International Journal of Progressive Sciences and Technologies (IJPSAT)
ISSN: 2509-0119.

Vol. 34 No. 1 August 2022, pp. 441-449

The Effect Of STEM Integrated Modules On Knowledge And Students' 21st Century Skill In Science And Physics Learning: A Meta Analysis

Naurah Nazifah[1] and Asrizal[2*]

[1]Magister of Physics Education
Faculty of Mathematics and Natural Sciences, Universitas Negeri Padang
Padang, Indonesia
naurahnazifah13@gmail.com

[2]Lecturer of Physics Education
Faculty of Mathematics and Natural Sciences, Universitas Negeri Padang
Padang, Indonesia
asrizal@fmipa.unp.ac.id

Abstract— Industrial revolution 4.0 students are required to have 21st century skills. These skills include critical thinking, creativity and innovation, communication, and collaboration. Teachers in the learning process teachers play a role in improving student skills. The learning method that can be used by teachers in improving students' 21st century skills is STEM (science, technology, engineering and mathematics). STEM indicators in learning can be integrated in a learning material in the form of a module. Modules can assist teachers in presenting learning information that is easy for students to understand. This study analyzes the effect of STEM integrated modules in science and physics learning on the knowledge and skills of 21st century students determined through effect sizes. Research data obtained from 20 articles. The analysis was carried out based on the category of education level, type of learning material and physics and science subject matter. The results show that stem-based modules are more effective if applied at the high school level with electronic module learning materials. The results of the analysis show that the use of integrated STEM modules is effective in improving the knowledge and skills of 21st century students.

Keywords— ***Modules, STEM, 21st Century Skill***

I. INTRODUCTION

In the industrial revolution 4.0 era, human resources must be able to compete with the wider community. One of the skills that must be possessed is 21st century skills. Mastery of technology is an important thing that must be mastered in the 21st century [1]. The development of science and technology affects the challenges and global competition faced by every country. Therefore, every country prepares human resources to master various skills in order to become a successful person in life.

Government efforts in creating human resources have various 21st century skills through the education sector. Education graduates must have good competencies to exist in the 21st century [2]. There are four skills needed by education graduates in the 21st century, namely ways of thinking, ways of working, tools for working, and skills for living in the world [3]. On this basis, all who play a role in education need to seek and develop these skills in learning activities.

Corresponding Author: Asrizal

These 21st century skills include critical thinking and problem solving, creativity and innovation, communication, and collaboration [4]. Critical thinking skills are skills to carry out various analyses, assessments, evaluations, reconstructions, decision making that lead to rational and logical actions towards solving a problem [5]. Creativity is the skill of finding new ideas, the ability to innovate, the ability to generate various kinds of ideas in solving problems outside the usual categories, providing unique responses, turning ideas into reality and being able to capture and produce various problems in response to a situation [6] [7]. Communication skills are basic skills that everyone has to express new thoughts, ideas, knowledge, and information in oral and written communication. Collaboration skills are the skills to work together to build relationships with others, the ability to value relationships to achieve common goals and [8].

Students 21st century skill learning has the following principles: contextual, related to community life, student-centered and collaborative [9]. Teachers play an important role in achieving the learning process.Teachers are required to provide diverse learning experiences both mentally, physically and socially for students [10]. so that it becomes meaningful learning. 21st century learning requires teachers to direct their students to be creative in managing everyday problems. One learning approach that is able to realize the achievement of 21st century competencies is STEM (Science, Technology, Engineering, and Mathematics) integrated learning[11] [12].

STEM-based learning is a new approach in the development of the world of education that integrates more than one scientific discipline which makes the future generation creative and innovative [13]. The purpose of STEM-based learning is also to make students have a balance between hard and soft skills, and have creativity [14]. STEM integrated learning is learning that is compatible with the applicable curriculum system in Indonesia [15]. Thus, STEM integrated learning will have a good impact on learning, including learning science and physics.

