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THE DEVELOPMENT OF LEARNING MATERIALS PjBL-STEM TO IMPROVE STUDENTS' SCIENTIFIC LITERACY SKILLS

Pengembangan Perangkat Pembelajaran PjBL-STEM untuk Meningkatkan Kemampuan Literasi Sains Siswa

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INFORMASI ARTIKEL

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Kata kunci:

pendekatan stem; pjbl; literasi sains

***ABSTRACT**:*

This study aims to develop the learning materials based on the STEM approach through the PjBL model that is feasible used to improve students' scientific literacy in physics learning. The study is a development study using the ADDIE model which consists of five stages of development, namely Analysis, Design, Development, Implementation, and Evaluation. The subjects of this study were the students of grade 11th at SMA Negeri 5 Banda Aceh in the academic year 2019/2020. This study in the implementation stage used an experimental research design (quasi-experimental design) in which the model used was non-equivalent control group design by utilizing research instruments such as the questionnaire, validation questionnaire, and scientific literacy skills question test. The post-test results of students' scientific literacy skills were then tested by using a t-test to investigate the differences between the experiment and control class. Based on the results of the study, the learning materials developed was feasibly used to improve students' scientific literacy skill.

ABSTRAK:

Penelitian ini bertujuan untuk mengembangkan perangkat pembelajaran berbasis pendekatan STEM

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melalui model PjBL yang layak digunakan untuk meningkatkan literasi sains siswa dalam pembelajaran fisika. Penelitian ini merupakan penelitian pengembangan dengan menggunakan model ADDIE yang terdiri dari lima tahap pengembangan, yaitu Analysis, Design, Development, Implementation, and Evaluation. Subjek penelitian ini adalah siswa kelas XI SMA Negeri 5 Banda Aceh. Uji lapangan pada tahap implementation menggunakan desaign penelitian eksperimen (quasi experimental design) model yang digunakan adalah non-equaivalent control group design. Instrumen penelitain berupa angket validasi, angket respon guru dan peserta didik serta soal tes kemampuan literasi sains. Hasil posttest kemampuan literasi sains peserta didik kemudian diuji menggunakan uji t untuk melihat perbedaan antara kelas eksperimen dan kelas kontrol. Berdasarkan hasil penelitian diketahui bahwa perangkat pembelajaran yang dikembangkan layak digunakan untuk meningkatkan kemampuan literasi sains peserta didik.

INTRODUCTION

The wide application and almost all fields make scientific literacy important to master, the importance of having scientific literacy skills makes developed countries continue to strive to improve the scientific literacy skills of the younger generation to be able to compete in the global world of work (Amri et al., 2017). Indonesia students' scientific literacy is currently still low. That is following the evaluation results by the International Organization for Economic Cooperation and Development (OECD) through the Programme for International Student Assessment (PISA). Based on the last PISA measurement in 2018, it showed that Indonesia's literacy capabilities rank 70 out of 78 countries (OECD, 2020).

Some factors affecting the low skill of students' scientific literacy in Indonesia include the learning model applied by the teachers and learning materials used by the students (Kurnia et al., 2014; Fuadi et al., 2020). Currently, The learning science using the 2013 curriculum in Indonesia has provided a reference for the selection of learning models that are suitable for the scientific approach, one of the models is Project-Based Learning (Sari et al., 2017).

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PjBL is project-based learning that confronts students with problems that exist in the lives of students (Sari et al., 2017; Afriana et al., 2016; Simbolon & Koeswanti, 2020). In PjBL learning the teacher plays a role in presenting problems, asking questions, and facilitating students to design projects that they will complete (Titu, 2015; Lestari, 2015). In project learning students are required to produce a product that is by the problems given by the teacher. The products produced by students can be in the form of designs, schemes, written works, works of art, technological works/tools, and others (Soleh, 2021; Furi et al., 2018).

Applying science is a lot of found in technology application so that it is needed an approach giving the alternative for students to be able to face the 21st century which is full of challenges. Science and technology are interrelated and they have links with other inseparable knowledge in science learning. STEM (Science, Technology, Engineering, dan Mathematics) is a combination of several disciplines that are closely related to one another. In science, mathematics is used to process the data meanwhile the technology and technique are the application of science (Stohlmann et al., 2012; Reeve, 2013).

Project-Based Learning and STEM have complementary advantages. In PjBL, the students can comprehend the concept through the process of producing the product, whereas in STEM the students do the process of planning and design (engineering design process) that helps the students in producing the best product (Lee et al., 2019; Ariani et al., 2019).

