Students' regional potential-based project for vocational education in engineering field

Syahril[1*], Rizky Ema Wulansari[1], Dian Safitri[2], Tee Tze Kiong[3], Sokolova Elizaveta Vitalyevna[4], Agariadne Dwinggo Samala[5]

[1] Department of Mechanical Engineering, Faculty of Engineering, Universitas Negeri Padang, **Indonesia**

[2] Department of English Language and Literature, Universitas Negeri Padang, **Indonesia**

[3] Faculty of Technical and Vocational Education, Universiti Tun Hussein Onn Malaysia, **Malaysia**

[4] Specialist of the Science Metrics Department, Ural State University of Economics, **Russian Federation**

[5] Department of Electronics, Faculty of Engineering, Universitas Negeri Padang, **Indonesia**

*Corresponding Author: syahril@ft.unp.ac.id

Abstract: This article discusses students' regional potential-based project for vocational education in engineering field as a strategy to strengthen the quality of project-based learning implementation, covering project-based learning, a project task based on potential of student's region, the seven standard elements of a project task based on potential of student's region, the stages of the implementation, and its effectiveness. It was driven by the existence of enormous potentials in Indonesia which have not been optimally developed. Most of universities here are located in urban areas, while most of the students come from rural regions. The previous research discloses students' positive perceptions toward this learning implementation. It helps them develop their soft skills, fosters better engagement with the learning process, and improves their 4C skills (Critical Thinking, Communication, Collaboration, and Creativity). The approach is able to serve as a model for vocational education learning, particularly in the field of engineering. It not only provides students with the opportunity to acquire knowledge, technology, and soft skills, but also contributes to students' regional development. This article is highly beneficial for learning implementation in Indonesia, particularly in vocational education, as well as a reference for further studies.

Keywords: project-based learning; vocational education; engineering student; regional potential

1. Introduction

Project-based learning (PjBL) is a popular learning model implemented not only in Indonesia, but also in other countries around the world. It is because of the need for education to adapt to a dynamic world (Huang et al., 2023; Krajcik & Shin, 2014). The implementation of PjBL in Vocational Education and Training in Germany has started since 2005 and has also been implemented in other European countries (Gessler & Sebe-Opfermann, 2018). In this learning model, students learn concrete things related to the real world. Students learn to work on a project of product manufacture or service job. The knowledge and skills learned are applied in a project task. Based on the experience of the authors' team in teaching and examining students' project tasks that have been reported, the given project tasks are only as students' learning assignments, even though they are based on the implementation of project tasks from the real world. Consequently, the impact of education does not contribute to national development, however education is an important component in the development of a country. In the essence, Technical and Vocational Education and Training (TVET) provides basic skills for young people and helps overcome socio-economic challenges around the world (Bhattarai, 2020). Therefore, to increase the effectiveness of learning and the usefulness of students'

project tasks, PjBL is strengthened with strategy of a project task which is based on the potential of students' region. Each group works on the projects oriented to develop the potential of their region or hometown.

The Students' Regional Potential-based Project (SRPP) strategy was inspired by the superiority of Indonesia as a country with abundant natural resources and a demographic dividend. Natural resources have contributed to developments in Indonesia, but have not been able to create economic prosperity, especially for people in rural areas (Anggraeni et al., 2017). One of the ways to strengthen the contribution of the natural resources to economic prosperity is by improving the quality of education (Anggraeni et al., 2020). Therefore, vocational education, especially the field of engineering, has an important role in assisting the development of natural resources for society economic welfare. The quality of human resources and applied technology as a result of vocational education are important to improve.

Since 2020, Indonesia, as well as countries in Southeast Asia, Vietnam and Thailand, has started to have a "demographic dividend", where the proportion of the population on productive working age is higher (OECD & ADB, 2015). The period between 2020 and 2030 will be the peak of this condition (Oey-Gardiner & Gardiner, 2013). This is an opportunity and a challenge for Indonesia to be a developed country. The utilization of this demographic dividend can be done by strengthening human resources through developing innovation skills and revitalizing vocational education (Rachman et al., 2022). The Indonesian government has made many improvement efforts, especially in vocational education. One of them is by requiring PjBL implementation in vocational education. It aims to get excellent and independent human resources to take advantage of Indonesia's abundant natural resources for society economic welfare. Since 2013, Indonesia government has gradually implemented a *hilirization* (downstreaming) program to natural resources. This policy requires the products of national natural resources to be processed into semi-finished or finished products before being exported overseas. The main objective of this policy is to increase the economic added value of commodities and strengthen the independence of domestic industries.

