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Integration of STEM-PjBL on Alternative Energy Sources to Improve Entrepreneurial Science Thinking

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Abstract

The demographic bonus by 2030 requires everyone to compete for jobs. Cultivating character and entrepreneurial thinking is an alternative to dealing with limited employment opportunities. This study aims investigate the increase of entrepreneurial science thinking through the STEM-PjBL integration learning model on alternative energy sources. This study used the Mix Method method in the form of a Sequential Explanatory design that used quantitative data as the main data, while qualitative data as supporting data. From the resulted of observations on four aspects of entrepreneurial science thinking, all aspects have a percentage above 70% so that they are included in the criteria quite well. The results of these observations indicated that the research carried out is in accordance with the research objective, namely the integration of STEM-PjBL can improve entrepreneurial science thinking.

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INTRODUCTION

Competency standards for vocational school or SMK graduates have the main goal of producing SMK graduates who are able to compete to be absorbed by the business world and industry. In fact, many SMK students have not found a job after they graduate, based on data from the Central Statistics Agency released in February 2020 showing that the Open Unemployment Rate for ages 15 years and over based on educational background, SMK graduates occupy the highest position, namely 8.49 percent. One of the factors causing these problems is the disproportionate number of employment opportunities with SMK graduates.

One of the solutions to overcome the limitations of employment opportunities and at the same time to improve the level of the community's economy is to develop entrepreneurial abilities (Widiyarini, 2018). Vocational High School graduates must be able to develop entrepreneurial skills so that in the future they can create their own jobs. Entrepreneurial abilities can be realized by involving entrepreneurial activities in the learning process so that students will get used to thinking, innovating and acting like entrepreneurs (Asih et al., 2020). Physics learning that involves entrepreneurial activities in the learning process is expected to be able to print students into science entrepreneurs. An increase in the number of entrepreneurial science graduates from SMK will become an oasis in the desert so as to reduce the number of unemployed and make the slogan "SMK can" a reality.

Entrepreneur science is formed from the habit of Entrepreneural Science Thinking (ESciT) which is a concept of teaching and learning science to produce students who have entrepreneurial thinking (Buang et al., 2009). The concept of ESciT is formulated through analysis results which show that scientists who succeed in producing ideas or products based on science are through combining scientific process skills and entrepreneurial thinking. Therefore, the concept of ESciT was generated based on the relationship between the steps in science process skills and entrepreneurial thinking. Entrepreneurial thinking refers to the cognitive phenomenon of looking for innovative, creative, and problem-solving entrepreneurial ideas and opportunities (Syukri, M., Lilia, H., & Subahan, 2013).

STEM-PjBL is an interdisciplinary teaching and learning approach that directs students to explore undefined problems on STEM subjects in a limited environment (Jamali et al., 2017). STEM Project-Based Learning (STEM-PjBL) can place students in a realistic and contextual problem-solving environment, it provides meaningful learning to students (Meita et al., 2018). STEM-PjBL is a learning model that is very appropriate to be applied to improve students' higher order thinking skills (Windasari et al., 2020). In addition to the cognitive and psychomotor aspects of STEM-PjBL, it fosters self-confidence and a sense of belonging to fellow friends, this can be a character to face the challenges of the world of work or the community environment in the future, both for the future (Singer et al., 2020).

STEM-PjBL learning process in the classroom requires the cooperation of teachers and students, teachers must have an open attitude and be ready to become agents of change (El Nagdi et al., 2018). The use of STEM-PjBL requires a conceptual framework that is structured systematically by considering all aspects that influence during the learning process (Kelley & Knowles, 2016). Researchers see that there is inequality in the community environment related to the increase in unemployment which is dominated by SMK graduates, these problems inspire researchers to grow entrepreneurship skills as an alternative to reducing unemployment. The growth of entrepreneurial skills begins with training entrepreneurial thinking in a learning process that utilizes the integration of STEM-PjBL. It is hoped that the use of STEM-PjBL integration can improve entrepreneurial science thinking as capital when students enter the community, becoming entrepreneurs who are able to reduce unemployment.

METHODS

This research used a mix method research that combined quantitative and qualitative approaches. The sample is 35 students in class X TOM 1 at SMK Negeri 4 Kuningan. Quantitative data collection used observation and documentation studies while qualitative data collection used interviews. Quantitative data collection is carried out first and then analyzed, the results of the analysis are used as the basis for collecting qualitative data with the aim of qualitative data being able to support quantitative data.

