Profile of the Need for STEM Teaching Materials in Science Learning in Vocational Schools

Aay Susilawati[1], Diana Rochintaniawati[2], Lilik Hasanah[3], Iwan Kustiawan[4], Nuryani Rustaman[5], Ida Kaniawati[6]

[1,2,3,4,5,6] Universitas Pendidikan Indonesia, Jl. Setiabudhi No. 229, Bandung, 40154, Indonesia

Coressponding Author. E-mail:

[1] aaysusilawati@upi.edu

Abstract

Science education in vocational schools has undergone several changes in subject characteristics. Science teachers need to understand these characteristics to facilitate the delivery and implementation of learning in the classroom. Therefore, the purpose of this article is to describe the requirements profile of needs for STEM teaching materials in science learning at vocational schools. The research methods used are descriptive and qualitative through field observations (field studies) derived from professional research in the form of curriculum documents, lesson plans, learning videos, and analysis of six science textbooks in vocational school. The results of a curriculum analysis from document, videos and textbooks on the availability of project-based STEM components in learning equipment plans and existing materials are still inadequate to support the life skills of 21st century professional students, and the following curriculum requirements are: Not yet supported. So, in future research need integration, project-based, and underlying skills according to competency skills in vocational school.

Keywords: Teaching Material, STEM, Science Learning in Vocational School

How to cite this article :

Susilawati, A., Rochintaniawati, D., Hasanah, L., Kustiawan, I., Rustaman, N. & Kaniawati, I.(2023). Profile of the Need for STEM Teaching Materials in Science Learning in Vocational Schools. *IJIS Edu : Indonesian Journal of Integrated Science Education, 5*(2), 145-153. doi:http://dx.doi.org/10.29300/ijisedu.v5i2.11160

INTRODUCTION

The Ministry of Culture and Education (Kemendikbud) is a national educational institution that plays an important role in improving the quality of education in accordance with the educational objectives of RI Law No. 20 of 2003, and the national education system ensures equal distribution of education. is needed. Improving the quality, adequacy and efficiency of education management, improving opportunities and promoting planned, targeted and sustainable education management to meet the challenges according to the changing demands of local, national and global life. It has become necessary to carry out educational reform in a way. In order to improve the quality of education and achieve its educational goals, the government created a special program for technical colleges (SMKs) as stipulated in the Minister of Education Decree, namely the "Center for Excellence School" programme. Did. Culture, Research and Technology No.165/M/2021.

The Center of Excellence Vocational High School Program aims to thoroughly and comprehensively adapt vocational training to the world of work and to serve as a base for improving the quality of vocational training and advocating for graduates who are immersed in the world of work. The aim is to produce graduates who will become entrepreneurs. Other schools (Ristek, 2019). One of the initiatives for the success of the Center of Excellence Vocational High School Program goals is the implementation of learning. Expected learning characteristics at Vocational School Centers of Excellence include enhancing students' non-technical (soft) and technical (hard) skills to meet the needs of society, and developing character for society. will be These Pancasila profile values are now the subject of sciences and scientific projects that have been merged with the natural sciences and social sciences cluster dai subjects and are related to the project, although in practice they are still being researched. Fundamentals of scientific workflow.

Given the nature of the Vocational School Center of Excellence Programme, guidelines and teaching materials that follow scientific procedures while being compatible with the nature of the integrated curriculum are required. Appropriate approaches may utilize science, engineering, and mathematics (STEM) approaches that incorporate engineering problem-solving properties (Ellis et al., 2020; English & King, 2019) and many integrate his STEM with project-based learning (Beier et al., 2019; Lin et al., 2021). Various studies on STEMPjBL with different outcomes such as improved creative thinking, problem solving, self-efficacy, knowledge and cognitive ability (Beier et al., 2019a; Ellis et al., 2020; English & King, 2019; Lin et al., 2021; Purzer et al., 2022).

A feature of the Center of Excellence program that plays a very important role is preparing students for the demands of industry. One of the technological developments that the industry currently needs is the use of technology based on the Internet of Things. By leveraging and matching student skills, you can create problem-based projects and generate solutions through the creation of IoT-based products. Several studies discuss his IoT-based product design at the Vocational School level as a means of adapting as technology evolves (Adam et al., 2021; Kotsifakos et al., 2019).