This article discusses the strategy of a project task which is based on the potential of students' region integrated to PjBL. This strategy is something new in the world of vocational education, where the common learning always deals with industrial world. It contradicts the fact that the industrial revolution 4.0 has started, which has become a reference for almost all industries around the world. They experience digital transformation in which production technology machines in factories use internet, robotics, artificial intelligence, data analytics, and sensor technology (Schwab, 2016). This will certainly have an impact on reducing the need of human labours as they are replaced by those automatic production machines. Therefore, in addition to developing competencies in adapting to industrial world, vocational education must also prepare its students to become entrepreneurs. Vocational education graduates are not only prepared to look for job opportunities, but also able to create vacancies through some businesses in their expertise obtained in education.

2. Project-based learning

PjBL is an approach which engages students to be fully involved in the construction of their knowledge by interacting with peers and the surrounding environment, as well as involving tutors as mediators between fellow students and studied objects that represent the knowledge to be acquired (Amamou & Cheniti-Belcadhi, 2018). It is a systematic method of teaching and learning, which gets students in complex real-world tasks to produce products and present to audiences, enabling them to acquire knowledge and skills (Thomas & D, 2000). It is an effective learning approach that allows students to learn through action by doing projects (Chen & Yang, 2019). It is positively related to students' engagement and instruction, and research results indicate students' positive responses to these teaching practices (Choi et al., 2019).

Students of PjBL classes have better social skills than those of non-PjBL classes (Culclasure et al., 2019). Research results from the implementation of PjBL in vocational education find that it can improve problem solving skills and students' competence (Jalinus & Nabawi, 2017), increase students' engagement with learning (Jalinus & Nabawi, 2018), improve teamwork skills (Jalinus et al., 2020), and students' competencies (Adli & Ambiyar, 2023). PjBL has a positive impact on growing the skills of vocational students aligning to the 21st century competency framework which includes skill of critical thinking, problem solving, communication, collaboration, and creativity (Jalinus et al., 2023; Megayanti et al., 2020).

Based on the literature review, the implementation of PjBL in learning varies when viewed from the syntax or stages of learning implementation by lecturers or teachers in class. Even though the stages of learning are different, students' project tasks are still based on the real world. The implementation of PjBL with six stages of student learning activities consists of (1) searching: students identify problems from the real world, (2) solving: students are guided to formulate problem solving and find alternative solutions, (3) designing: students prepare project plans, (4) producing/creating: students produce or carry out the product manufacture or service work according to what has been designed, (5) evaluating: students with guidance from lecturers test the results of project work, and (6) sharing: students present their project results (Kamdi, 2009). In vocational education curriculum in China, the stages of implementing learning with project-based learning comprise three basic components, which are project design, project implementation, and project evaluation (Zhang, 2013). PjBL syntax with seven learning steps has also been developed, which is principally divided into three basic stages (Jalinus et al., 2017). The skill competence debriefing stage includes three steps, which are formulating the expected learning outcome, understanding the concept of teaching material, and training skills. At the stage of carrying out the project, students' activities involve designing the project theme, making project proposals, and executing the project. At the evaluation stage, students present the project task result in a class seminar.

3.   Students' Regional potential based-project

SRPP is a strategy to strengthen the learning quality of PjBL implementation. Students' love and concern for their region or hometown is the basis for increasing motivation, enthusiasm, and good engagement during the learning process. Students have an emotional bound to their region or hometown as they were born and grew up there, have close relationships with relatives and social ties with the community. Students also have a better understanding of the potential of their own region, the social problems encountered in its development, and the potential for sustainability of what they are doing through the project task. In carrying out the project, students have access to consult related parties such as community leaders, non-governmental organizations, and local governments. This certainly provides an opportunity for success in doing their project task. In addition, the projects that are useful for their region's potential development encourage them to produce better products.

When students engage in the project task, they do not just focus on developing personal knowledge and skills, or simply getting grades, but also implementing the results of their work to develop the potential of their region or hometown. In this context, the project task becomes a means for students to produce innovative solutions, products, or services which have real and positive impacts in developing their region's potential. The stages of implementing SRPP in the PjBL, which can be applied to learning courses for one semester, are divided into two basic stages, including learning activities for basic theory and skills of the course and implementation of SRPP (Figure 1).

