13 (3) (2024) 239-247

Unnes Science Education Journal

Accredited Sinta 2

https://journal.unnes.ac.id/journals/usej

Effectiveness of PjBL-STEM Based Edukit Biocomposter Learning Media on Environmental Pollution Materials to Train the Creativity of VII Grade Junior High School Students

Adinda Hanif Diastuti, Erti Hamimi✉

DOI: http://dx.doi.org/10.15294/usej.v13i1.9918

Universitas Negeri Malang, Indonesia

Article Info

Submitted 2024-09-27
Revised 2024-11-28
Accepted 2024-12-30

Keywords

Edukit Biocomposter; Environmental Pollution; Creativity; Learning Media; PjBL-STEM

Abstract

21st century education requires students to develop thinking skills, one of which is creative thinking. One learning model that can be used to train creative thinking skills is PjBL-STEM with educational media. This research aims to measure the effectiveness of the biocomposter edukit PjBL-STEM based in training students creativity in environmental pollution material. The development model used is quantitative research method which displays details of data collection and analysis to measure the effectiveness of edukit in improving creativity skill. Quantitative data were obtained from media and material validation, teacher and student practicality tests, as well as limited effectiveness tests using the result scores from the pretest and posttest questions. While qualitative data obtained from teacher interviews. Data collection techniques using interviews, questionnaires, and questions. Data analysis techniques were carried out using descriptive qualitative and percentage analysis. The pretest and posttest results in this study showed a difference, the pretest data with a significance value of 0.219 and the posttest data with a significance value of 0.138. Based on the results of expert validation, practicality tests, and limited effectiveness tests, it can be concluded that the PjBL-STEM based biocomposter is very feasible, practical, and effective for use in class VII environmental pollution materials to train creative thinking skills.

How to Cite

Diastuti, A.H., & Hamimi, E. (2024). Effectiveness of PjBL-STEM Based Edukit Biocomposter Learning Media on Environmental Pollution Materials to Train the Creativity of VII Grade Junior High School Students. *Unnes Science Education Journal*, 13(3), 239-247.

✉ Correspondence Author:
E-mail: erti.hamimi.fmipa@um.ac.id

p-ISSN 2252-6617
e-ISSN 2502-6232

INTRODUCTION

A very important human need today is education, because it aims to prepare superior human resources for nation building. The independent curriculum was developed with the hope of producing young people who have thinking skills including critical thinking, creativity, and problem solving (Indarta et al., 2022). To fulfil 21st century skills can be done by updating the quality of education, increasing student engagement and motivation, emphasis on problem/project learning, stimulating creativity and innovation in learning by designing learning activities that are relevant to the real world (Jayadi et al., 2020).

In the current 21st century, students must have 4C skills including creative thinking, critical thinking, communication, and collaboration (Septikasari, 2018). Creativity in the 21st century has an important position in improving the quality of education in all fields of learning (Mardhiyah et al., 2021). However, in reality the level of student creativity is still very low in Indonesia. This is reinforced by data by TIMSS in 2015, referring to Indonesia's science achievement which ranks 44th out of 49 countries with an average score of 397 (Martin, 2015). In addition, based on the results of the Global Creativity Index study in 2015, Indonesia was ranked 115 out of 139 participating countries, this shows the low creativity of students (Global Creative Index, 2015), which is evidenced by data from the Global Innovation Index (GII) in 2022, the level of innovation owned by the State of Indonesia is ranked 75th, which is very different from other ASEAN countries such as Malaysia and Singapore which are in the top position (Dutta et al., 2022). According to Wiyono (2020), innovation can be realised if there is high enough creativity (Wiyono, 2020). This further strengthens that the level of creativity of students in Indonesia is still low. Student creativity has not been developed much in schools, even though solving complex problems requires high creativity in order to get the right solution (Wulandari et al., 2019).

So far, learning in schools has mostly referred to textbooks that seem theoretical and do not involve students directly to improve creative thinking skills (Amirudin et al., 2017). Therefore, to attract students attention, it is necessary to make innovations in learning, one of which is through learning media (Wicaksono et al., 2020). One of the things that plays a role in supporting the quality of the teaching and learning process in the classroom is learning media. Learning becomes more interesting and fun when using interesting learning media. The development of technology today, in accordance with the rapid development of the times, requires the ability to innovate in designing an appropriate learning environment from teachers (Firmadani, 2021). Edukit can be one solution to fullfil the learning media needed by students. A practicum kit or edukit is a series of tools that are smaller than the tools usually available in the laboratory (Harahap, 2019). This is because edukit can be a vehicle for simulation to run something in real life and be able to give students an overview and describe complicated processes to be more easily understood (Kusdiyanti et al., 2021).