In the learning process, learning materials are needed. Learning materials are everything that is prepared by the teacher so that the implementation and evaluation of learning can be carried out systematically so that it can achieve the desired goals (Nazarudin, 2017; Fitri et al., 2020). Some of the learning materials needed in managing the teaching and learning process are learning plan, student worksheet, syllabus, learning outcomes tests, and student textbooks (Al-Tabany, 2017; Nababan & Tanjung, 2020). The learning materials developed in this research are lesson plan and student worksheet.

The lesson plan is a face-to-face learning activity plan for one or more meetings. The lesson plan was developed from the syllabus to direct student learning activities in an effort to achieve basic competencies (Permendikbud, 2016; Gunawan &

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Asrifan, 2020). The lesson plan is a guide to the steps that will be used by teachers in teaching and learning activities that are arranged in the form of learning scenarios so that learning is in accordance with the learning objectives (Al-Tabany, 2017; Aguss et al., 2021). The lesson plan is used by teachers as a learning activity plan that contains a guide to the steps that will be used in learning to achieve predetermined competencies.

The components that must be considered from the lesson plan are; 1) school identity, 2) subject identity or theme/subtheme, 3) class/semester, 4) subject matter, 5) time allocation, 6) learning objectives formulated based on basic competencies, 7) basic competencies and indicators of competency achievement, 8) teaching materials, 9) learning methods, 10) learning media, 11) learning resources, 12) the learning steps are carried out through the preliminary, core, and closing stages, and 13) assessment of learning outcomes (Permendikbud, 2016). In this study, the lesson plans were arranged according to the stages in the PjBL model.

There are 6 stages of implementing the PjBL model in learning, namely; 1) start with essential questions, 2) design a plan for the project, 3) create a schedule, 4) monitor the students and the progress of the project, 5) asses the outcome, 6) evaluate the experience (Kemendikbud, 2014; Lestari, 2015).

Student Worksheet are sheets containing tasks that must be done by students. Student Worksheet must at least contain the title, basic competencies to be achieved, completion time, equipment/materials needed to complete the task, brief information, work steps, tasks to be done, and reports to be done (Depdiknas, 2008). In this study, the worksheets were arranged according to the stages in the engineering design process which are the characteristics of the STEM approach. There are 5 stages of the engineering design process used in this study, namely; 1) Ask, 2) Imagine, 3) Plan, 4) Create, 5) Improve (Hester, 2007; Syukri et al., 2020).

Based on the results of Afriana's research (2016), the PjBL learning model integrated by STEM observed from the gender aspect can enhance students' scientific literacy skills where male and female classes have an improvement either knowledge context or competency. There are three scientific competencies measured in scientific literacy in this study, namely; 1) identify scientific issues or problems 2) explain scientific phenomena, 3) use

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scientific evidence (Sujudi et al., 2020; Setiawan, 2019).

The low ability of students 'scientific literacy can be influenced by not evaluating students' scientific literacy abilities. Based on the results of observations and interviews that have been conducted with several physics teachers in Banda Aceh, it is known that there has never been a scientific literacy test of students and there has been no learning that has directed students to improve scientific literacy skills in several schools in Banda Aceh. In addition, low scientific literacy skills are often associated with learning activities that are still oriented to conventional learning methods where students tend to memorize material so that it makes it difficult for students to understand the material. In order for students to improve their scientific literacy skills, the PjBL model with the STEM approach can be used as an effort to improve scientific literacy skills.

METHODS

The kind of study used is Research and Development that the study will produce a product and examine the effectiveness product (Hamzah, 2021; Muqdamien et al., 2021). This study develops learning material PjBL-STEM that aim to improve students' scientific literacy skills. The learning materials developed include lesson plans and student worksheet. The development design used in this study was ADDIE consisted of five stages such as analysis, design, development, implementation, and evaluation (Rangkuti: 2015; Rayanto & Sugianti, 2020).

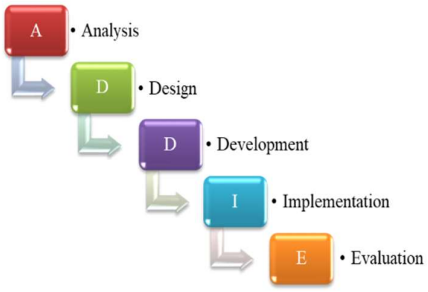

Figure 1: **ADDIE Model**

The five stages of developing the ADDIE model used in this study are as follows (Arimadona & Silvina, 2019; Salas-Rueda et al., 2020):

1) Analysis: At this stage, the requirements for developing learning materials are clearly defined.

