BIOSFER: JURNAL TADRIS BIOLOGI

Development of STEM-Based Environmental Change Module to Enhance Environmental Literacy

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ABSTRACT

At this time there are many learning modules circulating both printed and electronic (online), however, the development of STEM-based modules that have been carried out does not see the effectiveness of the module. The purpose of this research is to see the validity, practicality and effectiveness of the module. The 4D research methodology (Define, Design, Development, Disseminate) was used. This research was conducted in class X Senior High School. The results showed that the Material Validity Test research obtained 98.57% (Very Valid), the Media Expert Validation Test assessment was 98.6% (Very Valid), the response assessment by the biology teacher was 85% (Practical), the average student response assessment was 86.07% (Practical). The STEM-based environmental change module produced from the research conducted is valid, practical, and effective in increasing the level of environmental literacy among grade X students at Senior High School.

Pengembangan Modul Materi Perubahan Lingkungan Berbasis STEM Untuk Meningkatkan Literasi Lingkungan

ABSTRAK: Pada saat sekarang ini modul pembelajaran sudah banyak beredar baik ditemukan secara cetak maupun juga elektronik (online), walaupun demikian pengembangan modul berbasis STEM yang sudah dilakukan tidak melihat keefektifan dari modul. Tujuan dari penelitian ini adalah untuk melihat validitas, kepraktisan, dan keefektifan modul. Metodologi penelitian 4D (Define, Design, Development, Disseminate) digunakan. Penelitian ini dilakukan pada kelas X SMAS. Hasil penelitian menunjukkan bahwa penelitian Uji Validitas Materi yang diperoleh 98,57% (Sangat Valid), penilaian Uji Validasi Ahli Media adalah 98,6% (Sangat Valid), penilaian respon oleh guru biologi adalah 85% (Praktis), rata-rata penilaian respon siswa adalah 86,07% (Praktis). Modul perubahan lingkungan berbasis STEM yang dihasilkan dari penelitian yang dilakukan adalah valid, praktis, dan efektif dalam meningkatkan tingkat literasi lingkungan di kalangan siswa kelas X di SMAS.

INTRODUCTION

The environment is the place where organisms interact to survive (Siregar & Nasution, 2020). Law of the Republic of Indonesia No. 32 of 2009, states that the environment is a spatial unity of all objects, forces, conditions, and living things including humans and their behavior that affect nature

itself. Human activities have the potential to change natural phenomena, including climate and all current natural events. Protecting the environment is the shared responsibility of the entire community. Human behavior towards the environment can be seen from how behavior in everyday life.

This is the same as the opinion (Suryanda et al., 2020) Behavior that supports environmental sustainability is behavior that practices environmental responsibility. Environmental change is one of the detrimental effects of excessive human activity in meeting their demands. In this situation, environmental responsibility behavior has a significant impact on human behavior and can be assessed using environmental literacy. This is in agreement with (Nopia et al., 2022), the use of pollution materials is a way to preserve the environment.

To achieve an eco-society that is aware of the importance of the environment for human survival, environmental literacy is required. Realizing this is very important because it helps people become more environmentally aware and sensitive, which is necessary to find solutions to existing problems. One such remedy is through environmental education.

One of the examples of environmental problems that occur in Bali due to the advancement of the tourism industry shows the imbalance of social and natural aspects in people's lives. Various factors do influence this occurrence, one of which is education. This is because today's society is the result of a previous and ongoing education system. Therefore, it is necessary to know the effectiveness of the implementation of the environmental education curriculum in schools. One of the efforts that can be made to determine the effectiveness of the implementation of the environmental education curriculum in schools is to measure the level of environmental literacy of students (Agung et al., 2022). This is in agreement with (Sari et al., 2021), the

education process should have good natural resources in order to create quality education.

Based on the interview with the biology instructor at Senior High School Medan, it is known that efforts have been made so far in teaching biology to help students solve environmental problems. Although environmental education has been established, there are still many children with poor attitudes and concerns about environmental literacy.

This is in agreement with the results of research conducted by (Yudha et al., 2020) noting that students' environmental literacy is still inadequate for various reasons, one of which is their lack of interest in learning about and researching environmental issues. It is considered that some students only learn ecology and rarely become aware of local ecological issues. Rachmatika et al., 2021 and Handoko et al., 2021 in his opinion, teachers must be able to create an effective and competent learning environment for their students. Teaching materials that do not support the learning process can also result in students lacking exploration for interaction and knowledge of the environment making problems for students' lack of environmental literacy.