The learning activities for basic theory and skills of the course consist of three stages, starting from apperception, basic theory learning, and basic skill training. Basic theory learning and basic skill training activities are placed into the beginning of the stages as learning in engineering education commonly deals with the operation of tools or machines. It certainly requires basic knowledge and operational skills in using these tools or machines for occupational safety and(Jalinus et al., 2017). The results of previous research disclose that

students are able to complete the project well because they have learned basic knowledge and skills from the courses (Syahril et al., 2021), and their proficiency on these basic competencies makes the projects done in accordance with the context of the course (Syahril, 2020). In carrying out the projects, students learning activities start from identifying their region's potential, designing projects to develop the potential, carrying out project work, promoting the project to related parties in their area, and reporting project results.
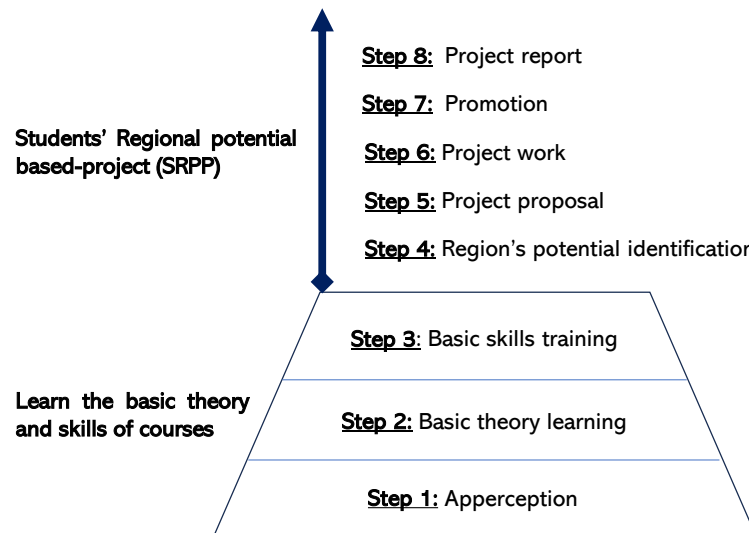
Figure 1. The Learning Syntax of SRPP in PjBL

Teaching and learning activities in the learning environment between lecturers, students, and learning resources on SRPP are described as follows:

Step 1. Apperception

The initial phase of the teaching and learning process is referred to as apperception, which involves the preparation of all elements related to the implementation of instructional activities to be conducted throughout the semester. Some things that need to be done by lecturers are:

a. Checking the readiness of teaching materials, learning media, practicum equipment and materials.
b. Checking students' learning readiness regarding materials or tools prepared by students personally.
c. Knowing student's initial abilities by checking the taken prerequisite courses related to the current course.
d. Directing students regarding the implementation of learning that will be carried out along the semester. In this activity, lecturer explained the syntax of SRPP integrated in PjBL implementation.
e. Motivating students for the importance of the course to be studied and the benefits of learning with the project task based on region's potential.

Step 2. Basic theory learning

Learning basic knowledge related to courses before practicum training or project work activities is very important. In the taxonomy for learning, the student learning process must be gradual, starting from remembering, understanding, and applying (Anderson, 2001). Referring to this theory, in this basic theory learning activities, it begins by providing students teaching modules for their self-learning. Through the literacy process in the module, the students are expected to be able to remember the basic theory taught from the course. Furthermore, discussion activities are carried out in class to confirm the

knowledge achieved by them during the independent learning activities. This discussion activity will make them better understand the material studied independently. At the end of this basic theory learning activities, a written test can be conducted to measure and evaluate their understanding.

Step 3. Basic skills training

Basic skill training, such as doing practicum activities using tools or machines, is crucial to do before students come to their project task. This activity can be done by using demonstration scenario method with the following stages:

a. Lecturer demonstrates the use of tools or machines professionally for product manufacture without explaining the operation steps.
b. Lecturer demonstrates and explains the operation of the tools or machines, tricks and tips, and/or occupational safety and health rules.
c. One or several students are instructed to operate a tool or machine, and lecturer confirms it by asking questions about what they are doing and if they understand every action they do.
d. All students are instructed to be involved in skill training to produce a part of a product under supervision and guidance from lecturers and instructors.

Students' skill proficiency can be assessed by doing observation during the practicum and evaluating the products made by the students.