Developing teaching materials using a STEM-PjBL approach aimed at producing IoT-based products to promote creative thinking skills and responsiveness of science teachers at vocational school Center of Excellence. In Ability to Think Creatively, Creative Thinking is stated to be his four-step process consisting of 'preparation', 'cultivation', 'enlightenment' and 'verification' (Cavendish, 2021). The preparation phase includes problem identification and information gathering. In the later stage, incubation, there is no conscious control or new integration, and some unique views emerge from the subconscious. Zyga et al., (2022) say that Torrance has four facets to creative thinking, fluency (generating ideas), originality (generating unusual ideas), sophistication (perseverance to introduce detail into the product), and flexibility (generating ideas in different categories). Creative thinking skills have many different definitions, levels and dimensions in the literature and begin with simple experiences and discoveries that babies make in infancy. Babies understand through their senses, explore their bodies and their surroundings, use toys, and even solve simple problems through experimentation (Hyland, 2018).

In addition to the programs and materials that we develop, we really need to prepare the willingness of the teachers to implement and implement the Vocational School Center of Excellence Programme. Readiness is the overall state of a person's readiness to respond to situations in a particular way (Baran et al., 2019; Sarjana et al., 2022; Sawawa & Solehudin, 2018; Wahono et al., 2020). The solution to enable teachers to implement the curriculum lies in the socialization of the curriculum at the Center of Excellence and the training activities of the College Programme. Against this background, teachers are the most important driving force for the successful implementation of vocational school programs of competence centers in this field. All teachers must be equipped with teacher readiness and understanding of the spirit of modern curricula. Understanding the curriculum enables teachers to act in line with the goals and objectives of the curriculum. Teacher motivation and understanding of this syllabus is therefore critical to the success and achievement of the syllabus objectives. Against the background of the problems described above, it is considered important to conduct a field survey titled "Profile of needs for STEM teaching materials in science learning at vocational schools."

METHOD

The field study (qualitative description) used in the research method was used to gather information for the topic paper in the form of documents that included: 1) on a copy of Permen No. 165 of 2021, an independent curriculum analysis of the vocational school Center of Excellence program, 2) Analysis of the IPAS Project's Learning Outcomes in the Field of Technology, 3) Evaluation of Core Competency (KI) and Basic Competency (KD) in Science Subjects in Vocational Schools Technology Skills Programs, 4) K13 Syllabus for Physics and Chemistry Subjects in the Technology Expertise Program and Analysis of Learning Objectives Flow (ATP) Bakti Nusantara Vocational School 666 Bandung Regency IPAS Project version, 5) Analysis of STEM-Project RPP at Vocational School Bakti Nusantara 666 Kab. Bandung, Bhakti Nusantara Vocational School, Salatiga, Tunas Harapan Vocational School, and 6) Examination of videos from Tunas Harapan Vocational School that focus on STEM education 7) Six Textbooks, including two vocational science books on business and management competency skills, four vocational physics and chemistry books on competence expertise in information and communication technology and technology and engineering, and a specially developed module for teaching science projects. Figure 1 shows the procedures used in the research.

