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Analysis of the Needs of STEM Teaching Materials in Physics Subjects in High Schools

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Abstract: Teaching materials as a support for the implementation of learning are needed so that they can be carried out properly in accordance with the competencies to be achieved from the learning process carried out. STEM is an approach that is suitable to be applied in a physics lesson in high school. Therefore, it is necessary to analyze the needs of STEM teaching materials in high school physics subjects. The research method used is descriptive using three objects studied including high school physics teachers (3 teachers through interviews and 44 teachers through questionnaires), documents including syllabus and teaching materials, and 183 high school students (83 students in class X, 51 students in class XI and 49 students of class XII) by using a questionnaire. The results show that there is a need for STEM-based teaching materials in high school physics learning to support students' skills in problem solving and product design. The recommendation given is the need for the development of STEM teaching materials in high school physics subjects.

Keywords: Physic; STEM; Teaching material

Introduction

STEM (Science Technology, Engineering and Mathematics) approach developed since the 1990s (Kang, 2019; Kelley et al., 2021), which has been widely developed by researchers in the form of Project-Based STEM (Beier et al., 2019; Hanif et al., 2019; Khotimah et al., 2021; Lin et al., 2021; Mckibben, 2021), integrated with ART (Harris et al., 2018; Kang, 2019; Yuni et al., 2021), even technology-based (Chen et al., 2020; Cornetta, 2020; Fidai, 2019) who are able to produce the latest products as a solution to various problems faced especially in the implementation of learning as a provision for students STEM (Science Technology, Engineering and Mathematics) approach developed since the 1990s (Kelley et al., 2021), which has been widely developed by researchers, so that it was developed in the form of Project-Based STEM (Beier et al., 2019; Khotimah et al., 2021; Lin et al., 2021; Hanif et al., 2019; Mckibben, 2021), integrated with ART (Harris, 2018; Jho et al., 2016; Yuni et al., 2021), even technology -based (Chen et al., 2020; Cornetta, 2020) who are able to produce the latest products as a solution to various problems faced especially in the implementation of learning as a provision for students' experiences to improve their skills. So, STEM is importance for enchance students skill likes critical thinking, creative thinking, problem solving, and skil in facing the industry 4.0 (Hafni et al., 2020; Izzati et al., 2019; Rizaldi et al., 2020).

The implementation of learning through any approach is needed some teaching devices, including teaching materials, media, tools and materials, documents that support the implementation and achievement of the learning objectives themselves (Ejiwale, 2019; Frumos, 2020; Powell et al., 2019; Suartama et al., 2020). Teaching materials that have been developed are STEM -based teaching materials in physics subjects developed by Widayanti et al. (2019). But there are still difficulties in the engineering process

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of the design process, if according to recommendations from further research it is necessary to make STEM teaching materials in physics subjects. It is also necessary to explore information about the profile of STEM teaching material needs in physics subjects in high school, with details of research questions as follows: 1) how is the teacher's response to the needs of stem teaching materials in physics subjects, 2) how to analyze documents in the form of syllabus and materials Teach that is often used to the characteristics of STEM, and 3) how students' responses to the needs of stem teaching materials in physics subjects in the classroom. Gain experience and improve your skills.

Regardless of the approach to learning, there is a need for teaching materials, media, tools and materials, and documents that support the implementation and achievement of the learning objectives themselves. The developed teaching materials are STEM-based physics teaching materials developed by Widayanti et al. (2019) was developed. However, the engineering process of the design process is still fraught with difficulties when his STEM teaching materials must be created in physics subjects, following recommendations from further research. Information on his STEM curriculum needs profile in secondary school physics subjects should also be explored. The details of the research question are as follows: how does the teacher address her STEM material needs in physics subjects? The need for regular material in physics subjects during class.