To support the success of STEM integrated learning, especially in learning science and physics, a teaching material is needed. Teaching materials directly affect the learning that will be given by the teacher. For this reason, the selection of teaching materials is very important [16] Teaching materials that can be used by students to learn independently without or with teacher guidance are modules. Modules are teaching materials that are arranged systematically and attractively, including content, methods, evaluations and can be used independently [17]. Modules are divided into two types, namely print modules and non-printed modules called electronic modules. In the module there is control over learning outcomes through the use of competency standards in each module that must be achieved by students, and they become more responsible for their actions. It is hoped that the more active students are, the better the quality of learning outcomes obtained [18].

After conducting an initial study by looking for several articles related to the use of integrated STEM modules in science and physics learning on 21st century knowledge and skills, there are similarities from the results of research that have been carried out and present research results in a wider scope. Contrary to this explanation, the researcher is interested in conducting research on the effect size analysis of the use of integrated STEM modules in science and physics learning on 21st century students' knowledge and skills. The purpose of this research is to1) determine the effect size of the module STEM integratedon 21st century students' knowledge and skills based on education level. 2) determine the effect size of the module STEM integratedon students' 21st century knowledge and skills by module type. 3) determine the effect size of the module STEM integratedin learning science and physics to knowledge. 4) determine the effect size of the module STEM integratedin learning science and physics on students' 21st century skills.

II. Research Methods

This study uses a type of meta-analysis research. Data collection was carried out by reviewing 20 articles in international and national journals from 2016 to 2020. The keywords used in this search were teaching materials in the form of modules, STEM, student learning outcomes and 21st century skills of students. The steps for reviewing the article are determining and studying the research topic, choosing the type of article publication, collecting articles, analyzing moderator variables, recording statistical data, calculating effect sizes, drawing conclusions, and interpreting the results of article reviews [19]. Determining the effect size of each research data, can be determined using several equations [20]. After the effect size of each data is calculated based on the appropriate formula, then the effect size is categorized at 3 levels [21]. First, if the ES value is between 0.0 to 0.2 then the value is in the low category. Second, if the ES value is between 0.2 to 0.8 then the value is categorized as moderate. Third, if the ES value is greater than 0.8 then it can be categorized as high.

III. RESULT AND DISCUSSION

a. Effects of STEM Integrated Modules Based on Educational Level

The first results in this study are related to the effect of the integrated STEM module in science and physics learning on 21st century students' knowledge and skills in terms of elementary, junior high and high school education levels. Of the 20 articles included in the article review, there are 3 articles on STEM integrated modules in science learning for elementary school students, 8 articles on integrated STEM modules in science learning for junior high school students and 9 articles on integrated STEM modules in learning physics for high school students. in Table 2.

Table 2.STEM Integrated Module Effect Size by Education Level

Category	Educational Stage	Article Code	Writer	Effect Size	Average
Physics	Senior High School	K1	(Gustria et al., 2020) [22]	2.63	1.90
		K2	(Aulia et al., 2021) [23]	0.47	
		K3	(Nisa et al., 2020) [24]	4.49	
		K4	(Arnila et al., 2021) [25]	0.21	
		K5	(Safitri et al., 2019) [26]	1.68	
		S1	(Azman., 2020) [27]	0.52	1.13
		S2	(Adlim et al., 2015) [28]	1.21	
		S3	(Suryatna et al., 2020) [29]	2.17	
		S4	(Cahyani et al, 2020) [30]	0.63	
Science	Junior High School	K6	(Standish et al., 2016) [31]	1.18	0.91
		K7	(Ozcan & Koca, 2019) [32]	0.8	
		K8	(Prasetyo et al., 2021) [33]	0.49	
		K9	(Utami Et Al., 2020) [34]	1.15	
		S5	(Shahali, 2016) [35]	0.5	1.71
		S6	(Ozcan et al., 2019 [36]	1.59	
		S7	(Almuharomah et al., 2019) [37]	0.92	
		S8	(Rusyati et al., 2020) [38]	3.81	
	Elementery School	K10	(Arsad et al., 2017) [39]	0.21	0.21
		S9	(Arsad & Osman, 2019) [40]	0.11	1.58
		S10	(Siew & Ambo, 2018) [41]	3.04	