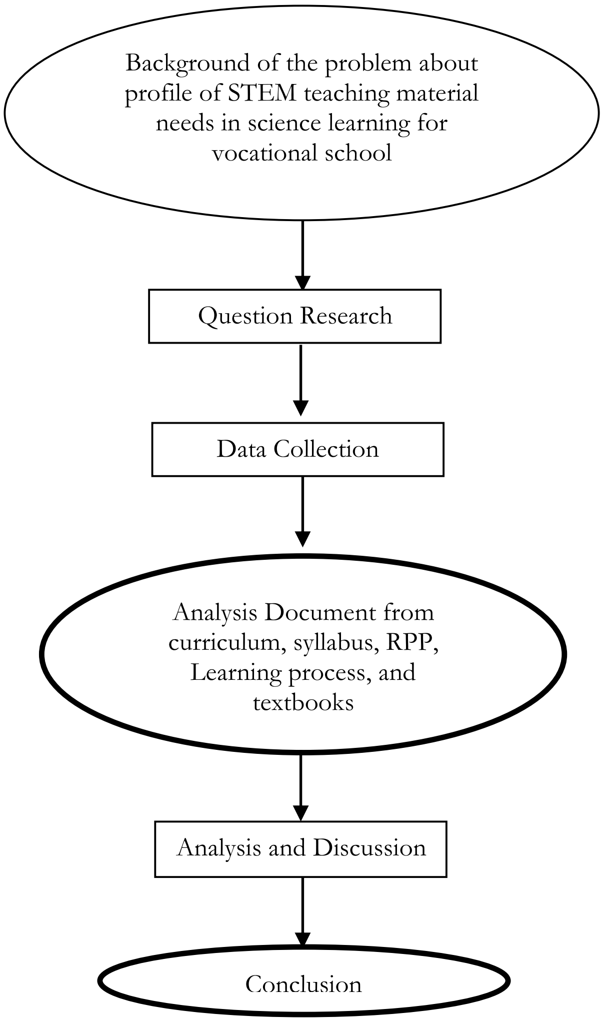

Figure 1. Research Scheme

RESULT AND DISCUSSION

Curriculum Analysis

The first analysis of the document was made by the Ministerial Decree No. 165/M of 2021 on Technical School Centers of Excellence Programs and Curriculum Analysis of 2013 (Ristek, 2019) and the Commissioner on Technical School Curriculum Structure. Based on Decree No. 130. (BSNP, 2017): By comparison, there are some changes in the characteristics of his 2013 curriculum using a unique curriculum based on his vocational school program at the Center of Excellence, the results of which are shown in Table 1. indicate.

Table 1. Differences between the 2013 curriculum and the Merdeka curriculum

No.	Aspect	2013 Curriculum	Merdeka Curriculum
1	Competency Based	Knowledge competency, Skills, social attitudes and spiritual attitudes	Integrate knowledge, skills and attitudes
2	Spectrum Skill at Vocational School	Based on the Director General Regulation Elementary Education No. 06 of 2018 there are 9 areas of expertise, 49 expertise programs, and 146 competency skills	Spectrum of Expertise Vocational School in 2021 there are 10 areas of expertise and 50 expertise programs
3	Character Strengthening	Penguatan Pendidikan Karakter (PPK) such as the school literacy movement, Adi Wiyata school, etc	Strengthening Pancasila student profiles and character development work culture
4	Curriculum Structure	Grouping of subjects is divided into 3: group A National Content (A), Regional Content (B), Basic Areas of Expertise (C1), Basic Expertise Programs (C2), and Expertise Competency (C3, as well as local content)	The grouping of subjects is divided into 2 namely the general group (A) and the vocational group (B) and programs to strengthen the Pancasila profile and work culture
5	Subject	Science, Physics, Chemistry are included in C1 (Basic content of productive), their availability is adjusted to the needs of the expertise program each in class X	The IPAS Project (integration of science and social studies subjects) is included in the vocational group (B) for all expertise programs in class X
6	Achievement Competence Minimum	Core Competency and Basic Competencies	Learning Achievement

Analisys of Basic Competencies and Learning Achievement

The second document analysis was a basic competencies analysis in learning achievement Phase E of the cross-disciplinary subjects Physics, Chemistry, and Science in the Technology Skills Program in Syllabus 13 and the Science Project subjects in the All Skills Program in the Vocational School for merdeka curriculum syllabus is showing. The results of the project analysis are shown in Table 2.