2) Design: at this stage, learning materials begin to be designed.

3) Development: this stage aims to produce learning materials that are in accordance with learning objectives. At this stage, the learning materials is validated by the expert and then redeveloped according to input from the expert.

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4) Implementation: At this stage, the learning materials that have been validated and developed based on expert input are implemented to students to find out the practicality of using them. The field test carried out at this stage used an experimental research design (quasi-experimental design). The model used was non-equivalent control group design.

5) Evaluation: At this stage, the researcher will analyze the feasibility of the learning materials developed based on the results of the trial to see the achievement of the objectives.

This study was conducted at SMAN 5 Banda Aceh. The population is the entire object or subject that is in an area and fulfills certain requirements related to the research problem, or the whole unit or individual within the scope of the study (Wibowo & Pranata, 2020). The population in this study was the students of grade 11th Science.

The sample is part of the number and characteristics possessed by the population (Bhoke, 2019; Hermawan, 2019). The sampling technique in this study is purposive sampling. Purposive sampling is a sampling technique with certain considerations (Lenaini, 2021). The sample was the students of class Science 4 as an experiment class in which studies used the learning materials based on the STEM approach through the PjBL model and the class of Science 2 as the control class that studies conventionally. The two classes were chosen because they had never been given the material to be studied, the number of students in both classes was the same and had relatively the same average learning outcomes.

The data collection instruments consist of:

a) Learning materials validation sheets which include lesson plans and student worksheet. This validation sheet is designed to see whether the lesson plans and student worksheet have met the PjBL model syntax and the characteristics of the STEM approach.

b) Questionnaire teacher responses to see the practicality of using lesson plans and student worksheet for teachers. The questionnaire was prepared covering the teacher's response to aspects of format, content, as well as the language of the lesson plans and student worksheet.

c) Questionnaire of student responses to see the practicality of using student worksheet and students' views on projects in the student worksheet. This response questionnaire includes aspects of convenience, attractiveness,

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helpfulness, and problem solving consisting of 10 statements.

d) Science literacy ability test questions (pretest and posttest) to find out the comparison of students' scientific literacy skills before and after being given treatment. The test questions consist of 3 scientific literacy questions with indicators explaining scientific phenomena, identifying scientific issues or problems, and using scientific evidence. The questions used are TIMSS and PISA questions on optical material.

RESULTS AND DISCUSSION

The product which produced in this study is the learning materials consisting of a lesson plan and student worksheets based on the STEM approach through PjBL model to improve the students' scientific literacy skill. The result of the study is according to the stages of ADDIE study as follows:

The first phase of the ADDIE model is Analysis, this stage is used to obtain background information about whether or not PjBL-STEM-based learning materials need to be developed to improve students' scientific literacy skills. The analysis consists of: 1) Needs analysis shows that the scientific literacy ability of Indonesian students is still relatively low and based on the results of initial observations at SMAN 5 Banda Aceh, it is known that there is no learning that specifically directs students to improve scientific literacy skills. Therefore it is necessary to develop learning materials that can help students improve their scientific literacy skills; 2) Curriculum analysis is carried out to formulate indicators and learning objectives based on Core Competencies and Basic Competencies. Based on the curriculum analysis, it was found that optic is suitable for use in this development research; 3) Analysis of student needs, it is known that students are less active in learning and it is necessary to develop learning models that can increase student activity in learning.

The second phase of the ADDIE model is Design, at this stage two types of designs are carried out, namely: 1) Lesson plans design which is based on the PjBL model syntax. At this phase, all learning activities are designed according to the PjBL model based on the STEM approach. Researchers determine the indicators achieved by students, learning methods, teaching materials, learning strategies and learning media. Learning activities are divided into three parts, namely preliminary activities, core activities, and closing

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activities; 2) student worksheet design which is prepared based on the stages of the engineering design process which is a characteristic of STEM.

The science aspect in the student worksheet is contained in the reading which contains initial knowledge about science and the problems that must be solved by students using science. The technological aspect in this worksheet is used to develop students' scientific knowledge regarding the problems given by using technology through video shows. The technical aspects in this student worksheet are found in student activities ranging from designing products in solving problems to producing products that have been designed. The mathematical aspect is related to all calculation and measurement activities carried out by students during learning.