Based on the data presented in Table 2, it can be explained that the STEM integrated module has a significant effect on the 21st century student's knowledge and skill competence in science and physics learning. The results of the data analysis show that there are differences in the value of the effect size on the 21st century students' knowledge and skill competencies between science learning in junior high school and elementary school and high school physics learning. First, the application of the STEM integrated module in high school physics with an effect size of 1.90 has a significant effect on students' knowledge competence

than in junior and elementary science learning. In physics learning, STEM helps students to use technology and collect experiments that can prove laws or concepts. Science [42].

Second, the application of the STEM integrated module in junior high school science learning with an effect size of 1.71 has a higher effect on students' 21st century skills than elementary science learning and high school physics learning. STEM in junior high school is a combination of several science subject areas to become one subject. Integrated science learning materials will be able to answer the challenges of the 21st century. Learning materials are connected with phenomena and facts that occur around students [43]

b. STEM Integrated Module Effects Based on by Module Type

The second result is related to the effect of STEM integrated modules in science and physics learning on 21st century students' knowledge and skills based on the type of module. Module is one type of teaching materials. There are 2 types of modules, namely print modules and non-printed modules or electronic modules. Of the 20 articles analyzed, 12 articles are STEM integrated modules in science and physics learning and 8 articles are STEM integrated electronic modules in science and physics learning. The average value of the effect size can be seen in Table 3.

Table 3.STEM Integrated Module Effect Size By Module Type

Module Type	Article Code	Effect Size	Average
Module	K3	4.49	1.38
	K5	1.68	
	K6	1.18	
	K9	1.15	
	K10	0.21	
	S1	0.52	
	S2	1.21	
	S5	0.5	
	S6	1.59	
	S7	0.92	
	S9	0.11	
	S10	3.04	
E-Module	K1	2.63	1.47
	K2	0.47	
	K4	0.21	
	K7	0.8	
	K8	0.49	
	S3	2.17	
	S4	1.15	
	S8	3.81	

Based on the data analysis in Table 3, the average value of effect size for the type of printed module teaching materials is 1.38 in the high category and the average value for the effect size for the type of electronic module teaching material is 1.47 in the high category. On the other hand, the average value of the highest effect size is on the type of electronic module teaching materials. This shows that the influence of STEM integrated electronic modules in science and physics learning is effective in improving students' 21st century knowledge and skills.

The development of technology in the digital era as it is today, the needs of daily life are influenced by the use of electronics. In the education sector there is an electronic use of teaching aids in schools, one of which is an electronic module [44]. The electronic module is a form of presenting self-study materials that are systematically arranged to achieve certain learning objectives which are presented in an electronic format which includes images, animations, audio, video, and navigation that make users more interactive with the program [45]. The reason for using electronic modules can attract students' interest in learning independently.

c. STEM integrated effect on Knowledge

The third result of research related to the effect of STEM integrated modules in learning science and physics on students' knowledge. Of the 20 articles analyzed, there were 10 articles on students' knowledge. Learning outcomes on aspects of student knowledge are obtained from test results. The test can be in the form of objective and essay. The average value of the effect size of the integrated STEM module in science and physics learning on knowledge can be seen in Figure 1.

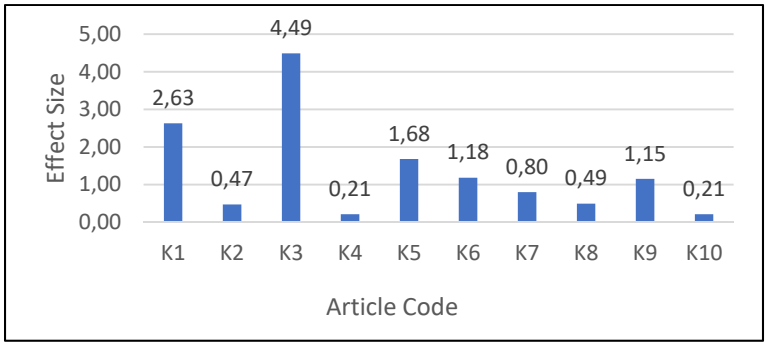

Figure 1. Effect Size of STEM Integrated Module in Science and Physics Learning on Students' Knowledge