Step 4. Region's potential identification

After completing the basic theory learning and basic skill training, students are led to do the project task based on the potential of their region, starting from identifying their region's potential. They are instructed to identify the potential of their region to be developed by directly engaging in discussions with community leaders, non-governmental organizations, and local government. It aims to align the students' project with that of government, so they can contribute each other.

Step 5. Project proposal

At this stage, students design projects that can develop their region's potential in the form of project proposals by following these structures:

A. Introduction

1. Region's potential
2. Challenges and opportunities
3. Purpose and benefits

B. Literature review

It contains a literature review about the machine to be made.

C. Machine design

1. The concept of machine
2. Machine Specification

D. Method

1. Project plan
2. Time schedule
3. Flow chart

During the proposal writing, students are guided by lecturers. They are also advised to discuss with related parties in their area for other inputs and suggestions. Students are also directed to refer to books, papers, articles, or final assignments that discuss machines made for project tasks. Proposals that have been written are then presented in class to get inputs and suggestions from other students.

Step 6. Project work

At this stage, students work on the project task. The process is done according to the project implementation plan that has been written in the proposal. During the students do the project, lecturers act as motivators, mentors, facilitators, and evaluators (Jalinus et al., 2017). Discussions related to the project between students and lecturers can be in or outside learning hours.

Step 7. Promotion

In this learning activity, students promote their project result to local governments or partners in their region. This activity trains their communication skill, personal branding, and expands their networks. The result can also be promoted on their social media. Those are effective promotion platforms which can reach wider audiences. However, students need to have knowledges and skills to appropriately use the social media platforms, produce engaging content, and utilize digital marketing techniques to promote their project results.

Step 8. Project work report

At the end of the project, students write a final project work report and present it by explaining the products being developed, milestones, challenges, and progress. The report will be a reference for lecturers to assess them as well as to provide suggestions for their next better projects.

4.   Seven standard elements

SRPP is a new learning model that still needs to be continuously evaluated for its relevance to the learning condition on the aspect of students, types of courses, and learning objectives. Various courses and fields of knowledge will possibly enable different implementation of the model. To ensure that the implementation result in a qualified learning according to its characteristics, seven standard elements are formulated which become a reference for lecturers in implementing the model.
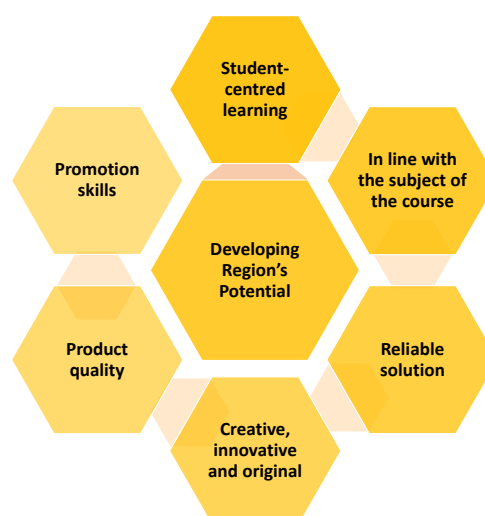
Figure 2.   Seven standard elements

Standard 1. Developing region's potential

The purpose of the project given to students is to develop the potential of their regions. Through an emphasis on it, it is expected that students' motivation, enthusiasm, and engagement in learning can be enhanced. The project is not only as their learning assignment, but also provides real benefits in developing the potential of their regions. Students are expected to be able to identify the potentials that exist in their area, such as natural resources or the needs of the local community. They have to set a priority potential to be developed, critically overcome the problems encountered by finding good solutions, formulate a comprehensive development plan or design by taking into account of economic, social, environmental and sustainability factors, and produce relevant products or policies with positive impacts on regional potential development. By these experiences, as a result, they will be influential agents of change in society who contribute much to their region development.

Standard 2. Student-centred learning

Student-centered learning is an approach that aims to provide opportunities for students to study independently, develop competencies according to their own learning style, and play an active role in the learning process. PjBL itself is a learning model with a student-centered learning approach. Student-centered learning involves changing the role of teacher, who is no longer dominant in teaching, but acts as a facilitator and guide. The main goal is to encourage students' active participation, and develop problem solving, critical thinking, collaboration, and metacognitive skill. In this context, the project becomes a means for students to learn responsibly and actively since the products resulted from the project will provide real benefits for their own regions.