An overview of the STEM aspects contained in the student worksheets design can be seen in Figure 2, Figure 3, Figure 4, and Figure 5.


Bacalah wacana dibawah ini dan temukan permasalahan yang ada dalam wacana bersama teman kelompokmu!

PERISKOP PENGINTAI

Sebelum libur panjang tiba, Pak Budi selaku guru Fisika ingin mengajak siswa-siswanya untuk berlibur sambil belajar ke Monumen Kapal Selam Surabaya (Monkasel). Pak budi menjelaskan bahwa monkasel merupakan satu-satunya monumen kapal selam yang ada di Asia Tenggara. Sambil terus menjelaskan tentang kapal selam, pak budi mengajak para siswa untuk menyisir bagian dalam kapal selam. Mereka terus berjalan hingga akhirnya mereka tiba di pusat komando yang menjadi ruang pengendali dan informasi tempur.

Dalam ruangan ini mereka menemukan sebuah alat yang pernah dicerikatan oleh pak Budi, alat itu adalah periskop. Pak Budi pun menjelaskan bahwa Periskop adalah bagian dari kapal selam yang berfungsi untuk mengamati suatu objek yang berada diatas permukaan laut yang tidak dapat dijangkau oleh awak kapal. Awak kapal selam yang berada di kedalaman laut dapat mengamati permukaan laut menggunakan periskop. Periskop menerapkan sifat cahaya yang berupa pemantulan. Cahaya dari atas permukaan laut ditangkap oleh suatu cermin, kemudian dipantulkan menuju mata pengamat di dalam kapal selam. Namun periskop hanya dapat melihat obyek-obyek yang segaris lurus dengan pengamat. Setelah para siswa bergantian mencoba menggunakan periskop penyisiranpun dilanjutkan hingga ke ujung bagian kapal selam.

Figure 2: **Aspects of Science**

Figure 3: **Aspects of Technology**

Figure 4: Aspect of Engineering

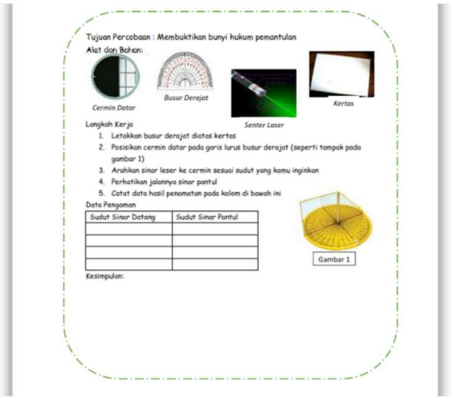

Figure 5: Aspect of Mathematics

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At this phase, a systematic determination is made that includes the work steps of students in the learning process. The components that must be considered in the preparation of the student worksheet are the student worksheet title, basic competencies to be achieved, completion time, equipment/materials needed to complete project tasks, work steps, task, and reports to be done.

The third phase of the ADDIE model of which is development, in this stage, the learning materials is assessed by one of the STEM expert lectures at the Physics Education Department at Syiah Kuala University. The assessment includes the lesson plan assessment is obtained 84.3%, the student worksheet assessment is acquired 79.5%, and the correlation among lesson plan, student worksheet, as well as STEM approach, are gained 80.5%. From the three assessments are acquired a total percentage of 81.9% is included in the feasible category.

The fourth phase of the ADDIE model is implementation, the tool that has been assessed, and deemed feasible by experts, then tested by students in this stage. The test takes place in three meetings. At the first meeting, the teacher conveys the learning objectives then the students form groups and start discussing about the problems in the student worksheet. Next, the teacher shows a video and does a simple practicum so that students can imagine concepts that are suitable for problems in the student worksheet. Students return to discussing solutions and schedules that must be done to solve the problems found. At the second meeting, students began to design tools according to the results of group discussions. Teachers as companion students in creating the products they make. In the third meeting, the tools that have been completed are tested in front of the class. Students convey the advantages of the tools that have been made and other groups provide input. Then the teacher asks students to collect their work so that they are then evaluated or given an assessment.