Based on Figure 1, it can be explained that the average value of the effect size for each journal is different. The value of the effect size of the STEM integrated module in learning science and physics on knowledge is the lowest in articles J8 and J19, while the highest effect value is in articles J7. The average value of the influence of the STEM integrated module in learning science and physics on students' knowledge is 1.33 which is in the high category. This shows that the STEM integrated module in science and physics learning has a significant effect on students' knowledge.

d. Effects of STEM Integrated Modules On Students' 21st Century Skills

The results of the next analysis are 10 articles about STEM integrated modules in science and physics learning for students' 21st century skills. These 21st century skills include critical thinking and problem solving, creativity and innovation, communication, and collaboration. The average value of the effect size of the STEM integrated module in science and physics learning on students' 21st century skills can be seen in Figure 2.

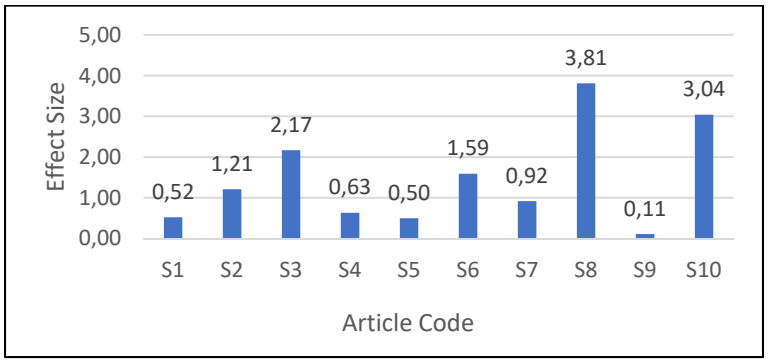

Figure 2. Effect Size of STEM Integrated Modules in Science and Physics Learning on Students' 21st Century Skills

Based on Figure 2, it can be analyzed that the average value of the effect size of each journal is different. The effect size value of the integrated STEM module in science and physics learning on 21st century students' skills is in article J18, while the highest effect size value is in article J17. The average value of the influence of STEM integrated modules in science and physics learning on 21st century skills of students is 1.60 in the high category. This shows that the STEM integrated module in science and physics learning has a significant impact on students' 21st century skills.

Analysis of the average results of the effect size of STEM integrated modules in science and physics learning on students' 21st century knowledge and skills. The results of the calculation of the effect size show that the use of integrated STEM modules in science and physics learning has a significant influence on the 21st century students' knowledge and skills. The module has been proven to be effective in increasing students' competence [46]. Implementation of STEM in education can encourage students to design, develop, and utilize technology to hone cognitive, manipulative and effective, and apply knowledge. This question is in accordance with previous researchers who also stated that STEM integrated learning can affect students' authentic assessment consisting of cognitive, affective and psychomotor aspects [48].

First, confirm that you have the correct template for your paper size. This template has been tailored for output on the A4 paper size. If you are using US letter-sized paper, please close this file and download the file “MSW_USltr_format”.

e. Maintaining the Integrity of the Specifications

The template is used to format your paper and style the text. All margins, column widths, line spaces, and text fonts are prescribed; please do not alter them. You may note peculiarities. For example, the head margin in this template measures proportionately more than is customary. This measurement and others are deliberate, using specifications that anticipate your paper as one part of the entire proceedings, and not as an independent document. Please do not revise any of the current designations.