In PjBL, students are given the responsibility to design, manage, and complete the project that are relevant to the potential development of their region. Through this project, students have opportunity to implement the knowledge and skills they learn in a practical context. They learn to think critically in identifying problems, planning strategies, collecting and analyzing data, and developing innovative and sustainable solutions. Student-centered learning also encourages collaboration between students in tackling project tasks. They work in team, share knowledge and experiences, and learn from different perspectives. In the process, they also develop their communication, negotiation, and leadership skill needed in the real world.

Through student-centered learning activities and project tasks which are beneficial to their regions, students not only develop academic competencies, but also become agents of change that contribute to regional development. They learn to be responsible for the project they do as they realize that the results can provide real benefits for their area.

Standard 3. In line with the subject of the course

The aim of giving SRPP is to get them implement the knowledges and skills they have learned in practical contexts that are relevant to the courses they are currently taking. In order to achieve this goal, it is important to align the project with the course being taught. For example, if a student is taking a Mechanical Drawing course, the project must be related to making a detail drawing of a machine. In this case, the project aims to provide opportunities for students to directly apply the knowledges and skills they acquire in the Mechanical Drawing course by producing accurate and comprehensive detail drawings.

By its relevance, students can optimize their learning by implementing their knowledges and skills practically. In addition, the projects that are appropriate to the context of the course will also provide motivation and a higher sense of engagement for students as they can see the relevance and benefits of what they are learning in a real context.

Standard 4. Reliable solution

In developing region's potential, effective problem-solving and innovative solutions require a proven and accountable basis. Although the project does not always involve a formal research approach, it is important to build solutions based on valid and trusted knowledge. References used by students in designing tools or technologies can come from various sources. Scientific journal is one of valuable resources since they reflect research that has been carried out by experts in related fields. Books can also be good references, especially if written by an authority on a relevant topic. In addition, previous students' final assignments or similar researches can also be a valuable source of information.

Apart from journals and books, advances in technology have also given students access to alternative sources of information. Blogs and videos on online platforms, such as YouTube, can provide a different and practical perspective on understanding a particular concept or technology. However, it is important to look over and verify the reliability and authenticity of the information obtained from these sources, as not all online contents can be considered accurate and trustworthy. In developing problem-solving and innovative solutions, students need to perform a critical analysis of the information they get from various sources. This involves checking the validity and credibility of sources, evaluating methodologies used in previous studies, and considering the feasibility and effectiveness of proposed solutions. By referring to trusted sources, students can ensure that the solutions they develop are based on a strong basis and meet the expected quality standards. In the process, students can also combine new perspectives and innovative ideas to produce solutions which are more efficient and relevant in developing their region's potential.

Standard 5. Creative, innovative and original

The projects developed by students come from their own ideas after analyzing the potential that exists in their region. The development of the project is considered innovative when it gets significant appreciation from the community, and the produced tools or machines become highly needed by the region. It is important to note that the developed tool or machine must be authentic and original, the result of the students' own creative ideas, with supervision and guidance from the lecturer as a reviewer or advisor.

The process of developing the project begins with students' identification on their region's potentials, such as unmet needs, problems that need to be solved, or open opportunities. Based on this potential analysis, students then develop innovative project ideas that are expected to provide relevant solutions and have a positive impact on their regions. At the project development stage, students act as creative thinkers who design the required tools or machines based on their own ideas. These ideas are reinforced by monitoring and guidance from lecturers as observers or advisors who ensure that the projects are developed in accordance with technical principles and local needs. In this process, it is important for students to maintain authenticity and originality of their project concepts and designs.

The success of the project is measured through the appreciation given by the community. If the developed tool or machine receives great appreciation and is considered important for the region, this shows that the project has a positive impact and innovative value. This appreciation proves that the students' ideas and contributions in developing their region have real relevance and are recognized by the community as useful solutions. Thus, the project can be considered as a creative achievement produced by students in their own regional development efforts.

Standard 6. Product quality

Each project given to students must adhere to predetermined quality standards to ensure that the resulted product reaches the expected feasibility level. This quality standard covers various aspects that need to be considered in product development, such as accuracy, reliability, and sustainability. It must be able to become a trusted solution to develop the potential of students' regions. In addition, it must reflect their ability to implement the knowledge and skills achieved from the course being studied. Students are expected to be able to apply relevant concepts, principles and methods to design and develop products according to region's needs and potential.

