worksheet are feasible to use because they have material that is from the 2013 curriculum learning.

B. Discussion

The results of this research will lead to ICT-based worksheet products for STEM that integrate work and energy to improve knowledge, data literacy, and technology literacy. The tool used in this study was a validation sheet consisting of five components including tangible material feasibility, visual communication representation, learning design, learning software, and STEM assessment. The analysis results for each component show valid categories. According to Saifuddin, a product is considered valid if the category exceeds 0.61 [30]. This is consistent with previous research, where his STEM-based e-modules developed received positive responses from students and were rated in the "highly feasible" category [31]. Asrizal research states that STEM-integrated e-learning materials can be applied to online and online learning, with an 88.0 effectiveness test in the high category [32]. In a similar study by Sunarti, the materials were developed in the form of e-learning materials with characteristics of his STEM content such as science, technology, engineering, and mathematics, with Aiken's average of verified validity [23]. I found it based on the validity of his Aiken'V a value of 0.92. In addition, Pratiwi declared that his STEM-based e-book, developed to train science literacy, was highly feasible with valid criteria he obtained 92.56% validation results. It is said that it was done [24]. Therefore, ICT-based worksheet products are effective in STEM teaching materials that integrate work and energy to improve knowledge, data literacy, and technology literacy. Using her ICT-based worksheets for STEM-integrated work and energy materials, the researchers hope they can be used in learning processes to improve students' knowledge, data literacy, and technology literacy.

This research has limitations in product development. The first limitation on product development. STEM-based ICT-based worksheet for work and energy materials to improve students' knowledge, data literacy, and technological literacy only until validity. The development stage includes validity, practicality, and effectiveness. The researcher hopes that further research can be developed to the stage of effectiveness.

A second limitation concerns the materials developed. STEM-based ICT-based worksheet are developed specifically for labor and energy materials. Through further research, researchers hope to develop STEM-based ICT-based worksheet to improve their knowledge of other materials, data literacy, and technical literacy.

A third limitation of literacy. The developed STEM-based ICT-based worksheet measures only data literacy and technology literacy. The new literacy skills consist of data literacy, technology literacy, and human literacy. The researchers hope future studies can develop his STEM-based ICT-based worksheets to measure other skills.

The fourth limitation on the software used. STEM-based ICT-based worksheet for work and energy materials to improve knowledge, data literacy, and technology literacy developed using the Flip PDF Professional application. The products produced in this application are only limited to flipbooks. Researchers hope that further research can develop STEM-based ICT-based worksheet by using applications that are more interactive for learning.

IV. CONCLUSION

Based on the results and discussions, the development of an ICT-based worksheet for STEM work and energy materials integrated to improve data literacy and human literacy was validated and supported by Aiken's validity test. It is concluded that it is applicable based on His V formula by UNP Physics Lecturer. The average material-to-substance ratio is 0.86, one of the high standards. The visual communication indicator component has an average score of 0.80, which is included in the high standards. The learning design component and his STEM score averaged 0.75, which is among the fairly high standards. Additionally, educational software components have a mean score of 0.85 and are included in the high standard. Efficacy test results averaged 0.80, included in the high standards. This research has limitations in product development such as material on the product, the product only until validity, literacy skills, and software used. The researcher hopes the future research can be developed to the stage of effectiveness, other materials, measure other skills, and can use applications that are interactive for learning.