Quantitative data were obtained through observations during the learning process on the four aspects of entrepreneurial science thinking that appeared from each student. The first aspect is observing the surrounding environment, in this aspect the researcher saw students' initiative in making observations, the ability to study environmental needs, environmental potential, product design with the environment, and materials that can be utilized in the surrounding environment. The second aspect is looking for the need for new ideas, observing students get ideas to solved problems in the environment, ideas for making product designs, ideas for obtaining materials, ideas for making products on time, and ideas for

marketing the products they have made. The third aspect is choosing an idea and realizing it in a product, in this aspect the researcher observes how students can choose an idea that can be applied in designing products, choosing tools and materials, determining the steps of manufacture, and marketing the product. The fourth aspect is assessing the product, product assessment is carried out between groups alternately with the criteria for product appearance, manufacturing costs, marketing methods, and practicality of use.

The data were obtained from the results of interviews conducted with group representatives to find out the problems that arise during the product manufacturing process and the learning process by utilizing the integration of STEM-PjBL on entrepreneurial science thinking. The following is a research flow with a sequential explanatory design shown in Figure 1.

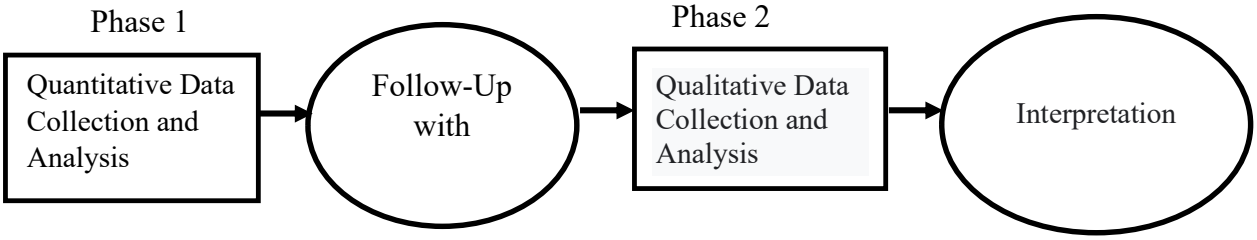

Figure 1. Mix Method Research Design With Sequential Explanatory Model

RESULTS AND DISCUSSION

Learning used STEM-PjBL integration was applied to class X TOM 1 students at SMK Negeri 4 Kuningan. The learning process refers to the syntax of the STEM-PjBL model, namely reflection, research, discovery, application, and communication. At the beginning of the lesson, the impact of limited fossil energy sources is presented, then each student is expected to be able to provide solutions to these problems by utilizing alternative energy sources which are realized by making simple products. The product manufacturing project is carried out in groups by first determining the manufacturing schedule so that the product manufacturing process can be on time. The resulting product in the form of a biomass stove is expected to be an alternative to the use of a gas stove on the roof of an oil stove. The next stage is product marketing by using effective strategies and methods, for example using social media.

The role of STEM can be observed during the product manufacturing process, the scientific aspect is based on the conversion of biomass or waste energy into heat and heat conduction through materials that occur on the surface of the stove made of cans. Knowledge of heat conduction can be seen when students are careful of a hot stove surface while doing an experiment. The technological aspect can be seen when students used information technology to collect important information related to biomass stoves. The engineering aspect appears when students design a biomass stove and design the placement of a mini fan in order to control the flames. The mathematical aspect can be seen when students calculate the price of a biomass stove to be sold based on the capital that has been spent. The following are the results of observations of the integration of STEM-PjBL on students' entrepreneurial science thinking, presented in Table 1.

Table 1. Observation Results of Entrepreneurial Science Thinking

No	Aspect	Entrepreneurial Science Thinking (%)
1	Observing the surrounding environment	77
2	Looking for new ideas	71
3	Choose one idea and make it happen in a product	71
4	Rate the product	71

Based on Table 1, the first aspect of observing the environment has the highest percentage, which is 77%. In this aspect, the researcher uses cellphones as a learning medium, on the cellphone the smart apps creator application is installed which contains shows about the limitations of energy sources and their impacts, alternative energy sources, and projects that will be carried out. The following is the display of the smart app creator on alternative energy sources presented in Figure 2.

Figure 2. Display of Smart Apps Creator on Alternative Energy Source Materials

Impressions on smart apps creator applications can provide a real picture of the impact of limited fossil energy sources, it provides a stimulus to find solutions that can be applied in their environment. The used of mobile phones as experimental tools or learning media can increase interest in learning physics in general and curiosity about experiments or shows, besides that students will feel challenged by the new media they use (Hochberg et al., 2018). Activities are carried out in groups to observe their environment with enthusiasm, these observations are related to environmental needs, environmental potential and the suitability of solutions with the environment.