Implementing predetermined quality standards is a must as it guarantees that the products produced by students have significant value and benefits. Products that meet quality standards will provide optimal benefits for the students themselves, in terms of developing skills, understanding concepts, and practical implementation. In addition, a qualified product also benefits those involved in the project, such as supervisors and partners who work with students in product development. Therefore, students need to understand and conform the predetermined quality standards. This involves the use of appropriate methods and techniques, careful testing, and objective evaluation to ensure that the product meets the expected quality. Thus, the products that fit quality standards will make a significant contribution to region's potential development and benefits for all parties involved.

Standard 7. Promotion

Promotion skill, or the ability to promote oneself, products, or services effectively, is an important competency that every student must have. In a business and organizational context, the ability to promote oneself and communicate the value of your product or service is key to achieving success and recognition. Promotion skill also include an understanding of social media and digital marketing, which are increasingly important in this digital age. In a highly competitive job market, a strong promotion skill gives students a competitive advantage. The ability to confidently present oneself, express strengths and expertise, and be convincing in selling ideas or products open wider career opportunities. A good promotion skill not only enhance an individual's career prospects, but also expand networks and connections, which can play an important role in securing future job opportunities or collaborations.

In today's interconnected world, where effective communication and self-presentation are highly valued, promotion skill plays an important role. By having the skill, students are equipped with the ability to explore the professional world and showcase their abilities to potential employers or partners. The skill allows them to stand out among their peers and gain valuable career opportunities. Moreover, in an increasingly digitized and globalized world, a solid understanding on social media platforms and digital marketing techniques is essential. Students with a good promoting skill are able to take advantages of these digital tools to reach wider audiences, build a personal brand, and effectively promote their ideas, products, or services.

5.   Implementation benefits

Based on published research results, the project task based on potential of students' region is better than free theme-based projects in terms of soft skills and positive students' perceptions (Syahril et al., 2021), is effective for making students engaged in the learning process (Syahril, 2020) and improves the students' 4Cs skills (Latifa et al., 2022; Nabawi et al., 2024; Syahril et al., 2022). The results of previous research indicate that the implementation of the model integrated in PjBL is very useful for developing students' competencies and improving the learning quality. In addition, the project results are valuable for students' regional development.

Figure 3 is one of the project tasks based on the potential of students' region done by students majoring in mechanical engineering, Universitas Negeri Padang. It is related to the development of the potential in Nagari Simawang, a village located in Tanah Datar District, about 90 km from the Universitas Negeri Padang. It is the hometown of the students carrying out the project. In that area, there was a water source potential that had not been used optimally to meet the needs of 25 residents' houses whose no access to clean water. After being examined, it was found that the cause was the water source was in the lowlands, while the 25 residents' houses were on higher ground. Previously, the residents used pumps operated by internal combustion engines to lift the water. However, the residents felt hard to pay for the engine maintenance and fuel. Based on this problem, students designed a hydram pump as a project done in the Appropriate Technology Engineering course. The beginning results of the project were in the form of a funding proposal and a hydram pump design. The students then submitted the proposal on the Village Community Empowerment activity held by the Directorate General of Vocational Education, Ministry of Education, Culture, Research and Technology. The students' proposal and design were approved to be funded. The students produced a hydram pump and handed them over to the community so they could use them.
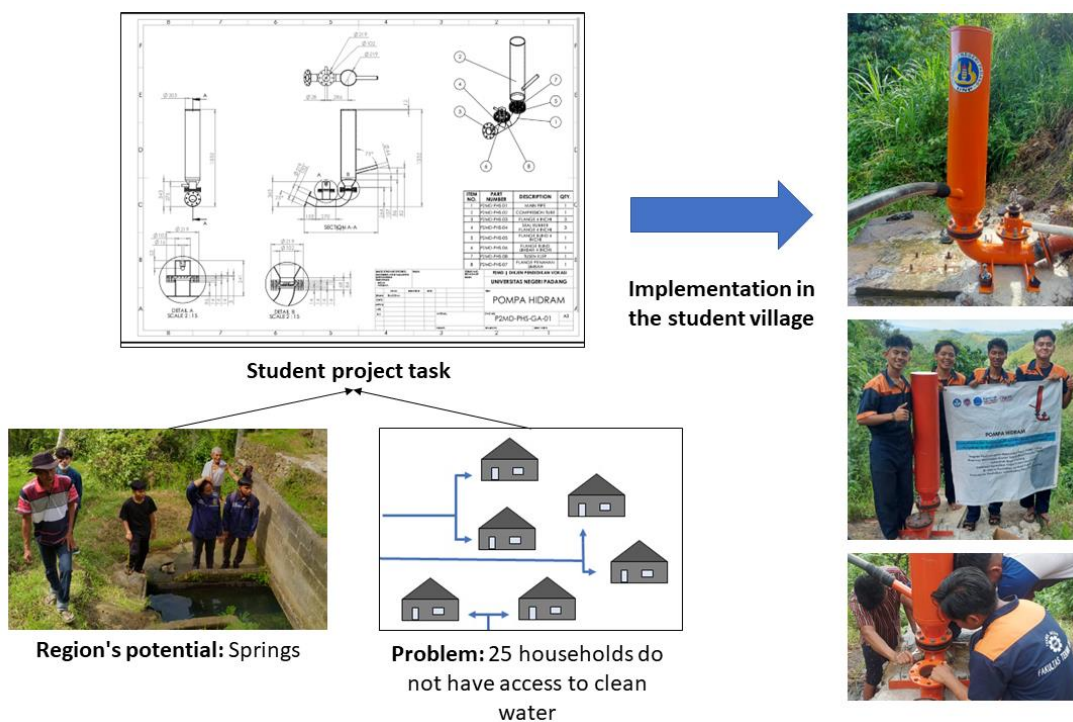
Figure 3. Project tasks based on potential of students' regions on producing a hydram pump