As a result, there is a need for alternative teaching materials that can increase enthusiasm or motivation for learning intentions to improve skills in direct contact with the learning environment. The learning that will be offered by the teacher is directly influenced by the teaching materials (Pareira et al., 2021).

Therefore, the selection of teaching materials is very important. Modules are one of the alternative choices of teaching materials that are in accordance with what is needed. Given the industrial revolution, alternative teaching materials are now needed that can provide students with competencies appropriate for their times.

One of the benefits of using modules can be filled by using problem-based design to address local and global issues, which will

increase environmental literacy (Anita et al., 2020). Efforts that can be made in improving students' environmental literacy can be dealt with by using approaches that help students improve their abilities and support the existing learning process (Aji et al., 2022). One of them is learning biology with the Science, Technology, Engineering, and Mathematics (STEM) approach.

One educational idea known as STEM combines a number of disciplines from the domains of science, technology, engineering and mathematics with the idea of learning implementation (Sartika, 2019). Learning about biology means learning how to learn and understand the environment systematically (Sulistyo, 2018). The use of learning with a STEM approach can make learning by increasing learning and student responsiveness to solving real problems in everyday life. Using STEM in learning can provide opportunities for students to improve and foster collaboration, critical thingking, creative thingking, accountability, perseverance, and leadership that are useful today (Al Fatihah et al., 2022). Learning using Modules with a STEM approach indirectly students in addition to getting the material, students can also improve environmental literacy. This is in agreement with (Allanta & Puspita, 2021), The STEM approach makes students more active and able to solve problems in their lives. (Novitasari et al., 2022) also argue that STEM approaches were developed to produce meaningful learning and improve science literacy.

The development of STEM-based modules has been widely applied, including modules for electrochemical material in class XII (Syahirah et al., 2020) space building material at the SMK level (Hasanah, 2020) and sound material (Syarah Syahiddah et al., 2021). At this time, there are many learning modules circulating both printed and electronic (online), however, the development of STEM-based modules that have been carried out does not see the effectiveness of the module. Thus, the development of this STEM-based Module can

be very helpful for schools, especially students in grade X SMA / MA. Astuti et al., (2021) his research suggests that STEM media use has a successful impact on learning. Adhelacahya (2023) It also argues that it can encourage students to have creativity and literacy in the environment.

In accordance with the problems that have been stated, the purpose of this study is to see the validity, practicality and effectiveness of the module. Therefore, the researcher intends to raise this issue to develop a module on STEM-based environmental change material to improve the environmental literacy of SMA / MA students in biology learning.

METHOD

The 4D model was used in this study to use research and development techniques. The four stages of the 4D development research model used in this study are define, design, develop, and disseminate (Sugiyono, 2019).

During the Define step, problems with the learning process are identified. The state of the defining step is used to guide the design step media compilation. In the Develop step, replies from biology teachers and grade X students of Senior High School are used as input until the final product is valid, and material experts and media experts are validated by Tadris Biologi UINSU lecturers. The Disseminate stage, consists of implementing the product on students as well as testing the effectiveness of the module's goal achievement.

Validity analysis, practicality analysis, and effectiveness analysis are some of the data analysis methodologies used. The validity test was conducted using a validation sheet of the module created by academics. The following Likert scale was used to rate the module: strongly agree, agree, moderately, disagree, and disagree. After being assessed by the validators, the data was calculated and then the results of the collected data will be presented in table 1.

Table 1. Likert Scale Validity Test

Achievement (%)	Categories
90-100	Very Valid
80-89	Valid
65-79	Moderately Valid
55-64	Not Valid
0-54	Very Invalid

Source: (Mukti & Nurcahyo, 2017)

Practicality analysis was carried out on the data collected through the biology teacher's response of students. The data collected was taken from the trial process with a Likert scale of 1-5 and then categorized with the practicality category in table 2.