For this reason, teachers need to prepare creative, meaningful and innovative learning designs, one of which is the STEM approach model so that learning objectives can be achieved (Oktapiani & Hamdu, 2020). The STEM approach is a learning innovation in the 4.0 era with a combination of learning from various fields of science disciplines including science, technology, engineering, and mathematics into one overall curriculum (Izzati et al., 2019). The benefits of the STEM approach are that students become good problem solvers, innovative, independent, logical, and technologically savvy (Maulana et al., 2020).

The PjBL (Project Based Learning) learning model can be used to complement learning that uses the STEM approach. This is because the PjBL learning model focuses on contextual learning by providing complex activities such as giving students the freedom to research, explore, observe, design projects, collaborate on projects, and produce a product (Jauhariyyah & Suwono, 2017). PjBL-STEM integrated project-based learning is project-based learning by connecting it to contextual learning through the integration of STEM fields (Furi et al., 2018). The characteristics of PjBL are largely similar to PjBL-STEM, but PjBL-STEM focuses on the Design process. Developing a solution to a problem through a structured approach is called the Design process. The PjBL-STEM learning process in guiding students consists of five phases aimed at specific processes, these stages are reflection, research, discovery, application, and communication (Vargas Alfonso, 2015).

The material presented in this PjBL-STEM-based biocomposter edukit is environmental pollution material. This material is closely related to the application of knowledge to students daily environment, making it easier to analyse and plan environmental and technological problems in the environment (Handayani et al., 2021). To train students ability to solve problems

through a project can use project-based learning that is integrated with many disciplines such as science, engineering, mathematics, and technology on environmental pollution material. This is very likely because it can provide meaningful learning for students (Aninda et al., 2020).

Based on observations at one of the State Junior High Schools in Malang Regency, it was found that teachers still find many obstacles and rarely use innovative learning models by encouraging students to play an active role in problem solving. This is reinforced by field studies that 64% of students find it difficult to understand environmental pollution material, 68% of students find it easier to understand ecosystem material through trials and observations, and 72% of students need interesting learning media. In addition, 76% of students stated that teachers still deliver learning materials by lecturing. Many students still cannot translate science learning into the reality around them because learning still does not emphasise thinking skills, especially creative thinking. Students only memorise the theory given by the teacher. Therefore, in order for students to achieve their maximum potential in creative thinking skills, the learning that takes place must emphasise the development of higher order thinking skills.

Previous research conducted by Hidayani et al. (2020), stated that contextualised environmental pollution problems can contribute to students' creative thinking. However, this research has not used the PjBL-STEM learning model in encouraging students' creative thinking skills. According to Cholisoh's research (2019), it states that learning carried out using the PjBL-STEM learning model can improve students' creative thinking skills with moderate categories in thermodynamic material (Wulandari et al., 2019). The research has not yet implemented learning using education on environmental pollution material. According to research by Putra et al., (2022), states that making biocomposters using used goods gets high enthusiasm from students. However, this research has not been applied as a learning media and has not used the PjBL-STEM model. Based on this explanation, a research was conducted entitled "Development of PjBL-STEM Based Edukit Learning Media on Environmental Pollution Material to Train the Creativity of Grade VII Junior High School Students". This study aims to produce PjBL-STEM-based biocomposter edukit that is feasible and practical and to determine the effectiveness in training students' creativity in environmental pollution material.

METHOD

This research is a type of quantitative research method which displays details of data collection and analysis to measure the effectiveness of edukit in improving creativity skill. The data used in this study are quantitative and qualitative data. Quantitative data is obtained from the scores given by validators on media validation and material validation. In addition, quantitative data were also obtained from teacher and student practicality tests and limited effectiveness tests using the results of pretest and posttest questions. The assessment criteria for validation and practicality tests were carried out using a Likert scale which can be seen in Table 1.