Method

The research was conducted using a descriptive method, with the aim of systematically describing the facts and characteristics of the object under study (Hunker et al., 2020). In this study there were three objects studied, including high school physics teachers, documents in the form of high school physics syllabus and teaching materials, and high school students. The Physics teacher was used to obtain information about the application of STEM learning in high school, there were three Physics teachers. Apart from conducting interviews, additional information about the need for teaching materials in STEM learning was also obtained from 44 high school physics teachers spread across West Java. The syllabus and teaching materials are used to obtain information about the characteristics of STEM (Science Technology Engineering and Mathematics) that appear in teaching materials, and the selection of several basic competencies in the high school physics syllabus. On the other hand, 183 students in class X SMA (83 class X, 51 class XI and 49 class XII) were used to obtain information about the need for teaching materials to support student learning.

The data collection technique used in this preliminary study consisted of three parts, namely interviews, document analysis and questionnaires. Interviews were conducted to obtain information about the implementation of STEM learning that had been carried out by Physics teachers. The instrument used was an interview guide sheet. Document analysis is used to obtain STEM characteristics in teaching materials that are often used in learning and material analysis or basic competencies in the Physics syllabus. The teaching material analyzed was the 2013 Curriculum 2013 Class X High School Physics textbook. The instrument used was a checklist. Questionnaires were given to students to find out the needs of teaching materials in need of students to support more meaningful learning. The instrument used is a questionnaire.

The data analysis technique used is descriptive statistics to provide an overview of the object under study either in the form of a percentage on the results of the questionnaire, a description of the results of the interviews and an overview of the results from the checklist used in document analysis on STEM characteristics in teaching materials and syllabus.

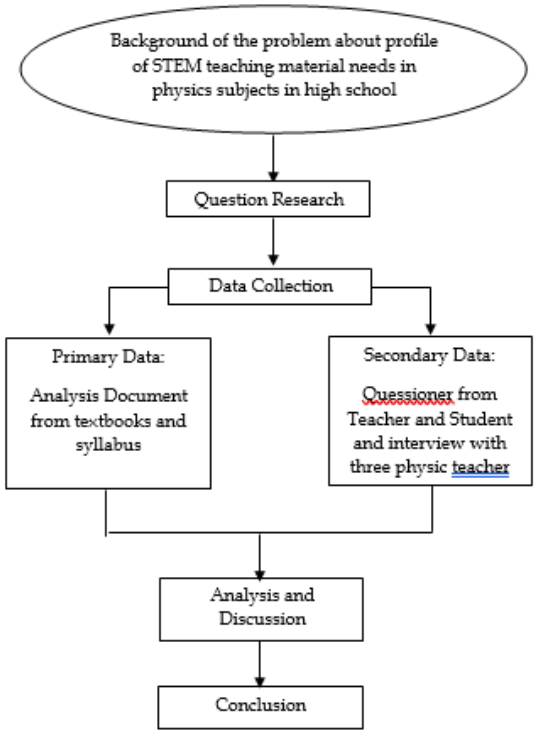

Figure 1. Research scheme

Result and Discussion

Result

The first result of this preliminary research is an overview of the implementation of STEM learning that has been carried out by Physics teachers. The data

collection technique used was interviews with three high school Physics teachers. The components given regarding STEM learning include 1) the science teacher's view of STEM learning, 2) implementation of STEM learning in class, 3) STEM components that are still difficult to do in learning, 4) examples of STEM learning that has been done, 5) problems faced in applying STEM learning, and 6) the factors that cause problems in implementing STEM learning.

From the analysis of the interview results, there are six results. The first result, two teachers stated that STEM learning was suitable for use in physics material in class X, and made students more active in class, while one teacher felt that STEM learning was difficult and very time-consuming. The second result, all teachers thought that they had done STEM-based learning even though two teachers felt that they were still not feeling well and were still doing it themselves without any assistance or observers during the learning process while one teacher had done STEM learning with special guidance and direction because obtaining research grants in implementing STEM-based learning. The third result, all teachers stated that the STEM component that was still difficult to implement was in the Engineering Design Process (EDP) section. The fourth result, examples of studies that have been carried out, including the material on electricity, optics, fluids, rigid body balance even the teacher also gives examples of implementation in learning where engineering is carried out using Arduino technology, solar cells and robotics.