Table 2. Likert Scale Practicality Test

Achievement (%)	Categories
90-100	Very Practical
80-89	Practical
65-79	Moderately Practical
55-64	Not Pravtical
0-54	Very Not Practical

Source: (Mukti & Nurcahyo, 2017)

Effectiveness analysis was conducted to see the achievement of the module development objectives. For the effectiveness of this module using posttest and pretest which includes indicators of Environmental Literacy namely knowledge, skills & skills, and environmental literacy characters consisting of 21 multiple choice questions and 5 description questions. Effectiveness test data will be analyzed and calculated using the N-gain formula. The results on the score are interpreted in table 3.

Table 3. N-gain formula Value Range

Score Range	Criteria
$N-gain > 0,7$	High
$0,3 \leq N-gain \leq 0,7$	Medium
$N-gain\ 0,3$	Low

Source: (Mukti & Nurcahyo, 2017)

A questionnaire with 10 questions can be used to assess environmental literacy as well as behavioral indicators. To ascertain how students behave with regard to environmental literacy, the raw score can be divided by the highest score, multiplied by a constant (100%). The results on the scores are interpreted in table 4.

Tabel 4. Environmental Literacy Interval Range

Interval (%)	Categories
$66,6 < P \leq 100$	High
$33,3 < P \leq 66,6$	Medium
$0 < P \leq 33,3$	Low

Source: (Eviyanti et al., 2022)

RESULTS AND DISCUSSION

Module design is carried out through several stages, in the initial design begins with the define stage. At the define stage, it begins with conducting various analyzes that aim to obtain information on the needs of module development (Maulidatul et al., 2019). Researchers first interviewed one of the biology teachers at Senior High School about matters relating to media, materials and also students' views on the environment studied in class. After collecting information based on interviews, the researchers developed a STEM-based learning module on environmental change material.

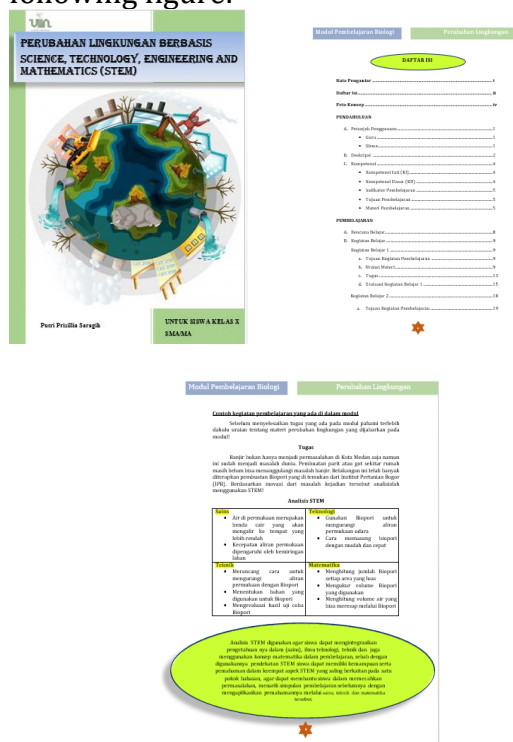The Module design can be seen in the following figure:

Figure 1: Environmental Change Module Design

The design step or module design stage is filled with the initial design of the product in making STEM-based modules on environmental change material for class X SMA / MA. At this step, researchers prepare and collect various books as references related to environmental change material. The preparation of module design and assessment instruments is also carried out to make the module in accordance with the content framework that will be designed. In the module, environmental literacy is also applied through tasks and various activities so that students are able to understand environmental change material and apply it in everyday life.

Validator Analysis

The product design of the STEM-based environmental change module has been validated by 2 expert validators. The content or content of the module will be assessed by material expert validators and the design and appearance of the module is assessed by media expert validators. The material expert validates the quality aspects of the module objectives and the quality of learning in the module. After developing with some suggestions from the validator during revision, the results of the module validity conclusion were obtained. The results of the material expert validation can be seen in table 5.

Table 5. Material Expert Validation

Aspect	Idealized Percentage (%)	Category
Quality of Content and Purpose Quality of Learning	98,57%	Very Valid

The mediators validated the aspects in terms of module size coverage, cover aspect, letter typography aspect, and module design aspect. The results of the media expert validation calculation can be seen from table 6.