IV. Conclusion

Based on the data that has been analyzed, four results from this study can be stated. First, the use of integrated STEM modules in science and physics learning is more effective if it is carried out at the high school level. Second, from the subject, the type of module will be more effective if it is applied in an integrated STEM electronic module. Third, the use of integrated STEM modules in science and physics learning has a significant influence in increasing students' knowledge competence. Fourth, the use of integrated STEM modules in science and physics learning has a significant impact in improving students' 21st century skills.

References

[1] Griffin, P., & Care, E. (Eds.). (2014). Assessment and teaching of 21st century skills: Methods and approach. Springer.

[2] Asrizal, A., Amran, A., Ananda, A., & Festiyed, F. (2018, April). Effectiveness of adaptive contextual learning model of integrated science by integrating digital age literacy on grade VIII students. In IOP Conference Series: Materials Science and Engineering (Vol. 335, No. 1, p. 012067). IOP Publishing.

[3] Germaine, Ron, et all. (2016). Purposeful Use of 21st Century Skills in Higher Education. Journalof Research in Innovative Teaching. Volume 9, Issue 1

[4] Redhana, I. W. (2019). Mengembangkan keterampilan abad ke-21 dalam pembelajaran kimia. Jurnal Inovasi Pendidikan Kimia, 13(1).

[5] King, F.J., Goodson, L., M.S., dan Rohani, F., (2010). Higher Order Thinking Skills. Assessment dan Evaluation Educational Service Program

[6] Munandar, Utami. (2004). Pengembangan Kreativitas Anak Berbakat. Jakarta: Pusat Perbukuan Depdiknas dan Rineka Cipta

[7] Patmawati, K, Puspitasari, N., Mutmainah, S. N., & Prayitno, B.E. (2019). Profil Kemampuan Berfikir Kreatif Ditinjau dari Kemampuan Akademik Mahasiswa. Edu Sains: Jurnal Pendidikan Sains dan Matematika, 7(2), 11-18.

[8] Greenstein, L., (2012). Assessing 21st Century Skills: A Guide to Evaluating Mastery and Authentic Learning. California: Corwin

[9] Asrizal, Amran, Ananda, Festiyed, & Sumarmin. (2018). The Development of Integrated Science Instructional Materials to Improve Students Digital Literacy in Scientific Approach. Jurnal Pendidikan IPA Indonesia, 7(4), 442-450.

[10] Festiyed. (2013). Perubahan Paradigma Proses Pembelajaran dalam Memberikan Layanan Profesional Berbasis Karakter. Seminar Nasional MIPA danPMIPA IAIN Sulthan Thaha Saifuddin Jambi, (hal. 1-27).

[11] Patmawati, K, Puspitasari, N., Mutmainah, S. N., & Prayitno, B.E. (2019). Profil Kemampuan Berfikir Kreatif Ditinjau dari Kemampuan Akademik Mahasiswa. Edu Sains: Jurnal Pendidikan Sains dan Matematika, 7(2), 11-18.

[12] Cropley, David H. (2015). “Promoting Creativity and Innovation in Engineering Education Why Do We Need Creativity and Innovation in Engineering ?” (May).

[13] Roberts, Julia Link. (2015). “Innovation and STEM Schools.” National Consortium of Secondary STEM Schools 20(1): 28–29

[14] Sunarno, W. (2018). Pembelajaran IPA di Era Revolusi Industri 4.0. Makalah Utama dalam Seminar Nasional Pendidikan Fisika IV 2018 di Universitas PGRI Madiun Tanggal 25 Juli 2018.

[15] Rustaman, N, Y. (2016). Pembelajaran Sains Masa Depan Berbasis STEM Education. Prosiding Seminar Nasional Biologi Edukasi. STKIP PGRI Sumatera Barat.

[16] Zulaiha, F., & Kusuma, D. (2020). Pengembangan Modul Berbasis STEM untuk Siswa SMP. Jurnal Pendidikan Fisika dan Teknologi, 6(2), 246-255.