Table 2. STEM Analysis on Basic Competencies and Learning Outcomes

Basic Competenties 4. (Skills Competency)	Learning Achievement Fase E
Physics 4.6 Presenting the results of an investigation regarding the killing of heat using the black principle 4.7 Overcome various problems caused by static electricity in information technology components and communication 4.10 Write a paper about the effects of electromagnetic radiation	**Project IPAS** At the end of phase E, students are expected to be able to understand and create information texts, describe events and phenomena, report experiments, present and evaluate data, provide explanations, and present opinions or claims according to the scope of their area of expertise. Domain reach
Chemistry 4.4 Solve problems related to the concept of relative molecular mass and the concept of moles 4.5 Solve problems related to basic laws and chemical equations 4.9 Submit ideas/ideas to overcome the corrosion process based on the factors that influence it in everyday life through experiments conducted 4.10 Proposing ideas to overcome the negative impact of radiochemistry	1. Explain phenomena scientifically. Students are expected to be able to understand scientific knowledge and apply it; or make simple predictions accompanied by proof. Students explain the phenomena that occur in the surrounding environment seen from various aspects such as **living things and their environment; substances and their changes; energy and its changes; earth and space; spatial and connectivity between space and time**; Students also associate these phenomena with technical skills in their area of expertise. 2. Design and evaluate scientific investigations 3. Translate data and evidence scientifically

Analisys RPP

The fourth analysis of the document is the analysis of the Learning Implementation Plan (RPP), in which there are 3 RPPs analyzed that are already STEM-based so that aspects of science, technology, engineering and mathematics are depicted. The results of the analysis of STEM availability can be seen in table 3.

Table 3. Comparison of the availability of STEM aspects and the EDP process in the RPP

No	Indicators	Cheklist RPP 1	RPP 2	RPP 3
1	There is an element of science (conducting experiments, trials, investigations, product design) which is problem oriented	√	√	√
2	There are technical elements that facilitate conducting research and designing experiments and products.	√	√	√
3	There is an engineering element as a process design in designing a product or process as a solution to a problem, by implementing EDP, among others:	√	√	√
	Ask (what are the problems? What are the constraints?)	√	-	-
	Image (Brainstrom ideas and choose the best one)	√	-	√
	Plan (Draw diagram, gather needed materials)	√	√	√
	Create (Follow the plan, Test it out)	√	√	√
	Improve (Discuss what can work better, Repeat Steps 1-5 to make changes)	-	-	-
4	Mathematics to interpret and analyze information, simplify and solve problems, assess risks, make informed decisions, and gain a deeper understanding of the world around you modeling abstract and concrete problems	√	√	√
5	There is an integrated element of project creation according to the expertise program	-	√	-

Notes:
RPP 1: Vocational School Bakti Nusantara 666 Name Project STEM Miniatur transportasi listrik sederhana
RPP 2: Vocational School Tunas Harapan Pati Name Proyek Rancangan APOFO
RPP 3: Vocational School Bhakti Nusantara Salatiga Perakitan Barang dan Jasa

Learning Video Analysis

Apart from lesson plans, the fifth document analysis is a video analysis of the implementation of STEM-based learning, there are two videos taken from the documentation of the implementation of STEM learning uploaded on YouTube, while the results are shown in table 4.

Table 4. Availability of STEM aspects and the EDP process in the Learning Implementation Video

No	Indicators	Checklist Video 1	Video 2
1	There is an element of science (conducting experiments, trials, investigations, product design) which is problem oriented	√	√
2	There are technical elements that facilitate conducting research and designing experiments and products.	√	√
3	There is an engineering element as a process design in designing a product or process as a solution to a problem, by implementing EDP, among others:	√	√
	Ask (what are the problems? What are the constraints?)	√	√
	Image (Brainstrom ideas and choose the best one)	√	√
	Plan (Draw diagram, gather needed materials)	√	√
	Create (Follow the plan, Test it out)	√	√
	Improve (Discuss what can work better, Repeat Steps 1-5 to make changes)	-	√
4	Mathematics to interpret and analyze information, simplify and solve problems, assess risks, make informed decisions, and gain a deeper understanding of the world around you modeling abstract and concrete problems	√	√
5	There is an integrated element of project creation according to the expertise program	-	√

Notes:
Video 1: STEM Learning (KIMIA: indikator Asam basa)_ Vocational School Tunas Harapan Pati which is on the youtube link: **https://www.youtube.com/watch?v=wCynENyaumo**
Video 2: Implementation of Learning 5E learning model (learning cycle 5E) with STEM approach at Public Vocational School 2 Kebumen about repairing the AC system on cars, which is on the link: https://www.youtube.com/watch?v=x5EG9y2z8Z0