Based on the table 6, it is known that the percentage score of the material expert is 98.57% or it can be concluded that the STEM-based environmental change module is said to be Very Valid. While the percentage score of media experts is 90.67% which also shows that the STEM-based environmental change module is said to be very valid. Suggestions and responses from validators aim to determine the feasibility of STEM-based modules that have been developed before field trials (Ramdoniati et al., 2018). The assessment of validity can be seen from several aspects such as content, presentation, language and visual appearance (Mutmainah et al., 2022).

Table 6. Media Expert Validation

Aspect	Idealized Percentage (%)	Category
Module Size		
Cover	90,67%	Very Valid
Font Typography Module Design		

Teacher and Learner Response

Data on the practicality of using the module was obtained through a response questionnaire from biology teachers and students of class X Senior High School after the module was used in the learning process. Teacher response practicality data is shown in table 7.

Table 7. Teacher Response

Respondents	Score	Category
Biology teacher of class X Senior High School	85%	Practical

Based on the biology teacher response questionnaire, it is known that the module is declared practical for use in learning with a percentage score of 85%. The module is categorized as practical because it can be used in the learning process and can be used as an independent learning media by students. This is in line with (Azis et al., 2023), activities that can be done using modules can be done independently such as

practicum, solving problems and making projects.

This is in line with Gunawan's opinion (2019) the purpose of preparing modules to increase students' passion for learning and help them learn independently. Students are encouraged to be able to think comprehensively in solving problems in the environment (Atika et al., 2023). In addition, the module is essentially used by students for learning, therefore the response of students will be needed in module development. The number of students who became respondents amounted to 30 people who would then fill out a response questionnaire to the developed module. The results of research Oktarina et al., (2023) stated that modules get better responses than by learning using conventional mod el textbooks. The STEM approach invites students to understand the phenomena that occur intheir lives so that they want to learn and understand the causes and impacts caused (Hariyadi et al., 2023;Rasmi et al., 2023).

After obtaining the results of the response questionnaire scores from the 30 students, they were then calculated with the percentage of practicality and the following results were obtained in table 8.

Table 8. Learner Response

Respondent Total	Percentage (%)	Category
30 Person	86,07%	Practical

Based on the results of the practicality questionnaire, it is known that the STEM-based environmental change module has been categorized as practical because it gets a score of 86.07% and in the study it was found that the module can be used independently by students because there are instructions for use in accordance with the purpose of the module itself. This is in agreement with Al Fatihah et al., (2022), STEM is one solution that is considered to be able to improve or hone concept understanding. In addition, the research also found that the module facilitates the learning

process because it has goals that are directed according to the KD. This is also in agreement with Hidayah et al., (2023) STEM assisted by teaching materials to improve students' abilities.

Module Effectiveness in Improving Environmental Literacy

The effectiveness test of the STEM-based environmental change module was carried out by giving questions and questionnaires before and after the use of the module to 30 students. This effectiveness test was conducted to test the use of modules to increase students' environmental literacy. In this effectiveness test, 4 indicators were used, namely knowledge, skills, character and behavior towards the environment according to the North American Association for Environmental Education (2011).

For the coverage of knowledge, skills and character indicators consisted of 21 multiple choice questions and 5 descriptions. The effectiveness test data before and after by students will be analyzed using the N - Gain calculation, can be seen in table 9.

Table 9. Effectiveness test data N-Gain results

Respondent Total	Amount N-gain	Average N-gain
30 Person	22,11	0,737

Based on table 9, it can be seen that the N-gain results that have been carried out at Senior High School get a total score of 22.11 which is then averaged to 0.737 with a high category. The results of the pretest and posttest scores that have been tested also show an increase in scores.

Next, the coverage of behavioral indicators of environmental literacy is carried out using a questionnaire consisting of 10 questions. The effectiveness test data before and after by students will be analyzed by calculating the raw score divided by the maximum score multiplied by a constant. The results of the data were analyzed to obtain the changes listed in Table 10.

In the questionnaire before the use of the module, the average questionnaire score is

65.2 with a medium category and in the questionnaire after the use of the module, the average questionnaire score is 83.4 with a high category. This illustrates that the module can be said to be effective in improving students' environmental literacy. Then these results are in line with (Syofyan et al., n.d.) The environmental literacy module will provide students with a unique opportunity to experience something connected to the environment. To achieve environmentally minded students, environmental literacy is needed (Widowati et al., 2021).