Table 1. Likert Scale Assessment Criteria

Score	Criteria
4	Strongly Agree
3	Agree
2	Disagree
1	Strongly Disagree

To ensure the material regarding the correctness of the concept of biocomposter education, material validation was carried out with a Guttman scale score of 1 means "Yes" and 0 means "No". Regarding qualitative data obtained from teacher interviews and comments and suggestions given by validators on expert validation as well as teachers and students in the readability test. Data collection techniques were conducted through interviews, questionnaires, and tests. The instruments used were interview sheets, needs analysis questionnaires and questionnaires on media expert validation sheets, material expert validation sheets, teacher and student practicality test sheets to measure the validity of the edukit, as well as pretest and posttest questionnaires in measuring student creativity.

$$P = \frac{\Sigma X}{X\,max} x100\%$$

Information:

P : Questionnaire feasibility score for each aspect

Σx : Total score obtained

N : maximum score

Source: (Novianti & Susilowibowo, 2015)

The effectiveness test is a test or assessment carried out as a measure of the success rate of media use (Fitra & Maksum, 2021). The limited effectiveness test of STEM-based biocomposter education was carried out using pretest and posttest. The PjBL-STEM learning process in guiding students consists of five phases aimed at

specific processes, these stages are reflection, research, discovery, application, and communication (Vargas Alfonso, 2015).

The data obtained are in the form of creative thinking ability test results which are processed by calculating the percentage of the scores obtained by students on each creative thinking ability indicator which is interpreted as follows: (Effendi, 2017).

Table 2. Interpretation of Students' Creative Thinking Levels

Percentage	Interpretation
81% - 100%	Very good
61% - 80%	Good
41% - 60%	Enough
21% - 40%	Not enough
0% - 20%	Very less

In this study, the effectiveness test was carried out in class VII with 32 students. There were 5 question items with each question presenting readings related to problems around based on Torrance's creative thinking indicators. The questions contain indicators of originality, fluency, flexibility, and elaboration. In the pretest and posttest questions, the same questions were given, only different in the topic or problem that occurred. The pretest and posttest results were analysed using the normality test to determine the normality of the data and the paired sample T test to determine the difference in values using SPSS Statistic 23.0. If the significance result is obtained> 0.05 in the normality test, it means that the distribution is normal (Oktaviani, 2014). Then if the paired sample T Test test gets a significance value of 0.000 <0.05 then there is a difference between the pretest and posttest results. After conducting the paired sample T Test test, the next step is to conduct the N-gain test on each indicator before and after learning to determine the effectiveness of the media used. The hypothesis tested is as follows:

H_0: There is no significant difference in students' creative thinking skills before and after learning using Edukit Biocomposter media.

H_a: There is a significant difference in students' creative thinking skills before and after learning using Edukit Biocomposter media.

After it was stated that there was an effect or difference, the N-gain test was continued to be calculated to determine the level of effectiveness before and after learning using PjBL-STEM based biocomposter education media. The formula equation used to determine N-gain is as follows.

$$Normal\ Gain = \frac{Skor\ Posttest - Skor\ Pretest}{Skor\ Ideal - Skor\ Pretest}$$

With the results of the N-gain calculation can be represented as in the table below. According to Wahab et al. (2021), the criteria for the N-gain level as follows can be seen in Table 3.

Table 3. N-gain Level Criteria

Average	Criteria
$g > 0,7$	High
$0,3 \leq g \leq 0,7$	Medium
$0 < g < 0,3$	Low
$g \leq 0,7$	Failed

RESULT AND DISCUSSION

In this study, the product developed is a PjBL-STEM-based biocomposter kit on environmental pollution material to train the creativity of seventh grade students. This PjBL-STEM-based biocomposter edukit is equipped with teaching modules which include Interactive Worksheet (LKPD), handouts, and guidebooks. The results of the design stage are the design of a biocomposter that will be adjusted to the material, packaging design, and design of learning tools. The design of educational products can be seen in Figure 1.