[17] Depdiknas. (2008). Panduan Pengembangan Bahan Ajar. Jakarta: Depdiknas

[18] Setyowati, R., Parmin, & Widiyatmoko, A. (2013). Pengembangan Modul IPA Berkarakter Peduli Lingkungan Tema Polusi sebagai Bahan Ajar Siswa SMK N 11 Semarang. Unnes Science Education Journal (2).

[19] Tumangkeng, Y. W., Yusmin, E., & Hartoyo, A. (2018). Meta-Analisis Pengaruh Media Pembelajaran Terhadap Hasil Belajar Matematika Siswa. Jurnal Pendidikan Dan Pembelajaran Khatulistiwa, 7(6).

[20] Glass, G.V., McGaw B., & Smith, M.L. (1981). Meta-Analysis in Social Research. Sage Publications. London: Sage Publications

[21] Becker, K. & Park, K. (2011). Effects of integrative approaches among science, technology, engineering, and mathematics (STEM) subjects on students’ learning: A preliminary metaanalysis. Journal of STEM Education, 12 (1).

[22] Gustria, A., & Fauzi, A. (2020). Effectivity Of Stem Education-Based Physics Learning E-Module Integrated With Climate Change Topic Towards Students’competence. Jurnal Pendidikan Fisika, 9(2), 105-111.

[23] Aulia, D. M., Parno, P., & Kusairi, S. (2021). Pengaruh E-Modul Berbasis TPACK-STEM terhadap Literasi Sains Alat Optik dengan Model PBL-STEM Disertai Asesmen Formatif. Jurnal Riset Pendidikan Fisika, 6(1), 7-12.

[24] Nisa, I. K., Yuliati, L., & Hidayat, A. (2020). Analisis Penguasaan Konsep melalui Pembelajaran Guided Inquiry berbantuan Modul Terintegrasi STEM pada Materi Fluida Dinamis. Jurnal Pendidikan: Teori, Penelitian, dan Pengembangan, 5(6), 809-816.

[25] Arnila, R., Purwaningsih, S., & Nehru, N. (2021). Pengembangan E-Modul Berbasis STEM (Science, Technology, Engineering and Mathematic) pada Materi FLuida Statis dan FLuida Dinamis Menggunakan Software Kvisoft Flipbook Maker. Edumaspul: Jurnal Pendidikan, 5(1), 551-556.

[26] Safitri, Y., Mayasari, T., & Handhika, J. (2019, March). Interdiciplinary Stem Module Of Guitar Based Scientific Literacy: Modul Stem Pada Gitar Berbasis Literasi Sains. In Prosiding Seminar Nasional Hasil Penelitian LPPM Universitas PGRI Madiun (pp. 109-115).

[27] Azman, M. N. A. (2020). The effectiveness of hands-on modules in learning science: A case Study in Malaysia

[28] Adlim, A., Saminan, S., & Ariestia, S. (2015). Pengembangan Modul STEM Terintegrasi Kewirausahaan Untuk Meningkatkan Keterampilan Proses Sains Di SMA Negeri 4 Banda Aceh. Jurnal Pendidikan Sains Indonesia, 3(2), 112-130

[29] Suyatna, A., Viyanti, V., & Sari, S. (2020). Dynamic Fluid E-Module with STEM Approach to Stimulate HOTS of High School Students in Distance Learning. Jurnal Pendidikan MIPA, 21(2), 132-145.

[30] Cahyani, A. E. M., Mayasari, T., & Sasono, M. (2020). Efektivitas E-Modul Project Based Learning Berintegrasi STEM Terhadap Kreativitas Siswa SMK. Jurnal Ilmiah Pendidikan Fisika, 4(1), 15-22.

[31] Standish, N., Christensen, R., Knezek, G., Kjellstrom, W., & Bredder, E. (2016). The effects of an engineering design module on student learning in a middle school science classroom. International Journal of Learning, Teaching and Educational Research, 15(6).

[32] Özcan, H., & Koca, E. (2019). The impact of teaching the subject “pressure” with STEM approach on the academic achievements of the secondary school 7th grade students and their attitudes towards STEM. Egitim ve Bilim, 44(198).