The second aspect of looking for the need for new ideas has a percentage of 71%, In this aspect the researcher observed students in finding several ideas to solve the impact of limited energy, ideas for making product designs, ideas for obtaining materials, ideas for making products on time, and ideas for marketing. the products they have made. The researcher observed that some students had difficulty finding ideas. This is because references and experience are still limited and less able to utilize information technology for learning purposes.

The third aspect of choosing an idea and realizing it in a product has a percentage of 71%, researchers provide opportunities for each student to discuss and determine the ideas that will be realized related to product design, tools and materials, manufacturing steps, and how to market the product. Researchers provide suggestions for marketing strategies using various media that are effective and have a great chance of being accepted by consumers. Seeing opportunities, making products, planning something before acting, finding effective marketing methods are characteristics of entrepreneurial character (Yanti, 2019). Online marketing through social media and E-commerce is a fairly effective strategy to market products. Online promotion is able to cut promotional costs by 80%, create a wide and fast marketing network and make it easier to build networks at affordable costs (Maftuhah & Rafsanjani, 2019). Sales through E-commerce can increase the selling power of the store as well as a data base for goods assets so that goods can be neatly arranged and become stock records of goods and are easy to find during the search process (Tarmizi & Firmansyah, 2020).

There are some groups who have difficulty determining the idea to be realized, besides that there are groups who have difficulty in making products. Difficulties in making products were identified due to the low commitment of each student in completing the product, some students did not attended the schedul product manufacture. Besides that, there are groups that do not work together in completed the product, the process of making the product is completed by several students.

The fourth aspect of assessing the product has a percentage of 71%, product assessment is carried out in groups, one group presents the product they have made while the other group provides an assessment. The assessment is based on several criteria, namely product appearance, product manufacturing costs, product marketing, and practicality of use. There are some students who have difficulty in assessing the products produced by other groups in addition to lack of self-confidence, indicated because they still do not have an assessment benchmark.

The results of interviews with several group representatives illustrate that during the learning process used STEM-PjBL integration encourages them to thought creatively to make a useful product in the surrounding environment based on observations related to science. In addition, they hope to developed products that are made more attractive and have high economic value. Students' statements imply that they are driven to innovate,

adapt, collaborate, actively seek information, are able to utilize various media and technology and have life skills to be able to find solutions to problems in everyday life in the future. Basically entrepreneurial science thinking is a thought to improve skills in aspects of social and cross-cultural interaction and to know the public's response to the products produced both in terms of benefits, selling value and feasibility as a form of responsibility to the wider community (Jamil et al., 2018). STEM-PjBL opens students' mindsets more deeply to understand a problem and improve the ability to assess a product and can motivate students to determine careers in the future (Maiorca et al., 2021). An example of a poster that will be uploaded on social media and E-commerce as a marketing strategy is presented in Figure 3.

Figure 3. Example of a Product Poster in E-commerce

The STEM-PjBL learning activities in this study from beginning to end were designed to grow and improve entrepreneurial science thinking. Research conducted by Triastuti (2020) states that STEM-PjBL applied in the learning process in addition to being able to train students' creative thinking skills can also foster an entrepreneurial spirit. From the results of observations on four aspects of entrepreneurial science thinking, all aspects have a percentage above 70% so that they are included in the criteria quite well. The results of these observations indicate that the research carried out is in accordance with the research objective, namely the integration of STEM-PjBL can improve entrepreneurial science thinking.

CONCLUSION

Based on the results and discussion on each aspect, STEM-PjBL integration is able to grow and improve students' entrepreneurial science thinking quite well. The most interesting activity for students and shows a high percentage is in the aspect of observing the surrounding environment so that they are able to stimulate various ideas. In addition, the activity of designing marketing has a good response from students because it makes them think more creatively.

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REFERENCES

Asih, W. M., Kamil, I., & Indrapriyatna, A. S. (2020). Peran Pendidikan Kewirausahaan Terhadap Perilaku Inovatif Mahasiswa Dalam Menghadapi Revolusi Industri 4.0. *JMKSP (Jurnal Manajemen, Kepemimpinan, Dan Supervisi Pendidikan)*, *5*(1), 31. https://doi.org/10.31851/jmksp.v5i1.3513

Buang, N. A., Halim, L., & Mohd Meerah, T. S. (2009). Understanding the thinking of scientists entrepreneurs: Implications for science education in Malaysia. *Journal of Turkish Science Education*, *6*(2), 3–11.