The results of the five problems that are often found during implementation include class management where students are still confused in carrying out each EDP stage, time management, interdisciplinary integration and evaluation. The factor causing the problem which is the sixth result is that there are no teaching materials as a special guide on STEM learning that will be carried out for both teachers and students, so that students have an overview of what will be done and monitoring in implementation so that it is easy to evaluate the implementation of learning.

In addition to the results of interviews obtained from teachers, science teacher questionnaires about STEM learning were also obtained, where the results can be seen in table 1. The results of the questionnaire can be seen that most teachers use teaching materials to support the implementation of learning that has been provided by the school, but the teaching materials used are felt to lack the characteristics of the nature of science and STEM, so based on the results of the questionnaires and interviews it can be concluded that according to the Physics teacher there is a need STEM-Based Teaching Materials that are adapted to the characteristics of the Curriculum and the Nature of Science.

The second result was obtained from document analysis, where the documents analyzed were the high school physics syllabus and teaching materials in the form of books and Student Activity Sheets used in learning activities. The analysis used in the syllabus, seen from basic competencies in the realm of skills that refer to engineering process design (EDP), including ask, image, plan, create and improve (Wu & Anderson, 2015). The results of the syllabus analysis using a checklist can be seen in table 2.

Table 1. Results of High School Physics Teachers' Responses to STEM Teaching Materials

Questions	%Answer	
	Y	N
Have teaching materials/books for science been provided at your school to support learning?	90%	10%
Do you often use science teaching materials provided by the school in the learning process?	66%	34%
Do you use science teaching materials other than those provided by the school/government?	93%	7%
What types of teaching materials are often used in class are teaching materials issued by other publishers? (Besides teaching materials from the government)	94%	6%
Science Teaching Materials that are often used are teaching materials published in the last five years (2017-2021)	66%	34%
In your opinion, are the teaching materials that have been used so far in class appropriate to the demands of the 2013 curriculum?	72%	28%
In your opinion, are the teaching materials that have been used so far in class appropriate to the characteristics of the nature of science itself?	68%	32%
Have you ever heard of the STEM approach in learning science?	80%	20%
Do you understand the STEM approach in learning science?	45%	55%
Have you ever used STEM-based science teaching materials?	36%	64%
In your opinion, is it necessary to have STEM-based science teaching materials to support science learning that is adapted to the demands of the curriculum and the nature of science?	97%	3%

Table 2. Results of Analysis of High School Physics Textbooks

Subject Matter	Characteristics STEM							
	Science	Technology	Engineering					Math
			Ask	image	plan	create	Improve	
Vector (page 53)	√	√	-	-	√	√	-	√
Newton's law of gravity (Page 181)	√	-	√	√	-	-	-	√
Work and Energy (Pages 195, 200, 202, 203, 207, 211)	√	√	√	√	-	-	-	√
Work and Energy by project (page 215)	√	√	√	√	√	√	-	√
Rigid balance (page 10)	√	√	√	√	-	-	-	-
Worksheet (page 17 dan 25)	√	√	√	√	-	-	-	√
Statics Fluids (page 59, 67, dan 76)	√	√	√	√	-	-	-	√
Worksheet (page 62 and 64)	√	√	√	√	-	-	-	√
Dinamic fluids (85,	√	√	√	√	-	-	-	√
Worksheets (page 86& 95)	√	√	√	√	-	-	-	√
Project Based (Page 103)	√	√	√	√	√	√	-	√
Heat Transfer (page 134)	√	√	√	√	-	-	-	√
Project based (137)	√	√	√	√	√	√	-	√
Gas Kinetic Theory (page 145, 153, 155, and 157)	√	√	√	√	-	-	-	√
Thermodinamic (page 173, 180, and 186)	√	√	√	√	-	-	-	√
Project based (page 192)	√	√	√	√	√	√	-	√
Optics (page 273, 276, 278, and 281)	√	√	√	√	-	-	-	√
Project based (page 289)	√	√	√	√	√	√	-	√
Global warming (page 295, 306, and 308)	√	-	√	√	-	-	-	-
Page 299	√	√	√	√	-	-	-	√
Project based (page 312)	√	√	√	√	√	√	-	√
Relativity (page 165, 170	√	√	√	√	-	-	-	-
(page 177)	√	√	√	√	-	-	-	√
Digital Technology (page 207, 210 and 219)	√	√	√	√	-	-	-	-
(page 217 and 221)	√	√	√	√	-	-	-	√
Project Based (Hal 224)	√	-	-	-	-	-	-	-