Table 10. Improvement of Module Effectiveness

Environmental Literacy Assessment	Average	Category
Questionnaire Before	65,2	Medium
Questionnaire After	83,4	High

Environmental literacy is defined as a reaction to the surrounding environment by not destroying the environment and taking care of the surrounding environment. . Therefore, instilling learners' environmental literacy skills is an important part of organizing education (Di & Lptk, 2019; Mabsutsah et al., 2023; Aspridanel et al., 2022). So the development of STEM-based modules that have been tested for effectiveness can improve learners' environmental literacy. It is seen that the impact of using this STEM-based module raises students' awareness and responsibility for the surrounding environment. Learners who initially did not realize that the small things they did not do could contribute most of the damage to the environment and surrounding ecosystems but after using the module they could realize, apply and find solutions to the environmental problems they found.

CONCLUSIONS AND SUGGESTIONS

Based on the validation test, practicality test and effectiveness test conducted at Senior High School, it can be concluded that the STEM-based Environmental Change Module is valid, practical, and effective in improving environmental literacy. Because this research is about development, it is recommended that future researchers follow up this research by conducting research at the Madrasah Aliyah level. So in the end, more comprehensive data will be obtained that can enrich knowledge in learning and writing.

REFERENCES

Agung, A., Paraniti, I., & C, J. W. (2022). Literasi lingkungan siswa : Refleksi program pendidikan untuk lingkungan yang berkelanjutan. *JPBI (Jurnal Pendidikan Biologi Indonesia). 8*(1), 1–9.

Adhelacahya, K. (2023). The Impact of Problem-Based Learning Electronics Module Integrated with STEM on Students ' Critical Thinking Skills. *Jurnal Penelitian Pendidikan IPA*. *9*(7), 4869–4878.https://doi.org/10.29303/jppipa.v9i7.3931

Aji, S. D., Pratiwi, H. Y., Badelwaer, Y., & Nur, M. (2022). Pengembangan E – Modul Ipa Terintegrasi Substainable Devolepment Goals (SDGs) Untuk Meningkatkan Literasi Lingkungan Siswa Pada Topik Tata Surya. *RAINSTEK : Jurnal Terapan Sains & Teknologi. 4*(4), 216–224.

Al Fatihah, I., Ramli, M., & Rahardjo, D. T. (2022). The Effect of STEM-ThingLink Learning Design on Students' Conceptual Understanding of Nutrition. *Biosfer: Jurnal Tadris Biologi, 13*(1), 1–11. https://doi.org/10.24042/biosfer.v13i1.11920

Allanta, T. R., & Puspita, L. (2021). Analisis keterampilan berpikir kritis dan self efficacy peserta didik: Dampak PjBL-STEM pada materi ekosistem. *Jurnal Inovasi Pendidikan IPA, 7*(2), 158–170. https://doi.org/10.21831/jipi.v7i2.42441

Anita, Y., Nur, M., & Nasir, M. (2020). Problem

Based Learning Terintegrasi Pembelajaran Science, Technology, Engineering, and Mathematics (Stem) Terhadap Literasi Lingkungan Mahasiswa. *BIOEDUKASI (Jurnal Pendidikan Biologi)*, *11*(2), 105. https://doi.org/10.24127/bioedukasi.v11i2.3278

Aspridanel, A., Abdurrahman, A., Lengkana, D., & Jalmo, T. (2022). STEM-Integrated Flipped Classroom in the Teacher's Perspective: Could its Implementation in E-Module Improve System Thinking Ability? *Indonesian Journal of Science and Mathematics Education*, *5*(1), 43–52. https://doi.org/10.24042/ijsme.v5i1.10663

Astuti, N. H., Rusilowati, A., & Subali, B. (2021). STEM-Based Learning Analysis to Improve Students' Problem Solving Abilities in Science Subject: a Literature Review. *Journal of Innovative Science Education*, *9*(3), 79–86. https://doi.org/10.15294/jise.v9i2.38505

Atika, S. D., Santhalia, P. W., Sudjito, D. N., Fisika, S. P., Sains, D., Sains, F., & Satya, U. K. (2023). STEAM Integrated Project Based Learning Exploration Against Understanding the Concept of Static Fluids. *Jurnal Penelitian Pendidikan IPA*. *9*(7), 5357–5364. https://doi.org/10.29303/jppipa.v9i7.2905