Textbooks Analysis

An analysis of textbooks was conducted to see whether STEM learning components were present in the learning guides (Weninger, 2018). The third document analysis is a book analysis, and the books analyzed are books on the application of the 2013 curriculum, so the parts analyzed are only related to heat transfer materials, static electricity, electromagnetic radiation and relative molecular weight using the black principle related to the concept of moles, basic laws and chemical equations, corrosion and radiochemical processes. The results of the IT and MINT process availability analysis are shown in Table 5.

Table 5. Book analysis on the availability of STEM projects in Vocational School

No	Subject Matter	STEM Characteristics							
		Science	Technology	Engineering					Math
				Ask	Image	Plan	Create	Improve	
Tittle Book: Physics in the Field of Technology and Communication Expertise at Vocational School class X Bumi Aksara Publishers									
1	Azas Black (Page 133)	√	-	-	-	-	-	-	-
2	Static electricity (Page 153)	√	√	-	-	-	-	-	-
3	Electromagnetic radiation (Page 191)	√	√	-	-	-	-	-	-
Tittle Book: Physics in the Field of Technology and Engineering Expertise at Vocational School class X Bumi Aksara Publishers									
1	Azas Black (Page 125)	√	-	-	-	-	-	-	-
2	Static electricity (Page 143)	√	√	-	-	-	-	-	-
3	Electromagnetic radiation (Page 155)	-	-	-	-	-	-	-	-
Tittle Book: Physics in the Field of Technology and Engineering Expertise at Vocational School class X Sinar Mandiri Publisher									
1	Azas Black (Page 177)	√	√	-	√	√	-	-	√
2	Static electricity (Page 193)	√	√	-	-	-	-	-	-
3	Electromagnetic radiation (Page 289)	√	√	-	-	-	-	-	-
Tittle Book: Physics C1 Field of Technology, Information and Communication Expertise for Vocational School class X Bumi Publisher CV Mediatama									
1	Azas Black (Page 65)	√	-	-	-	-	-	-	-
2	Static electricity (Page 74)	√	-	-	-	-	-	-	-
3	Electromagnetic radiation (Page 101)	-	-	-	-	-	-	-	-
Tittle Book: Chemistry in Technology and Communication Skills for Vocational School class X Bumi HUP Publisher									
1	Relative molecular mass and moles concept (Page 53)	√	-	-	-	-	-	-	-
2	Basic laws and chemical equations (Page 67)	√	√	√	√	-	-	-	√
3	Corrosion process (Page 174)	√	√	√	√	√	-	-	√
4	Radiochemistry (Page 180)	√	-	-	-	-	-	-	-
Tittle Book: Chemistry C1 Field of Technology and Engineering Expertise for Vocational School class X Bumi Publisher CV Mediatama									
1	Relative molecular mass and moles concept (Page 124)	√	√	√	√	-	-	-	√
2	Basic laws and chemical equations (Page 138)	-	-	-	-	-	-	-	_
3	Corrosion process (Page 168))	-	-	-	-	-	-	-	_
4	Radiochemistry (Page 180)	-	-	-	-	-	-	-	_

Based on the analysis of multiple documents such as curriculum documents, teaching materials, lesson plans, videos, etc. and the focus of the problem, several conclusions can be drawn: 1) Curriculum development focuses on the integration of multiple subjects, learning is more project-based, and IPAS project subject learning outcomes are given areas based on scientific methods. 2) textbooks commonly used in schools do not yet fully cover his STEM aspects such as computing steps, practical implementation procedures, project design, and still support subject competency programs; 3) Lesson plans and instructional videos created in his project-based STEM subjects have not yet clearly recognized the ambiguity of the EDP process, especially the improvement steps.