The results of the analysis of textbooks studied were from three books, namely Physics books for Classes X, XI and XII in high school where there are several terms in the book that reflect observation, experimentation and project creation to explore student skills in order to achieve the learning objectives to be achieved. These terms include; 1) Let's explore, in this section the stages of student observation activities are given in exploring several concepts based on facts and activities carried out, in this section it is analyzed that several STEM characteristics emerge, such as 100% emerging science, almost all exploratory activities using technology, but in Newton's law material about gravity and global warming it does not bring up technological elements, but in answering questions it is only faced with finding suitable sources or concepts without the help of a particular design, while in the engineering element, all exploration activities are given a question to look for the answer, however, there are elements of this question that form the basis of a problem, but there are also many questions that are more about proving a concept or law, other than that other elements in EDP do not appear, most only get to the image process and even then it leads to the search for ideas or fail San, in answering questions, has not yet entered the realm of finding a solution to a problem, let alone designing the right solution to that problem. 2) Let's Experiment is the second term used in the book to explore student skills, in this term students are more directed in carrying out practicums, so that the presentation is made according to the stages in student worksheets in general. In this section, STEM elements are very likely to be analyzed because activities are more student-oriented. After doing the analysis, it can be seen that the elements of science. Technology and mathematics are very clear, but in the EDP process apart from the process of non-consecutive stages which are in accordance with the EDP there are also some deficiencies, including the questions given which are not problem-oriented but rather proof of concept, principle or law, so that in data collection it only races on the required data collection stage in accordance with applicable principles or laws, although there is an improvement process in replacing data with a different value or magnitude but it is not a process of finding the right solution to the problem. 3) Project Assignment, in this term it is very interesting and of course STEM elements may exist at its stages. After analysis, almost all STEM elements are present, but in the EDP process at the improve stage it is still very unclear the direction in making the project as the best

solution to the problems given. In addition, on the subject of digital technology, the projects assigned are not in the form of a product design project as a solution to a problem, but in the form of a summary of several terms and concepts in digital technology itself.

Based on the results of the analysis of the two documents in the form of syllabus and teaching materials, it is clear that the STEM approach can be used as a strategy used in the learning process that is adapted to the basic competencies to be achieved, especially competencies in the skills domain. In addition, the results of the analysis of teaching materials found that the design of the implementation of student activities still does not fulfill all the elements in STEM, especially in the engineering process. The stages of the EDP still need to be clarified. This shows the need for the development of STEM teaching materials for Physics in high school.

The third result in this preliminary study was taken from the results of student questionnaires about teaching materials that are often used in learning. This questionnaire was given to 183 high school students consisting of 83 students in class X, 51 students in class XI and 49 students in class XII. There are several things that become topics in this questionnaire, including: 1) The nature of science in learning Physics, Chemistry and Biology, 2) The use of Teaching Materials in the implementation of learning, 3) The implementation of practicum in class, 4) Involved in product design, 5) The use digital-based media, 6) Engage in problem solving. Of the six topics asked were developed into 15 reasoned questions. The percentage of results from the student questionnaire can be seen in Figure 1.

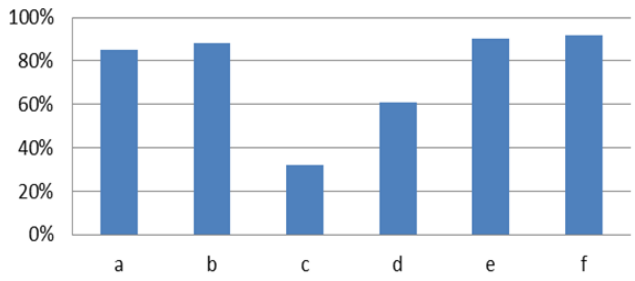

Figure 2. Results of a student questionnaire about learning Physics in SMA. Note: a. Nature of Science; b. Learning Material; c. Practicum; d. Planning product; e. Media Based Technology; f. Problem Solving