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REFERENCES

- [1] Puspita. Y, Fitriani. Y, Astuti. S, & Novianti. S, "Selamat Tinggal Revolusi Industri 4.0, Selamat Datang Revolusi Industri 5.0," In *Prosiding Seminar Nasional Program Pascasarjana Universitas PGRI Palembang*, 2020.
- [2] Lase. D, "Pendidikan Di Era Revolusi Industri 4.0. *Sundermann*," *Jurnal Ilmiah Teologi, Pendidikan, Sains, Humaniora dan Kebudayaan*, 12(2), 28-43, 2019.
- [3] Putriani. J. D, & Hudaidah. H, "Penerapan Pendidikan Indonesia Di Era Revolusi Industri 4.0," *Edukatif: Jurnal Ilmu Pendidikan*, 3(3), 830-838, 2021.
- [4] Anggraeni. H, "Penguatan Blended Learning Berbasis Literasi Digital Dalam Menghadapi Era Revolusi Industri 4.0," *Al-Idarah: Jurnal Kependidikan Islam*, 9(2), 190-203, 2019.
- [5] Azis. T. N, "Strategi Pembelajaran Era Digital," In *The Annual Conference on Islamic Education and Social Science* (Vol. 1, No. 2, pp. 308-318), 2019.
- [6] Suhendi. H. Y, "Profil Kemampuan Literasi Teknologi Peserta Didik Sekolah Menengah Atas Di Kota Bandung", *Journal of Teaching and Learning Physics*, 2(2), 1-6, 2017.
- [7] Anggaira. A. S, "Literasi Terkini Dalam Pembelajaran BIPA Pada Era Revolusi Digital," In *Prosiding Seminar Nasional Program Pascasarjana Universitas PGRI Palembang* (Vol. 12, No. 01), 2019.
- [8] Nida'ul Khairiyah. S. P., *Pendekatan Science, Technology, Engineering Dan Mathematics (STEM)*, SPASI MEDIA, 2019.
- [9] Rusyati. R, Permanasari. A, & Ardianto. D, "Rekonstruksi Bahan Ajar Berbasis STEM Untuk Meningkatkan Literasi Sains Dan Tekonologi Siswa Pada Konsep Kemagnetan," *Journal of Science Education and Practice*, 2(2), 10-22, 2019.
- [10] Salirawati. D, *Penyusunan dan Kegunaan LKS dalam Proses Pembelajaran*, UNY, 2004.
- [11] Astari. T, "Pengembangan Lembar Kerja Siswa (LKS) Berbasis Pendekatan Realistik Untuk Meningkatkan Hasil Belajar Siswa SD Kelas IV," *Jurnal Pelangi*, 9(2), 2017.
- [12] Fitriani. A, Lubis. R, & Maningsih. S. A, "Analisis Kebutuhan (Need Analysis) Untuk Pengembangan Lembar Kerja Siswa (LKS) Dengan Bantuan Digital Mind Maps.," *Bioedukasi (Jurnal Pendidikan Biologi)*, 13(1), 92-96, 2022.