Figure 1. Biocomposter education design and packaging

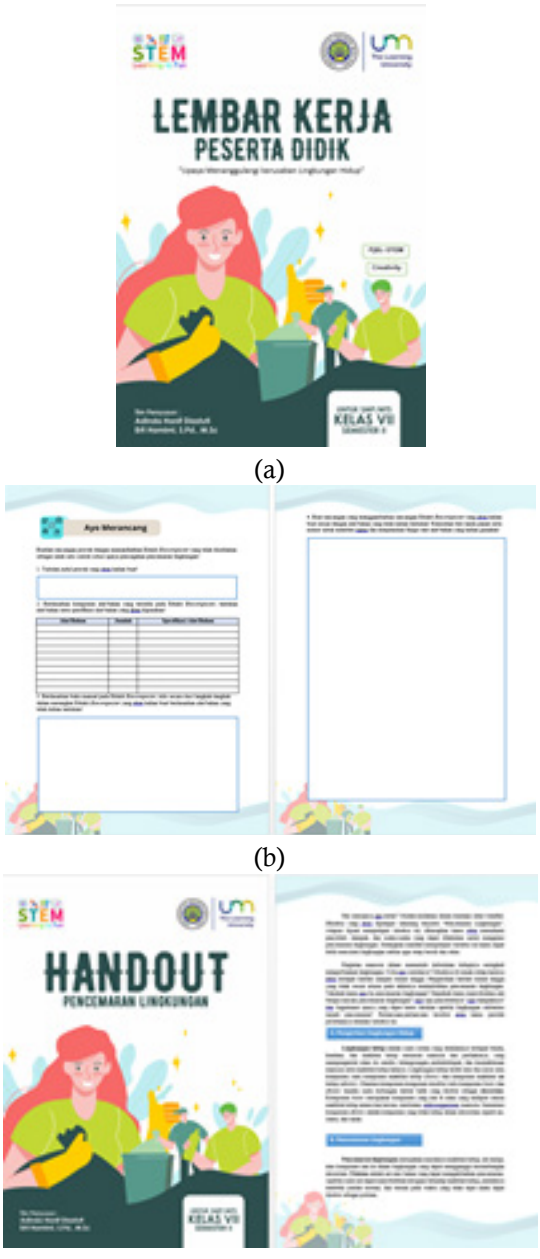
In the assembly of educational components consisting of biocomposter containers, pipes, pipe filters as a separator between solid and liquid fertiliser, taps as a place for the release of liquid fertiliser in one unit so that it can be used in making compost. The biocomposter education product is equipped with supporting compo-

nents, namely an instruction manual, bioactivator liquid to accelerate the fertiliser process, burnt husks, a set of shovels, and a pH meter to measure the quality of the fertiliser. In addition, at this stage also developed learning tools in the form of LKPD based on PjBL-STEM, handouts, and packaging made using thick cardboard material measuring 30x30 cm and designs tailored to environmental pollution material.

The biocomposter Edukit circuit is carried out by installing a filter to separate liquid and solid fertiliser. Then install the connecting pipe and install the pipe on the right and left side of the hole which is then composted with the materials provided and then closed. In training students' creativity, this product is designed to be able to make organic fertiliser from several treatments by combining the ratio between green, brown, burnt husk, and bioactivator components. The STEM aspects of the biocomposter edukit media are in the science aspect, namely the application of waste recycling to prevent environmental pollution, the technology aspect, namely sustainable agricultural technology in making compost, the engineering aspect, namely the method used to assemble the edukit to be functional, and the mathematics aspect, namely measuring the composition of the materials used in making biocomposter. The biocomposter edukit is also equipped with a manual book which contains a brief explanation of the edukit, components contained in the edukit, tools and materials, and usage procedures.

In the PjBL-STEM-based edukit LKPD there are also several aspects, namely "Let's Think", "Let's Search", "Let's Design", "Let's Try", and "Let's Present". These aspects are used to train students' creativity when learning by using PjBL-STEM-based biocomposter edukit. The LKPD that was prepared was adjusted based on the syntax of PjBL-STEM and indicators of creative thinking skills. In addition, there are handouts that are used to provide learning material assistance to students. Handouts are prepared containing material related to environmental pollution taken from sources that have been proven to be true. LKPD and biocomposter educational handout can be seen in Figure 2.

The fourth stage is implementation. This stage was conducted in one of the VII classes at SMPN 1 Pakisaji with a total of 32 students. The implementation of the PjBL-STEM learning model was observed for two meetings. In addition to the practicality of the product that has been carried out by teachers and students, direct learning assessment is also carried out in the field by observers. This learning assessment was carried out by two observers, namely science education students.



(a)

(b)

(c)

Figure 2. LKPD and handout: a) Cover LKPD; b) Activities to practise creative thinking; c) Handout

The results of the learning assessment obtained an average score of 100%, these results interpret that each syntax of PjBL-STEM is implemented properly and coherently. This is also in accordance with the validation results that the biocomposter educational media products developed have fulfilled the aspects of product feasibility, teaching module feasibility aspects,

presentation feasibility aspects, concept correctness aspects, usage aspects, linguistic aspects, and aspects of media suitability for the PjBL-STEM learning model. The implementation of each stage of the PjBL-STEM learning model is presented in Table 4.