The results of the student questionnaire clearly show that the smallest percentage value is in the implementation of practicum, where based on the answers to the question that students rarely carry out practicum in the learning process, this is due to several things including, students are not introduced to many existing tools and facilities to be used as a means physics practicum in class, the implementation of online learning greatly reduces the implementation of practicum by teachers, due to limited time and facilities. Even though if you look at the books or teaching materials provided by the government there are practicum guidelines and 79% of students answered that the teaching materials used had lots of practicum guides, they found it very difficult to implement them if the teacher did not give direct directions. The second answer which can be said to be low is the process of student involvement in designing projects, only 61% of students answered that they had been involved in designing projects, but many other students had never been involved in designing certain projects or products, this was very unfortunate for students, because from the students' statements really hope to get hands-on experience in designing and producing a product, of course, with directions from the teacher. There are several factors that cause students to be less involved in designing projects, one of which is that the teaching materials used by teachers in learning are still minimal in the project design stage. As for student answers about teaching materials with a total of 88% of students stated that they often study using teaching materials, the types of teaching materials used are divided into several categories, including: 1) the teaching materials used are teaching materials in the library (provided by the government) 90%, 2) teaching materials that discuss more about conceptual as much as 83%, 3) practicum-based teaching materials as much as 79%, 4) teaching materials that contain a lot of higher-order thinking questions as much as 46%, 5) teaching materials that contain design products by 55%, 6) Digital-based teaching materials by 63%. In this case the types of teaching materials that are still lacking are teaching materials that contain high-level thinking and product design, even though the results of answers about problem solving as one of the high-level skills show results of 98% being very happy when learning on the basis of problem solving.

Based on the results of the student questionnaire that the teaching materials that are often used are still lacking in problem solving and product design, where these two skills are needed by students. When viewed from the basic characteristics of problem solving and product design, the STEM approach is very suitable. Therefore the design of STEM teaching materials for high school physics subjects is felt to be very much needed to explore higher-order thinking skills, problem solving and involve students directly in product design as a solution to the problem itself.

Discussion

Based on the results obtained from several data sources, namely teacher questionnaire data, teacher interviews, documents in the form of syllabi and teaching materials as well as student questionnaire data, there are several things that can be discussed, including: 1) Teaching materials are very much needed by teachers and students as one of the sources and guidelines in carrying out learning. This is in accordance with the opinion of Sumiati et al. (2018), that teaching materials are needed in learning activities so that students are more active in participating in learning, as well as the opinion of (Denisa et al., 2021; Maarif, 2022; Ramadan et al., 2022) that teaching materials are able to invite students to be active in following learning is teaching material by following scientific approach procedures. 2) Teaching materials used in learning must be adapted to the competencies to be achieved and based on curriculum demands, in this case adapted to the competencies in the syllabus that has been designed (Denisa et al., 2021). 3) Teaching materials developed especially for high school physics learning really need several elements such as practicum guides, product design, problem-solving based, questions that can hone high-level skills, technology assistance, and mathematical integration as an aid in simplifying when searching solution of problem solving.

Based on these results and discussion, there is an approach whose characteristics can include several elements from the results of the analysis, namely the STEM approach, where STEM (Science, Technology, Engineering and Math) is an approach that integrates science. Technology, engineering and mathematics in learning, in the STEM science approach will be very explored by starting from a problem which is then carried out by an engineering process which is often called EDP (Engineering Design Process) where the stages are sequential from ask, image, plan, create, improve as a stage in solving the problem is continuously carried out until the best solution is found in solving the problem with the help of technology and the process of calculating in mathematics . Because the results of the preliminary research revealed that there were no teaching materials that had these characteristics, it was highly recommended to develop STEM teaching materials on physics in high school.