The fifth phase of the ADDIE model of that evaluation, in this stage, the result of the teacher responses is obtained 81.25% and the result of the student responses is acquired 85.09%. Either result of a teacher or student is included in very good criteria (positive). In the stage, The researcher analyzes the result of the scientific literacy test gained the average data as follows:

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Table 1: The result of scientific literacy

Class	Pre-Test	Post-Test
Experiment	30,87	63,44
Control	30,78	51,56

The results of the independent sample t-test analysis showed that there is a significant difference in the results of scientific literacy skills between the experimental class (M=63.44, SD=22.73) and the control class (M=51.56, SD=19.59). The experimental class has higher scientific literacy results compared to the control class (t[52]=2.05, p=0.05). Therefore, it can be concluded that there is a significant difference between the experiment class taught by using the learning materials through the PjBL model based on the STEM approach and control class taught conventionally in improving the students' scientific literacy skills in physics learning.

Feasibility of Learning Materials

Before using in learning, The learning materials developed must be validated by one of the STEM experts at the Physics Education Department at Syiah Kuala University and validation test are also carried out based on student responses. There are three kinds of assessments to validate tests in the learning materials carried out by experts, namely Lesson Plan, student worksheet, as well as the correlation among Lesson Plan, student worksheet, and STEM approach gained the average percentage 81,9% are included in a feasible category. validation which is assessed based on students' responses to the student worksheet obtained an average of 85.09% which shows a positive response so that it can be concluded that the student worksheet is feasible to use.

According to the questionnaires of teacher and student responses were gained positive responses to the learning materials based on the STEM approach through the PjBL model showed that lesson plans and student worksheet were practical to use in learning activities. Moreover, the result of the t-test was accomplished to check the difference between the experiment and control class know that there is a significant difference between the two classes in the scientific literacy test that are conducted after learning takes place. Based on the average score of the post-test both classes which are determined that the average score of the experiment class is higher than the average score of the control class.

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The Effect of PjBL-STEM on Improving Students' Scientific Literacy

The various positive results obtained in this study to improve students' scientific literacy skills certainly cannot be separated from the advantages of the PjBL model and the STEM approach that the researchers applied in the development of these learning materials. According to the study result of Sari et al. (2017), found that the learning by using the project requires the students to solve the problem based on real-life and involve the students in investigation allowing the students to apply their science concepts so that they can create the scientific literacy skill better than the students who do not get the learning using project assignments.

Jagantara et al. (2014), said that PJBL makes the students more active in the learning process because the project learning commands the students to commit various skills such as operating the project, setting time, organizing, working in groups, investigating, finding the learning material, and solving the problem. Therefore, the students can comprehend the material overall and give better results than the learning in general (Tias & Octaviani, 2018; Syukri et al., 2017).

Furthermore, in the experiment class, the students can also extend the material through new knowledge which they gained in the process of completing given project assignments. According to the statement of Dedovets & Rodionov (2015), the project assignment given to the students can expand the insight and potency of the students. Tjahyono (2021) also said that PjBL allows the students to study individually so that the students can extend the learning material that they learned through the process of completing the project. As a consequence, the students can give the best score in learning. It is also shown by the post-test results of two classes in which the post-test score of the experiment class is higher than the control class.

The new insight received by the students can be gotten in implementing the second stage of PjBL namely design the project planning as well as the second stage of the Engineering Design Process (EDP) is one of the STEM characteristics that is imagining (Syukri et al., 2018). The students are demanded to have knowledge that can help to finish the given project. Mayasari et al. (2014), said that through STEM learning, the students can gain knowledge of technology and scientific literacy acquired from the process of reading,

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writing, observing, and applying science in the environment.

The knowledge that is obtained by the students in the process of completing the project can be achieved from available sources and media as the books and internet. Loipha (2014) supported that by using the internet, information can be received from various sources all over the country, and Bang (2018) also said that the internet can accelerate students in the learning process (Halim et al., 2020).

According to the result of the study had been conducted and supported by the relevant research, then it can be concluded that the development of the learning materials based on STEM approach through PjBL model is feasible to be used as the physics learning material and give the positive effect in the improvement of students' scientific literacy skills.

CONCLUSION

Based on the results of the research that has been carried out, it can be concluded that the PjBL-STEM learning materials based on a validation test by experts and student responses is declared feasible to use. The results of the student's scientific literacy test showed that the learning materials developed could improve students' scientific literacy skills so that it was in accordance with the purpose of developing these learning materials, namely to improve students' scientific literacy skills.

However, the development of this product only involved SMAN 5 Banda Aceh, differences in the environment and characteristics with other schools may allow different research results. For this reason, further research can be carried out at the implementation stage by involving several schools in order to get more responses and can also develop student worksheet in electronic form and validate with more validators in order to get better results.