Azis, M. A., Wahono, B., Mahardika, I. K., & Haryadi, S. (2023). Development and Implementation of Integrated STEM-Based Science Textbooks and Local Potential of Coffee Agroecosystems to Improve Science Literacy for Junior High School Students. *BIOEDUKASI*. *21*(2), 68–73. https://doi.org/10.19184/bioedu.v21i2.38442

Eviyanti, S. J., Ngabekti, S., & Sumarni, W. (2022). Effectiveness of Teaching Materials Based on Local Wisdom in the Takalar Region to Improve Literacy Capabilities of High School Students. *Jurnal Penelitian Pendidikan IPA*, *8*(6), 3089–3094. https://doi.org/10.29303/jppipa.v8i6.1978

Handoko, A., Sartika, S., & Anggoro, B. S. (2021). Subject-specific pedagogy: Development of biology teaching materials based on van hiele thinking theory. *JPBIO (Jurnal Pendidikan Biologi)*, *6*(1), 125–132. https://doi.org/10.31932/jpbio.v6i1.933

Hariyadi, S., Wahono, B., Subiantoro, A. W., Dwi, A., & Permatasari, A. (2023). Media Design " Detector Marker " based on STEM with Dragon Fruit Peel Extract for Detection of Formaldehyde Additives at School in Agroecosystem Zone. *BIOEDUKASI*. *21*(2), 132–137. https://doi.org/10.19184/bioedu.v21i2.40076

Hasanah, H. (2020). Pengembangan Bahan Ajar Matematika Berbasis STEM Pada Materi Bangun Ruang. *Indonesian Journal of Learning Education and Counseling*, *3*(1), 91–100. https://doi.org/10.31960/ijolec.v3i1.582

Hidayah, N., Masykuri, M., & Ramli, M. (2023). Effect of Enviromental Pollution E-Module STEM Based (Science Technology Engineering and Mathematics) to Improve Student's Inquiry Skills. *Jurnal Penelitian Pendidikan IPA*, *9*(3), 1099–1106. https://doi.org/10.29303/jppipa.v9i3.2605

Mabsutsah, N., Hariyadi, S., & Prihatin, J. (2023). The Readiness of Science Teachers to Implement Differentiated Learning and Integrated STEM in Ecology Subject of the "Merdeka" Curriculum in Junior High School .*BIOEDUKASI*. *21*(2), 99–110. https://doi.org/10.19184/bioedu.v21i2

.39567

Maulidatul, H. A., Ismail, & Mukhlishoh, S. S. (2019). Pengembangan Modul Biologi Benilai Islami Materi Sistem Reproduksi pada Manusia. *Bioeduca : Journal of Biology Education*, *1*(65), 18–28.

Mukti, I. N. C., & Nurcahyo, H. (2017). Pengembangan media pembelajaran biologi berbantuan komputer untuk meningkatkan hasil belajar peserta didik. *Jurnal Inovasi Pendidikan IPA*, *3*(2), 137. https://doi.org/10.21831/jipi.v3i2.7644

Mutmainah, O., Hakim, A., & Syam, M. (2022). Validity of Physics Teaching Materials Based on STEM to Improve Climate Literacy of High School Students. *Jurnal Pendidikan Fisika Dan Teknologi*, *8*(2), 208–216. https://doi.org/10.29303/jpft.v8i2.4053

Nopia, S., Juanda, A., & Gloria, Y. R. (2022). Increasing Student Learning Outcomes In Environmental Pollution Learning Material By Utilizing Waste as a Hidden Curriculum. *BIOSFER: Jurnal Tadris Biologi*, *13*(2), 217–230. https://doi.org/10.24042/biosfer.v13i2.13204

Novitasari, A., Widiasari, B., Haka, N. B., Hidayah, N., & Handoko, A. (2022). Pengaruh Pendekatan STEM Berbantuan Google Classroom terhadap Keterampilan Berpikir Kreatif Peserta Didik. *Assimilation : Indonesian Journal of Biology Education*. *5*(2), 71–79.