Conclusion

The conclusions obtained in the introduction to this study included: 1) Science teachers' responses about the need for STEM teaching materials, based on the results of the teacher's questionnaire stating that 97% needed STEM-based teaching materials adapted to the characteristics of the Curriculum and Nature of Science, 2) based on the interview results it was found that in the implementation of STEM learning in the classroom, teaching materials are still needed that support the implementation of STEM and clarity in the engineering process, 3) the results of the syllabus analysis show 13 basic competencies in the realm of skills that are in accordance with STEM characteristics, 4) The results of the student questionnaire show that there is a need for material STEM teaching that supports problem-solving abilities and involves students in product design as a solution to the problem. From the preliminary results of this study there are a number of things that are still lacking, such as the absence of direct observation of the implementation of learning using the STEM approach in class, the absence of an analysis of the Learning Implementation.

Author Contributions

Aay Susilawati conceptualization, which includes research ideas, design with methodology, data analysis, and coordination of respondents. Diana Rochintaniawati conceptualization has been carried out by reviewing investigation research, literature review and provided feedback on the manuscript. Lilik Hasanah and Iwan Kustiawan as a reviewer and validation instrument.

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Conflicts of Interest

Research directors and funders play a role in decisions regarding study design, data collection, analysis or interpretation, manuscript writing, or publication of results. This article is one of preliminary studies to prepare the article for further research.

References

Beier, M. E., Kim, M. H., Saterbak, A., Leautaud, V., Bishnoi, S., & Gilberto, J. M. (2019). The effect of authentic project-based learning on attitudes and career aspirations in STEM. *Journal of Research in Science Teaching*, *56*(1), 3–23. https://doi.org/10.1002/tea.21465

Chen, R., Zheng, Y., Xu, X., Zhao, H., Ren, J., & Tan, H. Z. (2020). STEM teaching for the internet of things maker course: A teaching model based on the iterative loop. *Sustainability (Switzerland)*, *12*(14), 1–20. https://doi.org/10.3390/su12145758

Cornetta, G. (2020). Fabrication-as-a-Service: A web-based solution for STEM education using internet of things. *IEEE Internet of Things Journal*, *7*(2), 1519–

1530. https://doi.org/10.1109/JIOT2956401

Denisa, L., & Hakim, L. (2021). Pengembangan E-Modul Kontekstual Akuntansi Perbankan Syariah Kelas XI Berbasis Flip Pdf Professional. *Jurnal Pendidikan Akuntansi (JPAK)*, *9*(1), 79–87. https://doi.org/10.26740/jpak.v9n1.p79-87

Ejiwale, J. A. (2019). Minimizing skills and training gaps through professional development course. *Journal of Education and Learning (EduLearn)*, *13*(3), 318–323. https://doi.org/10.11591/edulearn.v13i3.9151

Fidai, A. (2019). Internet of Things (IoT) Instructional Devices in STEM Classrooms: Past, Present and Future Directions'. *Proceedings - Frontiers in Education Conference, FIE*, 1–9. https://doi.org/10.1109/FIE43999.2019.9028679

Frumos, L. (2020). Inclusive education in remote instruction with universal design for learning. *Revista Românească Pentru Educație Multidimensională*, *12*(21), 138–142. Retrieved from https://www.ceeol.com/search/journal-detail?id=952

Hafni, R. N., Herman, T., Nurlaelah, E., & Mustikasari, L. (2020). The importance of science, technology, engineering, and mathematics (STEM) education to enhance students' critical thinking skill in facing the industry 4.0. *Journal of Physics: Conference Series*, *1521*(4), 1–7. https://doi.org/10.1088/1742-6596/1521/4/042040

Hanif, S., Wijaya, A. F. C., & Winarno, N. (2019). Enhancing Students' Creativity through STEM Project-Based Learning. *Journal of Science Learning*, *2*(2), 50. https://doi.org/10.17509/jsl.v2i2.13271

Harris, A., & de Bruin, L. R. (2018). Secondary school creativity, teacher practice and STEAM education: An international study. *Journal of Educational Change*, *19*(2), 153–179. https://doi.org/10.1007/s10833-017-9311-2