- [13] Dehani. S. K, Nurcahyono. N. A, & Imswatama. A, "Pengembangan E-LKS Ragamatika untuk Meningkatkan Kemampuan Representasi Matematis Siswa SMP," *Jurnal Cendekia: Jurnal Pendidikan Matematika*, 5(2), 1537-1547, 2021.
- [14] Ramadhani. A, Setiawan. D, Mahanal. S, Priambodo. B, & Amalia. E, "Analisis Analisis Masalah Pembelajaran dan Literasi Teknologi Siswa SMA Laboratorium UM Malang sebagai Dasar Pengembangan Media," In *Prosiding Seminar Nasional IKIP Budi Utomo* (Vol. 2, No. 01, pp. 413-421), 2021.
- [15] Subakti. D. P, Marzal. J, & Hsb. M. H. E, "Pengembangan E-LKPD Berkarakteristik Budaya Jambi Menggunakan Model Discovery Learning Berbasis STEM Untuk Meningkatkan Kemampuan Berpikir Kreatif Matematis," *Jurnal Cendekia: Jurnal Pendidikan Matematika*, 5(2), 1249-1264, 2021.
- [16] Sanders. M, "STEM, STEM education, STEM mania". *The Technology Teacher*, 68(4), 20-26, 2009.
- [17] Sartika. D, "Pentingnya Pendidikan Berbasis STEM Dalam Kurikulum 2013," *JISIP (Jurnal Ilmu Sosial dan Pendidikan)*, 3(3), 2019.
- [18] Asrizal. A, Zan. A. M, Mardian. V, & Festiyed. F, "The Impact of Static Fluid E-Module by Integrating STEM on Learning Outcomes of Students," *Journal of Education Technology*, 6(1), 2022.
- [19] Kelley. T. R, & Knowles, J. G., "A Conceptual Framework For Integrated STEM Education," *International Journal of STEM education*, 3(1), 1-11, 2016.
- [20] Syaripudin. A, & dkk, *Kerangka Literasi Digital Indonesia*. Jakarta: ISBN, 2016.
- [21] Haryono. S, *Re-Orientasi Pengembangan Sdm Era Digital Pada Revolusi Industri 4.0*, Universitas Muhammadiyah Yogyakarta, 2018
- [22] Ningrum. Y. S, & Wulandari. R, "Korelasi Implementasi Pembelajaran IPA Daring Terhadap Literasi Teknologi Siswa Di Kelas VIII SMP," *JPPS (Jurnal Penelitian Pendidikan Sains)*, 10(1), 1889-1898, 2020.
- [23] Sunarti. S, & Rusilowati. A, "Pengembangan Bahan Ajar Digital Gerak Melingkar Berbantuan Scratch Berbasis Science, Technology, Engineering, and Mathematics," *UPEJ Unnes Physics Education Journal*, 9(3), 284-290, 2020
- [24] Pratiwi. R. S, & Rachmadiarti. F, "Pengembangan E-Book Berbasis Science, Technology, Engineering, and Mathematics (Stem) Materi Pertumbuhan dan Perkembangan Tumbuhan untuk Melatihkan Keterampilan Literasi Sains," *Berkala Ilmiah Pendidikan Biologi (BioEdu)*, 11(1), 165-178, 2022.
- [25] Chania. D. M. P, Medriati. R, & Mayub. A, "Pengembangan Bahan Ajar Fisika Melalui Pendekatan STEM Berorientasi HOTS pada Materi Usaha dan Energi," *Jurnal Kumparan Fisika*, 3(2 Agustus), 109-120, 2020.
- [26] Sugiyono, *Metode Penelitian Pendidikan (Pendekatan Kuantitatif, Kualitatif dan R&D)*. Bandung: Alfabeta, 2016.
- [27] Djidu. H, & Jailani. J, "Developing Problem Based Calculus Learning Model," *Jurnal Kependidikan: Penelitian Inovasi Pembelajaran*, 2(1), 68-84, 2018.
- [28] Sunarti. S, & Rusilowati. A, "Pengembangan Bahan Ajar Digital Gerak Melingkar Berbantuan Scratch Berbasis Science, Technology, Engineering, and Mathematics," *UPEJ Unnes Physics Education Journal*, 9(3), 284-290, 2020.
- [29] Febriandi. R. F, Susanta. A. S, & Wasidi. W. W, "Validitas LKS Matematika Dengan Pendekatan Sainifik Berbasis Outdoor Pada Materi Bangun Datar," *Jurnal Pembelajaran Dan Pengajaran Pendidikan Dasar*, 3(1), 148-158, 2020.
- [30] Saifuddin. A, *Reabilitas dan Validitas*. Yogyakarta: Pustaka Pelajar, 2012.
- [31] Umbara. D. M. A, "Pengembangan E-Modul Berbasis Stem Untuk Meningkatkan Hasil Belajar Siswa Pada Materi Limbah Hasil Hewani," *Jurnal Pendidikan*, 13(1), 32-50, 2022.
- [32] Asrizal. A, Mardian. V, Festiyed, "The Validity of STEM Integrated Electronic Learning Material on Elasticity Material to Improve Students' 21st Century Skills," In *Journal of Physics: Conference Series* (Vol. 2309, No. 1, p. 012065), IOP Publishing, 2022.