El Nagdi, M., Leammukda, F., & Roehrig, G. (2018). Developing identities of STEM teachers at emerging STEM schools. *International Journal of STEM Education*, *5*(1), 1–13. https://doi.org/10.1186/s40594-018-0136-1

Hochberg, K., Kuhn, J., & Müller, A. (2018). Using Smartphones as Experimental Tools—Effects

on Interest, Curiosity, and Learning in Physics Education. *Journal of Science Education and Technology*, *27*(5), 385–403. https://doi.org/10.1007/s10956-018-9731-7

Jamali, M., Nurulazam, A., Samsudin, M. A., & Ebrahim, N. A. (2017). Self-Efficacy, Scientific Reasoning, and Learning Achievement in The Stem Project-Based Learning Literature. *Journal of Nusantara Studies*, *2 (2)*(February 2018), 29–43. https://doi.org/10.6084/m9.figshare.5923585.v1

Jamil, D. K., Muslim, M., & Supriatno, B. (2018). *Entrepreneurial science thinking approach in project-based learning*. *3*, 514–518.

Kelley, T. R., & Knowles, J. G. (2016). A conceptual framework for integrated STEM education. *International Journal of STEM Education*, *3*(1). https://doi.org/10.1186/s40594-016-0046-z

Maftuhah, R., & Rafsanjani, H. (2019). Pelatihan Strategi Pemasaran Melalui Media Online Pada Produk Usaha Rumahan Krupuk Bawang dan Kripik Sukun. *Aksiologiya: Jurnal Pengabdian Kepada Masyarakat*, *3*(2), 227. https://doi.org/10.30651/aks.v3i2.1996

Maiorca, C., Roberts, T., Jackson, C., Bush, S., Delaney, A., Mohr-Schroeder, M. J., & Soledad, S. Y. (2021). Informal Learning Environments and Impact on Interest in STEM Careers. *International Journal of Science and Mathematics Education*, *19*(1), 45–64. https://doi.org/10.1007/s10763-019-10038-9

Meita, L., Furi, I., Handayani, S., & Maharani, S. (2018). Eksperimen Model Pembelajaran Project Based Learning dan Project Based Learning Terintegrasi STEM untuk Meningkatkan Hasil Belajar dan Kreativitas Siswa pada Kompetensi Dasar Teknologi Pengolahan Susu. *Jurnal Penelitian Pendidikan*, *35*, 49–60.

Singer, A., Montgomery, G., & Schmoll, S. (2020). How to foster the formation of STEM identity : studying diversity in an authentic learning environment. *International Journal of STEM Education*, 1–12.

Syukri, M., Lilia, H., & Subahan, M. M. T. (2013). (2013). Pendidikan STEM dalam Entrepreneurial Science Thinking "ESciT": Satu Perkongsian Pengalaman dari UKM untuk Aceh. Aceh Development International Conference. *Aceh Development International Conference 2013*, *March*, 105–112.

Tarmizi, & Firmansyah, J. (2020). Sistem penjualan online dengan strategi pemasaran cross selling. *Journal of Informatics and Computer Science*, *6*(1), 11–16. http://jurnal.uui.ac.id/index.php/jics/article/view/737

Triastuti, E. (2020). Model Pembelajaran Stem Pjbl Pada Pembuatan Ice Cream Learning Model of Pjbl Stem in Making Ice Cream Train. *Ideguru : Jurnal Karya Ilmiah Guru*, *5*(2), 67–74.

Widiyarini. (2018). Mengurangi Pengangguran Terdidik dengan Meningkatkan Semangat Kewirausahaan Melalui Pelatihan Jasa Laundry. *Jurnal Sosio E-Kons*, *10*(3), 199–206.

Windasari, N. S., Yamtinah, S., & VH, E. S. (2020). Pengaruh Model Project Based Learning Terintegrasi STEM (PjBL-STEM) Terhadap Kemampuan Berpikir Tingkat Tinggi pada Materi Asam dan Basa Kelas XI di SMA Negeri 3 Surakarta Tahun Pelajaran 2018/2019. *Jurnal Pendidikan Kimia*, *9*(1), 47–53.

Yanti, A. (2019). Pengaruh Pendidikan Kewirausahaan, Self Efficacy, Locus of Control dan Karakter Wirausaha Terhadap Minat Berwirausaha. *Maneggio: Jurnal Ilmiah Magister Manajemen*, *2*(2), 268–283. https://doi.org/10.30596/maneggio.v2i2.3774