Table 4. Implementation of Each Stage of the PjBL-STEM Learning Model

No	Aspects Observed	Applicability
1	Reflection	100%
2	Research	100%
3	Discovery	100%
4	Application	100%
5	Communication	100%

The results of the implementation stage are the pretest and posttest scores from the limited effectiveness test. The results of the pretest and posttest scores were tested for normality using the Shapiro-Wilk test. The pretest data with a significance value of 0.219 is greater than 0.05 and the posttest data with a significance value of 0.138 is greater than 0.05. The normality test if the significance result is obtained> 0.05, it means that the data is normally distributed (Oktaviani, 2014). Therefore, the two data are normally distributed so that they can be directly tested in the paired sample T test. The paired sample T test serves to determine the effectiveness of the treatment to students which is indicated by the difference in the average pretest and posttest scores. If the calculation results obtained sig value. (2-tailed) <0.05 from the paired sample T Test test, it can be concluded that in the pretest and posttest data there are differences in student creativity scores. So it can be concluded based on the paired sample T-Test test on PjBL-STEM-based biocomposter education is stated to be able to increase the creativity of seventh grade students.

Based on the results of the table above, it is found that the T-count> T table is 10.685> 2.042 so it can be interpreted that there is a difference in the value of student creativity before and after being given biocomposter education treatment. In the table above, T count is negative, this is because the posttest value is greater than the pretest. For the level of significance in the study, the sig. 0.000 means it has a high level of significance because sig is less than 0.05.

The N-Gain test was conducted to determine the effectiveness of biocomposter education in learning. Based on the N-Gain test conducted, the average of all indicators was 0.45 with moderate criteria. The table of N-Gain test results for each indicator can be seen in Table 5.

Table 5. N-Gain Test Calculation Results

Indicators	N-Gain	Criteria
Originality	0.47	Medium
Fluency	0.40	Medium
Flexibility	0.51	Medium
Elaboration	0.54	Medium
Average	0.45	Medium

Originality is the ability to create unique and original thoughts or ideas to solve a problem (Handayani et al., 2021). The pretest results of originality obtained a percentage of 49.61% while in the posttest it was 75%. The N-gain test results show a medium effectiveness criterion of 0.47 because it has trained originality to students by providing stimulation through LKPD. In the PjBL-STEM-based biocomposter educational LKPD in the "Let's Think" aspect, students are given readings and data related to environmental damage to train originality indicators to students. Students are asked to write down information in the reading and ideas or solutions to problems about environmental damage caused by waste with their own sentences based on their thoughts by combining learning concepts obtained by students during learning. This is in accordance with the research of Firdausi et al. (2018), stating that the originality indicator can be trained to students by giving a problem and then students are required to find ways to solve the problem with new and innovative solutions that have not been thought of before.

Fluency is the ability to generate many ideas and come up with more than one way or suggestion or question smoothly (Pertiwi & Rosidin, 2017). The pretest results of fluency obtained a percentage of 85.94% while in the posttest it was 93.75%. The N-gain test results show criteria with moderate effectiveness of 0.40 because it has trained fluency to students by providing stimulation through LKPD. In the biocomposter educational LKPD based on PjBL-STEM in the "Let's Design" aspect, students are asked to design a project from the problem of environmental pollution caused by organic waste. Based on student answers, students can design ideas well because in learning there are videos to motivate students to be more interested in completing projects. This is in accordance with Hendriyani's research (2020), which states that audio-visual media such as videos can help convey information,

increase students' understanding and creativity. Through this media, students can better express various ideas because of the motivation from the learning tools.

Flexibility is the ability to generate different ideas, answers, and questions from different perspectives (Handayani et al., 2021). The pretest results of flexibility obtained a percentage of 53.91% while in the posttest it was 80.47%. The N-gain test results show criteria with moderate effectiveness of 0.51 because it has trained flexibility to students by providing stimulation through LKPD. In the PjBL-STEM-based biocomposter edukit LKPD in the "Let's Try" aspect, students are asked to compare the results of several treatments of biocomposter edukit that have been assembled based on their point of view so that it allows students to see the differences between these treatments. In the flexibility question, some students have been able to provide solutions to problems that occur using various points of view. In this indicator question, it has been trained when using components with various comparisons to produce compost fertiliser. This is in accordance with the research of Firdausi et al. (2018), stating that flexibility of thinking is a basic ability in comparison skills to see similarities and differences possessed by two or more observed objects.