Consistent with his STEM character of project-based integration of multiple disciplines (Donmez, 2020; Nuraeni et al., 2020). Following IPAS project characteristics and his many project-based STEM references, including:

(Beier et al., 2019b; McKibben & Murphy, 2021; Siew & Ambo, 2018), especifically for his SMC tailored to the subject competency program (Hyland, 2018; Nantsou et al., 2021). As her EDP process is very important in conducting STEM learning, teaching materials are also provided that can support his conducting STEM learning that is suitable for the EDP process (Abdurrahman et al., 2023; Duong et al., 2022; Nusyirwan & Prayetno, 2020).

The implementation of this field study is not yet complete as some limitations remain, such as: 1) Document analysis for foundational skills is still limited to technology competency programs and cannot be performed for science subjects in other competency programs. 2) The analyzed materials are still very few, he had 6 unanalyzed textbooks on science subjects. Because there was no technical expertise program, only chemistry and physics in engineering. 3) Although the lesson plans used were still limited by different schools and different subjects, there is still the integration of science subjects and the integration of lesson plans with observation of learning practices. If the (videos) are out of sync or not from the same source, it would be better if the lesson plans and implementation observations were from the same source.

CONCLUSION

The results of a curriculum analysis on the availability of project-based STEM components in learning equipment plans and existing materials are still inadequate to support the life skills of 21st century professional students, and the following curriculum requirements are: Not yet supported. Next, you need integration, project-based, and underlying skills according to your competency skills. Field research results provide advice for designing technology-integrated, project-based STEM materials to guide science learning in college technology literacy programs.

REFERENCES

Abdurrahman, A., Maulina, H., Nurulsari, N., Sukamto, I., Umam, A. N., & Mulyana, K. M. (2023). Impacts of integrating engineering design process into STEM makerspace on renewable energy unit to foster students' system thinking skills. *Heliyon*, *9*(4), 1-12. https://doi.org/10.1016/j.heliyon.2023.e15100

Adam, A., Yusuf, H. A., Abubakar, A., Labaran Ali, I., & Usman, S. (2021). Green supply chain management and performance of listed oil and gas firms in Nigeria: A moderating role of internet of thing. *In Gusau Journal of Accounting and Finance (GUJAF)*, 2 (2), 1-23. https://doi.org/10.57233/gujaf.v2i2.61

Baran, E., Bilici, S. C., Mesutoglu, C., & Ocak, C. (2019). The impact of an out- of- school STEM education program on students' attitudes toward STEM and STEM careers. *School Science and Mathematics*, *119*(4), 223–235. https://doi.org/10.1111/ssm.12330

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

BSNP. (2017). Keputusan Direktur Jenderal Pendidikan Dasar dan Menengah Nomor : 130/D/KEP/KR/2017 tentang Struktur Kurikulum Pendidikan, 1-4. Retrieved from: https://dikdasmenpdmlamtim.files.wordpress.com.

Cavendish, Margaret. (2021). Philosophical letters (Sin, Ed.). *Londres*, 1-22. Retrieved from: http://www.trevorpearce.com.

Donmez, I. (2020). STEM Education Dimensions: from STEM Literacy to STEM Assessment. In S. Idin (Ed.), Research highlights in education and science 2020, *ISRES Publishing*, 3, 154–170. Retrieved from: https://www.isres.org/

Duong, X. Q., Nguyen, N. H., Nguyen, M. T., & Thao-Do, T. P. (2022). Applying stem engineering design process through designing and making of electrostatic painting equipment in two rural schools in Vietnam. *Jurnal Pendidikan IPA Indonesia*, *11*(1), 1–10. https://doi.org/10.15294/jpii.v11i1.31004

Ellis, J., Wieselmann, J., Sivaraj, R., Roehrig, G., Dare, E., & Ring-Whalen, E. (2020). Toward a productive definition of technology in science and STEM education. *Contemporary Issues in Technology and Teacher Education*, *20*(3), 472–496. Retrieved from: https://citejournal.org.