REFERENCES

Afriana, J., Permanasari, A., & Fitriani, A. (2016). Penerapan project based learning terintegrasi STEM untuk meningkatkan literasi sains siswa ditinjau dari gender. *Jurnal Inovasi Pendidikan IPA*, 2(2), 202. https://doi.org/10.21831/jipi.v2i2.8561

Aguss, R. M., Amelia, D., & Permata, P. (2021). Pelatihan Pembuatan Perangkat Ajar Silabus Dan Rpp Smk Pgri 1 Limau. *Journal of Social Sciences and Technology for Community Service (JSSTCS)*, 2(2), 48-53.

Al-Tabany, T. I. B. (2017). *Mendesain model pembelajaran inovatif, progresif, dan konteksual*. Prenada Media.

Amri, M. Y. B., Rusilowati, A., & Wiyanto. (2017). Penerapan Model Pembelajaran Conceptual

http://doi.org/10.31800/jtp.kw.v11n1.p66--82

Understanding Procedures untuk Meningkatkan Kemampuan Literasi Sains Siswa SMP di Kabupaten Tegal. *Unnes Physics Education Journal*, 6, 80–93.

Ariani, L., Sudarmin, S., & Nurhayati, S. (2019). Analisis berpikir kreatif pada penerapan problem based learning berpendekatan Science, Technology, Engineering, and Mathematics. *Jurnal Inovasi Pendidikan Kimia*, 13(1).

Arimadona, S. & Silvina, R. (2019). Pengembangan modul pembelajaran zat adiktif dan psikotropika berbasis scientific approach dengan crossword puzzle. *Jurnal Pendidikan IPA Veteran*, 3(1), 64-76. https://doi.org/10.31331/jipva.v3i1.661

Bhoke, W. (2019). Pengaruh pendidikan matematika realistik berbantuan LKS terhadap hasil belajar matematika ditinjau dari motivasi belajar siswa kelas V SD gugus 2 Kecamatan Bajawa Kabupaten Ngada. *Ejurnal Imedtech*, *3*(2).

Dedovets, Z., & Rodionov, M. (2015). The Development of Student Core Competencies through the STEM Education Opportunities in Classroom. *International Journal of Social, Behavioral, Educational, Economic, Business and Industrial Engineering*, 9(No.10), 3237–3240.

Departemen Pendidikan Nasional. (2008). *Panduan Pengembangan Bahan Aja*r. (Online)(http://ericbio.files.wordpress.com/2012/09/panduan-pengembangan-bahan-pelajaran 1.doc.).

Fitri, M., Yuanita, P., & Maimunah, M. (2020). Pengembangan Perangkat Pembelajaran Matematika Terintegrasi Keterampilan Abad 21 Melalui Penerapan Model Problem Based Learning (PBL). *Jurnal Gantang*, 5(1), 77-85. https://doi.org/10.31629/jg.v5i1.1609

Fuadi, H., Robbia, A, Z., Jamaluddin, & Jufri, A,W. (2020). Analisis Faktor Penyebab Rendahnya Kemampuan Literasi Sains Peserta Didik. *Jurnal Ilmiah Profesi Pendidikan*, 5(2), 108-116. https://doi.org/10.29303/jipp.v5i2.122

Furi, L, M, I. Handayani, S. & Maharani, S. (2018). Eksperimen Model Pembelajaran Project Based Learning Dan Project Based Learning Terintegrasi Stem Untuk Meningkatkan Hasil Belajar Dan Kreativitas Peserta didik Pada Kompetensi Dasar Teknologi Pengolahan Susu. *Jurnal Penelitian Pendidikan*, 35(1), 49-60.

Gunawan., & Asrifan, A. (2020). Penerapan Kerja Kelompok Kegiatan MGMP Guru Ekonomi dalam Menyusun RPP untuk Meningkatkan Kompetensi Pedagogik. *Celabes Education Review*, 2(1), 31-36.

Halim, A., Wahyuni, A., Malvina, & Yani, E. (2020). The impact of the

http://doi.org/10.31800/jtp.kw.v11n1.p66--82

use of the internet on the learning outcomes in physics for high school students. *Journal of Physics: Conference Series*, 1521(2). https://doi.org/10.1088/17426596/1521/2/022060

Hamzah, A. (2021). *Metode Penelitian & Pengembangan (Research & Development) Uji Produk Kuantitatif dan Kualitatif Proses dan Hasil Dilengkapi Contoh Proposal Pengembangan Desain Uji Kualitatif dan Kuantitatif.* CV Literasi Nusantara Abadi.