Elaboration is the competence to develop an idea and detail the details of an object or idea to make it more interesting (Handayani et al., 2021). The pretest results of elaboration obtained a percentage of 30.47% while in the posttest it was 68.75%. The N-gain test results show criteria with moderate effectiveness of 0.54 because it has trained elaboration to students by providing stimulation through LKPD. In the PjBL-STEM-based biocomposter education LKPD in the "Let's Design" aspect, students are asked to provide a detailed description and explanation of the idea of their biocomposter education design. Based on the results of student answers in general, students are able to elaborate on each answer so that the ideas developed are more understandable. This is in accordance with the research of Firdausi et al. (2018), stating that the high ability of elaboration thinking is seen from the right answer with clear, elaborative, and detailed explanation (Firdausi & Asikin, 2018).

Based on the results of the N-gain value on the creativity indicator, the lowest of the other 3 indicators is the fluency indicator of 0.40 with moderate criteria. This is because the answers given by students during the pretest have been able to provide several solutions related to the problem. This is in accordance with the research of Islami et al. (2018), stating that the fluency indicator will be low when students have not been able to answer questions with many ideas. This is also in accordance with the practicality test conducted on 32 students stating that 87.50% of students were able to mention many solutions related to the problems that occurred. Meanwhile, the N-gain value of the highest creativity indicator of the other 3 indicators is the elaboration indicator of 0.54 with moderate criteria. This is because during the learning process, students find problem solving from environmental problems and conduct experiments using edukit to be able to examine the details of the steps taken to expand their ideas. This is reinforced by the research of Layyina et al. (2021), that the elaboration indicator can increase because students are trained to detail answers by doing detailed things such as designing an experiment. In answering problems, students are more capable of enriching ideas in detail than answering by revealing new things (Sari et al., 2013). Based on the comparison of the average pretest and posttest after learning with PjBL-STEM-based biocomposter edukit, students have additional knowledge so that it is found that in the effectiveness test carried out there is an increase in posttest scores.

Based on the results of the study in general, students have been able to solve problems related to problems that occur around, but not yet optimal because they are not used to thinking creatively. Therefore, it is necessary to have repeated learning so that students' creative thinking skills can continue to improve and students are accustomed to creative learning. One of them is by using PjBL-STEM-based biocomposter education. The advantage of PjBL-STEM-based edukit is that it is able to train the creative thinking process in students with complete learning tools so that it can keep up with the development of learning in the 21st century.

CONCLUSION

One of the skills that students must have in the 21st century is creativity which can be improved through the development of PjBL-STEM-based biocomposter education on environmental pollution material. The development that has been carried out obtains edukit products that can be used for learning. The biocomposter edukit has the characteristic that the product is in accordance with the syntax of PjBL-STEM which is all implemented during the learning process. PjBL-STEM has 5 syntaxes, namely reflection, research, discovery, application, and communication.

This is because based on media validation, material, teacher and student practicality tests, the results are very feasible for the products developed. Based on the results of the paired sample T test, it states that there is a difference between the pretest and posttest results. Edukit biocomposter is quite effective if used in learning based on the results of the average posttest score (77.47) > the average pretest score (50) with the N-gain value obtained on average from all indicators is 0.45 with moderate criteria so that the product can be declared feasible, practical, and effective for use in learning environmental pollution class VII.

ACKNOWLEDGMENT

Thanks to PNBP UM with contract number 5.4.472/UN32.20.1/LT/2023 for helping fund this research through the Thesis Grant Fund and to Mrs. Dr. rer.nat. Safwatun Nida, M.Pd as a material expert validator, Mr Muhammad Fajar Marsuki, S.Pd., M.Sc as a media expert validator, Mr Fajar Sidi Paripurna, S.Pd as a science teacher, and SMP Negeri 1 Pakisaji students who have helped in the practicality test and limited effectiveness test.