[33] Prasetyo, D., Marianti, A., & Alimah, S. (2021). Improvement of Students' Science Literacy Skills Using STEM-Based E-Modules. Journal of Innovative Science Education, 10(1), 216-221

[34] Utami, A., Rochintaniawati, D., & Suwarma, I. R. (2020, March). Enhancement of STEM literacy on knowledge aspect after implementing science, technology, engineering and mathematics (STEM)-based instructional module. In Journal of Physics: Conference Series (Vol. 1521, No. 4, p. 042048). IOP Publishing.

[35] Shahali, E. H. M., Halim, L., Rasul, M. S., Osman, K., & Zulkifeli, M. A. (2016). STEM learning through engineering design: Impact on middle secondary students’ interest towards STEM. EURASIA Journal of Mathematics, Science and Technology Education, 13(5), 1189-1211.

[36] Özcan, H., & Koca, E. (2019). Turkish adaptation of the attitude towards STEM scale: A validity and reliability study

[37] Almuharomah, F. A., Mayasari, T., & Kurniadi, E. (2019). Pengembangan modul fisika stem terintegrasi kearifan lokal “beduk” untuk meningkatkan kemampuan berpikir kreatif siswa smp. Berkala Ilmiah Pendidikan Fisika, 7(1), 1-10.

[38] Rusyati, L., Rochintaniawati, D., Agustin, R. R., Sanjaya, Y., & Deandra, I. G. (2020). Gender Differences in The Attribution of Creative Thinking: Experimental Evidence using STEM-based E-Module.

[39] Arsad, N. M., Osman, K., & Embi, M. A. (2017). Effect of STEM-5E Learning Cycle (Am-STEM Kids Module) in Fostering Noble Values Among Elementary School Children. The Eurasia Proceedings of Educational and Social Sciences, 6, 160-166.

[40] Arsad, N. M., & Osman, K. (2019). Penerapan Nilai Murni Melalui Interaksi TAM dan Kitaran Pengajaran 5E dalam Modul Tauhidik STEM Kids (Inculcation of Noble Values through TAM Interaction and 5E Teaching Cycle in Tauhidik STEM Kids Module). Jurnal Pendidikan Malaysia (Malaysian Journal of Education), 44(1SI), 67-82

[41] 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

[42] Permanasari A. (2016) STEM Education: Inovasi dalam Pembelajaran Sains, Seminar NasionalPendidikan Sains (Surakarta, 22 Oktober 2016) pp 23-34

[43] Aulia, D. M., Parno, P., & Kusairi, S. (2021). Pengaruh E-Modul Berbasis TPACK-STEM terhadap Literasi Sains Alat Optik dengan Model PBL-STEM Disertai Asesmen Formatif. Jurnal Riset Pendidikan Fisika, 6(1), 7-12.

[44] Lawless, K. A. and Pellegrino J. W. (2007). Professional Development in Integrating Technology into Teaching and Learning : Knowns, Unknowns, and Ways to Pursue Better Questions Answers, Creative Education Journal, vol. 7, no. 10, pp 576-614, 2007

[45] Arnila, R., Purwaningsih, S., & Nehru, N. (2021). Pengembangan E-Modul Berbasis STEM (Science, Technology, Engineering and Mathematic) pada Materi FLuida Statis dan FLuida Dinamis Menggunakan Software Kvisoft Flipbook Maker. Edumaspul: Jurnal Pendidikan, 5(1), 551-556.

[46] Serevina, V., Astra, I., & Sari, I. J. (2018). Development of E-Module Based on Problem Based Learning (PBL) on Heat and Temperature to Improve Student's Science Process Skill. Turkish Online Journal of Educational Technology-TOJET, 17(3), 26-36.

[47] Sukma, M. (2018). Pengaruh Pendekatan STEM (Science, Technology, Engineering, Mathematics) Terhadap Pengetahuan, Sikap dan Kepercayaan. Prosiding Seminar Nasional MIPA IV (hal. 180-186). Banda Aceh: Unsyiah.