Hermawan, I. (2019). *Metodologi Penelitian Pendidikan (Kualitatif, Kuantitatif dan Mixed Method)*. Hidayatul Quran.

Hester, K. & Cunningham, C. (2007). Engineering is elementary: An engineering and technology curriculum for children. *ASEE Annual Conference and Exposition Conference Proceedings*.

Jagantara, I. M. W., Adnyana, P. B., & Widiyanti, N. L. P. M. (2014). Pengaruh model pembelajaran berbasis proyek (Project Based Learning) terhadap hasil belajar biologi ditinjau dari gaya belajar siswa SMA. *Jurnal Pendidikan dan Pembelajaran IPA Indonesia*, 4(1).

Kementerian Pendidikan dan Kebudayaan. (2014). *Materi Pelatihan Guru Implementasi Kurikulum 2013 Tahun Ajaran 2014/2015 Mata Pelajaran Matematika SMP/MTs*. Jakarta: Kementerian Pendidikan dan Kebudayaan.

Kurnia, F., Zulherman, & Fathurohman, A. (2014). Analisis Bahan Ajar Fisika SMA Kelas XI di Kecamatan Indralaya Utara Berdasarkan Kategori Literasi Sains. *Jurnal Inovasi dan Pembelajaran Fisika*, 1(1):43-47.

Lee, Y., Capraro, R. M., & Bicer, A. (2019). Affective mathematics engagement: A comparison of STEM PBL versus non-STEM PBL instruction. *Canadian Journal of Science, Mathematics and Technology Education*, 19(3), 270-289.

Lenaini, I. (2021). Teknik pengambilan sampel purposive dan snowball sampling. *Historis: Jurnal Kajian, Penelitian dan Pengembangan Pendidikan Sejarah*, 6(1), 33-39.

Lestari, Tutik. (2015). *Peningkatan Hasil Belajar Kompetensi Dasar menyajikan ContohContoh Ilustrasi Dengan Model Pembelajaran Project Based Learning dan Metode Pembelajaran Demonstrasi Bagi Siswa Kelas XI Multimedia SMK Muhammadiyah Wonosari*. Skripsi. Program Studi Pendidikan Teknik Informatika Fakultas Teknik Universitas Negeri Yogyakarta. Yogyakarta

Loipha, S. (2014). Thai elderly behavior of internet use. *Procedia-Social and Behavioral Sciences*, 147, 104-110.

Mayasari, T., Kadarohman, A., & Rusdiana, D. (2014). Pengaruh Pembelajaran Terintegrasi Science , Technology , Engineering , and Mathematics (STEM) Pada Hasil Belajar Peserta Didik : Studi Meta

http://doi.org/10.31800/jtp.kw.v11n1.p66--82

Analisis. *Prosiding Semnas Pensa VI "Peran Literasi Sains" Surabaya*, 20 Desember 2014, 371–377.

Muqdamien, B., Umayah, U., Juhri, J., & Raraswaty, D. P. (2021). Tahap Definisi Dalam Four-D Model Pada Penelitian Research & Development (R&D) Alat Peraga Edukasi Ular Tangga Untuk Meningkatkan Pengetahuan Sains Dan Matematika Anak Usia 5-6 Tahun. *Intersections*, 6(1), 23-33.

Nababan, S, A., & Tanjung, H, S. (2020). Pengembangan Perangkat Pembelajaran Berbasis Pendekatan Matematika Realistik untuk Meningkatkan Kemampuan Disposisi Matematis Siswa Negeri 4 Wira Bangsa Kabupaten Aceh Barat. Genta Mulia: *Jurnal Ilmiah Pendidikan*, 11(2), 233-243.

Nazarudin. (2017). *Manajemen Pembelajaran: Implementasi Konsep, Karakteristik dan Metodologi Pendidikan Agama Islam di Sekolah Umum*. Yogyakarta: Tesis.

OECD. (2020). *"PISA 2018 Results"*, (online). http://www.oecd.org/pisa/publications/pisa-2018-results.htm. (Diakses 5 Januari 2020).

Peraturan Menteri Pendidikan dan Kebudayaan. (2016). Peraturan Menteri Pendidikan dan Kebudayaan, Nomor 22, Tahun 2016, tentang Standar Proses pendidikan Dasar dan Menengah.

Rangkuti, Ahmad Nizar. (2015). *Metode Penelitian Pendidikan.* Bandung: Citapustaka Media.