REFERENCES

Al Hakim, R., Mustika, I., & Yuliani, W. (2021). VALIDITAS DAN RELIABILITAS ANGKET MOTIVASI BERPRESTASI. *FOKUS (Kajian Bimbingan & Konseling dalam Pendidikan)*, 4(4), 263. https://doi.org/10.22460/fokus.v4i4.7249

Amirudin, A., & Widiati, U. (2017). Pentingnya Pengembangan Bahan Ajar Tematik untuk Mencapai Pembelajaran Bermakna bagi Siswa Sekolah Dasar. *In Prosiding Seminar Nasional Mahasiswa Kerjasama Direktorat Jenderal Guru dan Tenaga Kependidikan Kemendikbud 2016*.

Aninda, A., Permanasari, A., & Ardianto, D. (2020). Implementasi Pembelajaran Berbasis Proyek pada Materi Pencemaran Lingkungan untuk Meningkatkan Literasi STEM Siswa SMA. *Journal of Science Education and Practice*, 3(2), 1–16. https://doi.org/10.33751/jsep.v3i2.1719

Dutta, S., Lanvin, B., Wunsch-Vincent, S., León, L. R., & World Intellectual Property Organization. (2022). *Global innovation index 2022: (Subtitle) /*. 2022. https://doi.org/10.34667/TIND.46596

Effendi, K. N., & Farlina, E. (2017). Kemampuan berpikir kreatif siswa SMP kelas VII dalam penyelesaian masalah statistika. *Jurnal Analisa,* 3(2), 130-137.

Firdausi, Y. N., & Asikin, M. (2018). Analisis Kemampuan Berpikir Kreatif Siswa Ditinjau dari Gaya Belajar pada Pembelajaran Model Eliciting Activities (MEA). 9.

Firmadani, F. (2021). *Media Pembelajaran Berbasis Teknologi sebagai Inovasi Pembelajaran Era Revolusi Industri 4.0*.

Fitra, J., & Maksum, H. (2021). Efektivitas Media Pembelajaran Interaktif dengan Aplikasi Powntoon pada Mata Pelajaran Bimbingan TIK. *Jurnal Pedagogi dan Pembelajaran*, 4(1), 1. https://doi.org/10.23887/jp2.v4i1.31524

Furi, L. M. I., Handayani, S., & Maharani, S. (2018). Eksperimen Model Pembelajaran Project Based Learning dan Project Based Learning Terintegrasi STEM untuk Meningkatkan Hasil Belajar dan Kreativitas Siswa pada Kompetensi Dasar Teknologi Pengolahan. *Jurnal Pendidikan*, 1.

Handayani, S. A., Rahayu, Y. S., & Agustini, R. (2021). Students' creative thinking skills in biology learning: Fluency, flexibility, originality, and elaboration. *Journal of Physics: Conference Series*, 1747(1), 012040. https://doi.org/10.1088/1742-6596/1747/1/012040

Harahap, N. M. (2019). Pengembangan Alat Peraga KIT Uji Fotosintesis untuk Meningkatkan Aktivitas Belajar Siswa Kelas VIII-6 di MTsN 1 Banda Aceh Tahun Ajaran 2018/2019. *Bioilmi: Jurnal Pendidikan*, 5(1), 1–9. https://doi.org/10.19109/bioilmi.v5i1.3506

Indarta, Y., Jalinus, N., Waskito, W., Samala, A. D., Riyanda, A. R., & Adi, N. H. (2022). Relevansi Kurikulum Merdeka Belajar dengan Model Pembelajaran Abad 21 dalam Perkembangan Era Society 5.0. *EDUKATIF : Jurnal Ilmu Pendidikan*, 4(2), 3011–3024. https://doi.org/10.31004/edukatif.v4i2.2589

Izzati, N., Tambunan, L. R., Susanti, S., & Siregar, N. A. R. (2019). Pengenalan Pendekatan STEM sebagai Inovasi Pembelajaran Era Revolusi Industri 4.0. *Jurnal Anugerah*, 1(2), 83–89. https://doi.org/10.31629/anugerah.v1i2.1776

Jauhariyyah, F. R., & Suwono, H. (2017). Science, Technology, Engineering and Mathematics Project Based Learning. 2.

Jayadi, A., Putri, D. H., & Johan, H. (2020). Identifikasi Pembekalan Keterampilan Abad 21 pada Aspek Keterampilan Pemecahan Masalah Siswa SMA Kota Bengkulu dalam Mata Pelajaran Fisika. J*urnal Kumparan Fisika*, 3(1), 25–32. https://doi.org/10.33369/jkf.3.1.25-32

Kusdiyanti, H., Febrianto, I., & Wijaya, R. (2021). edia Kewirausahaan sebagai Upaya Menumbuhkan Potensi Entrepreneurship.