Hunker, J., Scheidler, A., Antonia, & Rabe, M. (2020). A systematic classification of database solutions for data mining to support tasks in supply chains. *Proceedings of the Hamburg International Conference of Logistics (HICL*, *29*, 395–425. https://doi.org/10.15480/882.3121

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

Kang, N. H. (2019). A review of the effect of integrated STEM or STEAM (science, technology, engineering, arts, and mathematics) education in South Korea. *Asia-Pacific Science Education*, *5*(1), 1–22. https://doi.org/10.1186/s41029-019-0034-y

Kelley, T. R., Knowles, J. G., Han, J., & Trice, A. N. (2021). Models of integrated STEM education. *Journal of STEM Education: Innovations and Research*, *22*(1), 1–12. Retrieved from https://www.jstem.org/jstem/index.php/JSTEM/article/view/2395

Khotimah, R. P., Adnan, M., Ahmad, C. N. C., & Murtiyasa, B. (2021). Science, Mathematics, Engineering, and Mathematics (STEM) Education in Indonesia: a Literature Review. *Journal of Physics: Conference Series*, *1776*(1), 012028. https://doi.org/10.1088/1742-6596/1776/1/012028

Lin, K. Y., Wu, Y. T., Hsu, Y. T., & Williams, P. J. (2021). Effects of infusing the engineering design process into STEM project-based learning to develop preservice technology teachers' engineering design thinking. *International Journal of STEM Education*, *8*(1). https://doi.org/10.1186/s40594-020-00258-9

Maarif, N. S. (2022). Peningkatan Ketrampilan Guru Dalam Penyusunan Modul Ajar Untuk Pembelajaran Kelas 1 Sd. *Jurnal Pendidikan Taman Widya Humaniora (JPTWH)*, *1*(1), 208–220. Retrieved from https://jurnal.widyahumaniora.org/index.php/jptwh/article/view/18

Mckibben, J. D. (2021). The Effect of Authenticity on Project-Based Learning: A Quasi-Experimental Study of STEM Integration in Agriculture. *Journal of Agricultural Education*, *62*(1). https://doi.org/10.5032/jae.2021.01144

Powell, W. A., Newhouse, A. E., & Coffey, V. (2019). Developing blight-tolerant American chestnut trees. *Cold Spring Harbor Perspectives in Biology*, *11*(7), 1–17. https://doi.org/10.1101/cshperspect.a034587

Ramadan, Z. H., & Ain, S. Q. (2022). Pelatihan Penyusunan Modul Pembelajaran Bagi Guru-Guru Sd di Kabupaten Inhil. *Journal of Human and Education*, *2*(1), 34–39. https://doi.org/10.31004/jh.v2i1

Rizaldi, D. R., Nurhayati, E., & Fatimah, Z. (2020). The Correlation of Digital Literation and STEM Integration to Improve Indonesian Students' Skills in 21st Century. *International Journal of Asian Education*, *1*(2), 73–80. https://doi.org/10.46966/ijae.v1i2.36

Suartama, I. K., Setyosari, P., Sulthoni, & Ulfa, S. (2020). Development of ubiquitous learning environment based on moodle learning management system. *International Journal of Interactive Mobile Technologies*, *14*(4), 182–204. https://doi.org/10.3991/ijim.v14i14.11775

Sumiati, E., Septian, D., & Faizah, F. (2018). Pengembangan modul fisika berbasis Scientific

Approach untuk meningkatkan Keterampilan Proses Sains siswa. *Jurnal Pendidikan Fisika Dan Keilmuan (JPFK)*, *4*(2), 75. https://doi.org/10.25273/jpfk.v4i2.2535

Widayanti, A., & Suyatna, A. (2019). Future physics learning materials based on STEM education: Analysis of teachers and students perceptions. *Journal of Physics: Conference Series*, *1155*(1). https://doi.org/10.1088/1742-6596/1155/1/012021

Yuni, S., Sahyar, & Bukit, N. (2021). Analysis the components of Science, Technology, Engineering, Art and Mathematics (STEAM) in Senior High School Physics Textbook. *Journal of Physics: Conference Series*, *1811*(1), 012118. https://doi.org/10.1088/1742-6596/1811/1/012118