Rayanto, Y. H., & Sugianti. (2020). *Penelitian Pengembangan Model ADDIE dan R2D2: Teori dan Praktek.* Lembaga Academic & Research Institute.

Reeve, E. M. (2013) *Implementing science, technology, mathematics, and engineering (STEM) education in Thailand and ASEAN.* Bangkok: Institute for the Promotion of Teaching Science and Technology (IPST).

Salas-Rueda, R. A., Salas-Rueda, E. P., & Salas-Rueda, R. D. (2020). Analysis and design of the web game on descriptive statistics through the ADDIE model, data science, and machine learning. *International Journal of Education in Mathematics, Science and Technology (IJEMST)*, 8(3), 245-260.

Sari, D. N. A., Rusilowati, A., & Nuswowati, M. (2017). Pengaruh Pembelajaran Berbasis Proyek terhadap Kemampuan Literasi Sains Siswa. *PSEJ (Pancasakti Science Education Journal)*, 2(2), 114. https://doi.org/10.24905/psej.v2i2.741

Setiawan, A, R. (2019). Menyusun Instrumen Penilaian untuk Pembelajaran Ekologi Berorientasi Literasi Sains. *Prosiding Seminar Nasional dan Workshop Biologi-IPA dan Pembelajaran ke-4*, Malang: 4-5 September 2019. Hal. 241-249.

Simbolon, Redina., & Koeswanti, H, D. (2020). Comparison Of Pbl (Project Based Learning) Models With Pbl (Problem Based Learning) Models

http://doi.org/10.31800/jtp.kw.v11n1.p66--82

To Determine Student Learning Outcomes And Motivation. *International Journal of Elementary Education*, 4(4), 519-529. https://ejournal.undiksha.ac.id/index.php/IJEE

Soleh, Dariyo. (2021). Penggunaan Model Pembelajaran Project Based Learning melalui Google Classroom dalam Pembelajaran Menulis Teks Prosedur. *Jurnal Karya Ilmiah Guru*, 6(2), 137-143. https://doi.org/10.51169/ideguru.v6i2.239

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

Sujudi, M. S., Idris, T., Suryanti, S., & Handayani, P. H. (2020). Profil Kemampuan Literasi Sains Siswa SMP Islam As-Shofa Kota Pekanbaru Berdasarkan PISA. *Journal of Natural Science and Integration*, *3*(1), 58-69.

Syukri, M. Maghfirah, S. Halim, A. &Herlina, F. (2020). Student responses toward worksheets based on stem approach through project-based learning model. *Journal of Physics: Conference Series.* doi:10.1088/1742-6596/1882/1/012031

Syukri, M., Halim, L., & Mohtar, L. E. (2017). Engineering Design Process: Cultivating Creativity Skills through Development of Science Technical Product. *Jurnal Fizik Malaysia*, 38(1), 10055–10065.

Syukri, M., Soewarno, S., Halim, L., & Mohtar, L. E. (2018). The impact of the engineering design process in teaching and learning to enhance students' science problem-solving skills. *Jurnal Pendidikan IPA Indonesia*, 7(1), 66–75. https://doi.org/10.15294/jpii.v7i1.12297

Tias, I. W. U., & Octaviani, S. (2018). The Effect of Using The Project-Based Learning Model On (Quasi Study Experiments for Class V Students of SD Negeri 8 Metro Timur, SD Negeri 1 Metro Barat, SD Negeri 1 Metro Utara dan SD Negeri 5 Metro Pusat). *Journal of Humanities and Social Studies*, 02(02), 25–30.

Titu, M. A. (2015). Penerapan model pembelajaran project based learning (PjBL) untuk meningkatkan kreativitas siswa pada materi konsep masalah ekonomi. *In Prosiding Seminar Nasional* (Vol. 9).

Tjahyono, T. D. (2021). Implementasi Project Based Learning pada Materi Menerapkan Instalasi Software Aplikasi di SMK Negeri 1 Banyuanyar: SMK Negeri 1 Banyuanyar. *Mitra Pendidikan*, 2(3), 101-109.

Wibowo, T. P., & Pranata, E. (2020). Survei Permainan Tradisional dalam Pembelajaran Pendidikan Jasmani di Sekolah Dasar Se-

http://doi.org/10.31800/jtp.kw.v11n1.p66--82

Kecamatan Air Priukan Kabupaten Seluma. *Educative Sportive*, 1(1), 13-17.

http://doi.org/10.31800/jtp.kw.v11n1.p66--82