Layyina, N., Agustini, R., & Indana, S. (2021). Efektifitas perangkat pembelajaran IPA berorientasi model inkuiri untuk melatihkan keterampilan berpikir kreatif siswa. *JPPS (Jurnal Penelitian Pendidikan Sains)*, 10(2), 2005-2015.

Maulana, M. (2020). Penerapan model project based learning berbasis STEM pada pembelajaran fisika siapkan kemandirian belajar peserta didik. *Jurnal Teknodik*, 39-50.

Novianti, D. A., & Susilowibowo, J. (2015). Pengem-

bangan Modul Akuntansi Aset Tetap Berbasis Pendekatan Saintifik Sebagai Pendukung Implemetasi K-13 di SMKN 2 Buduran. 03.

Oktapiani, N., & Hamdu, G. (2020). Desain Pembelajaran STEM berdasarkan Kemampuan 4C di Sekolah Dasar. *Jurnal Ilmiah Pendidikan Dasar*, 7(2), 99. https://doi.org/10.30659/pendas.7.2.99-108

Oktaviani, M. A. (2014). Perbandingan Tingkat Konsistensi Normalitas Distribusi Metode Kolmogorov-Smirnov, Lilliefors, Shapiro-Wilk, dan Skewness-Kurtosis.

Pertiwi, R. S., & Rosidin, U. (2017). Efektivitas LKS STEM untuk Melatih Keterampilan Berpikir Kreatif Siswa.

Prasetyo, M. F., & Prihatnani, E. (2018). PPengembangan Permainan Monomath pada Materi Persamaan Garis Lurus Bagi Siswa Kelas VIII SMP Negeri 10 Salatiga. 5(1).

Rifa Hanifa Mardhiyah, Sekar Nurul Fajriyah Aldriani, Febyana Chitta, & Muhamad Rizal Zulfikar. (2021). Pentingnya Keterampilan Belajar di Abad 21 sebagai Tuntutan dalam Pengembangan Sumber Daya Manusia. *Lectura : Jurnal Pendidikan*, 12(1), 29–40. https://doi.org/10.31849/lectura.v12i1.5813

Sari, W. P., Hidayat, A., & Kusairi, S. (2013). Keterampilan Berpikir Kreatif Siswa SMA dalam Pembelajaran Project Based Learning (Pjbl) pada Materi Fluida Statis.

Septikasari, R., & Frasandy, R. N. (2018). Keterampilan 4c Abad 21 dalam Pembelajaran Pendidikan Dasar. 11.

Stohlmann, M., Moore, T., & Roehrig, G. (2012). Considerations for Teaching Integrated STEM Education. *Journal of Pre-College Engineering Education Research*, 2(1), 28–34. https://doi.org/10.5703/1288284314653

Utami, T. N., Jatmiko, A., & Suherman, S. (2018). Pengembangan Modul Matematika dengan Pendekatan Science, Technology, Engineering, And Mathematics (STEM) pada Materi Segiempat. *Desimal: Jurnal Matematika*, 1(2), 165. https://doi.org/10.24042/djm.v1i2.2388

Vargas Alfonso, D. (2015). Evidence of Critical Thinking in High School Humanities Classrooms. *GiST Education and Learning Research Journal,* 11, 26–44. https://doi.org/10.26817/16925777.281

Wicaksono, A. G., Jumanto, J., & Irmade, O. (2020). Pengembangan media komik komsa materi rangka pada pembelajaran IPA di sekolah dasar. *Premiere Educandum : Jurnal Pendidikan Dasar dan Pembelajaran*, 10(2), 215. https://doi.org/10.25273/pe.v10i2.6384

Wiyono, H. D. (2020). Kreativitas dan Inovasi dalam Berwirausaha. *Jurnal Pendidikan*. 1(2), 19–25. https://doi.org/10.30998/juuk.v1i2.503

Wulandari, A. S., Suardana, I. N., & Devi, N. L. P. L. (2019). Pengaruh Model Pembelajaran Berbasis Proyek Terhadap Kreativitas Siswa SMP pada Pembelajaran IPA. *Jurnal Pendidikan dan Pembelajaran Sains Indonesia (JPPSI),* 2(1), 47. https://doi.org/10.23887/jppsi.v2i1.17222