English, L. D., & King, D. (2019). STEM integration in sixth grade: Desligning and constructing paper bridges. *International Journal of Science and Mathematics Education*, *17*(5), 863–884. https://doi.org/10.1007/s10763-018-9912-0

Hyland, T. (2018). Beyond the vocational/academic divide: Inclusion through craftwork and embodied learning. *Springer Nature*. 209-231. Retrieved from: https://link.springer.com/chapter/10.1007/978-3-319-90671-3_9

Kotsifakos, D., Makropoulos, G., & Douligeris, C. (2019). Teaching Internet of Things (IoT) in the electronics specialty of vocational education and training. *IEEE*, 1–6. Retrieved from: https://doi.org/10.1109/SEEDA-CECNSM.2019.8908384

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). 1-15. https://doi.org/10.1186/s40594-020-00258-9

McKibben, J., & Murphy, T. (2021). The effect of authenticity on project-based learning: A quasi-experimental study of STEM integration in agriculture. *Journal of Agricultural Education*, *62*(1), 144–155. https://doi.org/10.5032/jae.2021.01144

Nantsou, T. P., Kapotis, E. C., & Tombras, G. S. (2021). A lab of hands-on STEM experiments for primary teachers at CERN. *IEEE Global Engineering Education Conference, EDUCON*, 582–590. https://doi.org/10.1109/EDUCON46332.2021.9453915

Nuraeni, F., Malagola, Y., Pratomo, S., & Putri, H. E. (2020). Trends of science technology engineering mathematics (STEM)-based learning at elementary school in Indonesia. *Premiere Educandum: Jurnal Pendidikan Dasar dan Pembelajaran*. *11*(2), 87–103. https://doi.org/10.25273/pe.v11i1.8805.

Nusyirwan, D., & Prayetno, E. (2020). Mengajar engineering design process untuk memperkenalkan STEM pada siswa Madrasah Ibtidaiyah Raudhatul Qur'an. *Warta Pengabdian*, *9*(2), 143-150. https://doi.org/10.19184/wrtp.v14i4.19726

Purzer, Ş., Quintana-Cifuentes, J., & Menekse, M. (2022). The honeycomb of engineering framework: Philosophy of engineering guiding precollege engineering education. *Journal of Engineering Education*, *111*(1), 19–39. https://doi.org/10.1002/jee.20441

Ristek, K. (2019). Salinan Keputusan Menteri Pendidikan, Kebudayaan, Riset dan Teknologi Republik Indonesia tentang Program SMK Pusat Keunggulan, 1-73. Retrieved from: https://ayogurubelajar.kemdikbud.go.id

Sarjana, K., Turmuzi, M., Tyaningsih, R. Y., Lu'luilmaknun, U., & Kurniawan, E. (2022). Faktor-faktor penentu keberhasilan belajar mahasiswa pendidikan matematika di era new normal. *Jurnal Ilmiah Profesi Pendidikan*, *7*(2), 309–316. https://doi.org/10.29303/jipp.v7i2.303

Sawawa, D., & Solehudin, A. (2018). Pengaruh faktor internal dan eksternal siswa terhadap hasil belajar pada mata pelajaran mekanika teknik dan elemen mesin. *Journal of Mechanical Engineering Education*, *5*(1), 21–27. https://doi.org/https://doi.org/10.17509/jmee.v5i1.12615

Siew, N. M., & Ambo, N. (2018). Development and evaluation of an integrated project-based and STEM teaching and learning module on enhancing scientific creativity among fifth graders. *Journal of Baltic Science Education*, *17*(6), 1017–1033. Retrieved from: https://eric.ed.gov/?id=EJ1315662

Wahono, B., Lin, P. L., & Chang, C. Y. (2020). Evidence of STEM enactment effectiveness in Asian student learning outcomes. In *International Journal of STEM Education*, 7 (1). 1-18. Springer. https://doi.org/10.1186/s40594-020-00236-1

Weninger, C. (2018). Textbook analysis. In *The Encyclopedia of Applied Linguistics*, 1–8. Wiley. https://doi.org/10.1002/9781405198431.wbeal1489

Zyga, O., Ivcevic, Z., Hoffmann, J., & Palomera, R. (2022). Developmental trends in creative ability: A cross-sectional examination of figural and verbal domains across the school-age years. *Psychology of Aesthetics, Creativity, and the Arts*, *16*(2), 196–208. https://doi.org/https://doi.org/10.1037/aca0000425