Oktarina, R., Fitria, Y., Ahmad, S., & Zen, Z. (2023). Development of STEM-Oriented E-Modules to Improve Science Literacy Ability of Elementary School Students. *Jurnal Penelitian Pendidikan IPA*. *9*(1), 5460–5465. https://doi.org/10.29303/jppipa.v9i7.4503

Pareira, J., Amsikan, S., & Salsinha, C. N. (2021). Upaya Meningkatkan Prestasi Belajar Matematika Siswa SMP Dengan Model Pembelajaran Kooperatif Tipe Jigsaw Pada Materi Himpunan. *MATH-EDU: Jurnal Ilmu Pendidikan Matematika*, *6*(2), 42–49. https://doi.org/10.32938/jipm.6.2.2021.42-49

Ramdoniati, N., Muntari, M., & Hadisaputra, S. (2018). Pengembangan Bahan Ajar Kimia Berbasis Problem Based Learning Untuk Meningkatkan Keterampilan Metakognisi. *Jurnal Penelitian Pendidikan IPA*, *5*(1). https://doi.org/10.29303/jppipa.v5i1.148

Rasmi, D. P., Hendri, M., & Azriyanti, R. (2023). Analysis of the Need for Development of Teaching Materials in the Form of STEM-Based Electronic Modules. *Jurnal Penelitian Pendidikan IPA*, *9*(6), 4135–4141. https://doi.org/10.29303/jppipa.v9i6.2683

Sari, D. P., Puspita, L., Handoko, A., & History, A. (2021). Contextual Teaching And Learning Model Assisted By Zoom Cloud Meetings: The Impact On Students' Critical Thinking Skills. *Biosfer : Jurnal Tadris Biologi*, *12*(1), 32–39. https://doi.org/10.24042/b

Sartika, D. (2019). Pentingnya pendidikan berbasis STEM dalam kurikulum 2013. *JISIP : Jurnal Ilmu Sosial Dan Pendidikan*, *3*(3), 89–93.

Siregar, E. S., & Nasution, M. W. (2020). Dampak Aktivitas Ekonomi Terhadap Pencemaran Lingkungan Hidup (Studi Kasus : di Kota Pejuang, Kotanopan). Journal *Education and Development*, *8*(9), 1689–1699.

Sulistyo, M. (2018). Upaya Meningkatkan Rasa Ingin Tahu Dan Prestasi Belajar Matematika Materi Bangun Ruang Melalui Model Pembelajaran Quantum. *Dinamika Jurnal Ilmiah*

Pendidikan Dasar, *10*(2), 107–111.

Suryanda, A., Miasyah, M., & Septiani, D. (2020). Pembentukan Perilaku Tanggung Jawab Lingkungan melalui Keikutsertaan Siswa SMA dalam Kegiatan Ekstrakurikuler Kelompok Pecinta Alam. *Quagga: Jurnal Pendidikan Dan Biologi*, *12*(2), 94. https://doi.org/10.25134/quagga.v12i2.2764

Syahirah, M., Anwar, L., & Holiwarni, B. (2020). Pengembangan Modul Berbasis STEM (Science, Technology, Engineering And Mathematics) Pada Pokok Bahasan Elektrokimia. *Jurnal Pijar Mipa*, *15*(4), 317–324. https://doi.org/10.29303/jpm.v15i4.1602

Syarah, D., Dwi, P., & Supriadi, B. (2021). Pengembangan E-Modul Fisika Berbasis STEM (Science, Technology, Engineering, and Mathematics) pada Materi Bunyi di SMA/MA. *Jurnal Literasi Pendidikan Fisika (JLPF)*, *2*(1), 1–8. https://doi.org/10.30872/jlpf.v2i1.438

Syofyan, H., Susanto, R., Nugroho, O. F., Ramadhanti, D., Mentari, I., & Mahareka, R. (2020). Efektifitas Modul Berbasis Literasi Lingkungan Melalui Pendekatan Saintifik. *Jurnal Pendidikan Dasar*, *11*(02), 181-196

Widowati, C., Purwanto, A., & Akbar, Z. (2021). Problem-based learning integration in STEM education to improve environmental literation. *International Journal of Multicultural and Multireligious Understanding*, *8*(7), 374-381.

Yudha, P. A., Rita, R. T., & Yolida. (2020). Pengaruh Literasi Lingkungan Terhadap Environmental Responsibility Siswa Kelas XI SMA Negeri 2 Bandar Lampung. *Jurnal Bioterdidik*, *8*(1), 56–65. https://doi.org/10.23960/jbt.v8.i1.07