6.   Conclusion

The implementation of SRPP in PjBL has proven to be effective in developing students' competence, improving the learning quality, and providing significant benefits for the development of the potential of students' region. By involving students in the projects related to their region's potential, they can develop skills and knowledge relevant to their field of study. Through this project, they also can learn practically and are directly involved in solving problems that encountered in their regions. The learning process provides real experiences that improve students' understanding and skills holistically. In addition, this project also provides direct benefits for the potential of the students' region, as described as an example in this article in which the design and manufacture of a hydram pump by the students from Nagari Simawang can provide access to clean water for the residents. Therefore, the implementation of SRPP in PjBL not only provides educational benefits for students, but also gives a significant contribution to the development of their region's potential. This approach can be an effective model to increase students' competence, improve learning quality, and support regional development by utilizing the existing potential.

Author's Declaration

Author contribution

Syahril: conceptualization, resources, and writing - original draft. **Rizky Ema Wulansari:** Data Curation and Writing - Review & Editin**g. Dian Safitri:** Data Curation and Writing - Review & Editing. **Tee Tze Kiong:** Writing - Review & Editing. **Sokolova Elizaveta Vitalyevna:** Visualization and Writing - Review & Editing. **Agariadne Dwinggo Samala:** Visualization and Writing - Review & Editing.

Funding statement

Acknowledgement

Competing interest

The authors state that there is no conflict of interest at all from any parties concerning both the research process and article completion.

Ethical Clearance

This research does not involve humans or animals as subjects.

AI Statement

This article is the original work of the author without using AI-tools for writing sentences and/or creating/editing tables and figures in this manuscript.

Publisher's and Journal's Note

Researcher and Lecturer Society as the publisher, and the editor of Journal of Engineering Researcher and Lecturer state that there is no conflict of interest towards this article publication.

References

Adli, A., & Ambiyar, A. (2023). The Influence of Project-based Learning Model on mechanical Engineering Drawing Learning Outcomes. *MEE Journal* , *1*(1), 26–31. https://doi.org/10.24036/MEEJ.V1I1.7

Amamou, S., & Cheniti-Belcadhi, L. (2018). Tutoring In Project-Based Learning. *Procedia Computer Science*, *126*, 176–185. https://doi.org/10.1016/j.procs.2018.07.221

Anderson, L. (2001). *A Taxonomi for Learning, Teaching and Assesing: A Revision of Bloom's Taxonomy of Educational Objectives.* A Bridged Edition Addison Wesly Longman, Inc.

Anggraeni, P., Daniels, P., & Davey, P. (2017). The Contribution of Natural Resources on Economic Welfare In Indonesia. *Jurnal Perencanaan Pembangunan: The Indonesian Journal of Development Planning*, *1*(3). https://doi.org/10.36574/jpp.v1i3.20

Anggraeni, P., Daniels, P., & Davey, P. (2020). Improving the Benefit of Natural Resources Endowment to Economic Welfare in Indonesia: A Mixed-Method Analysis. *International*

Journal on Advanced Science, Engineering and Information Technology, *10*(3), 1234. https://doi.org/10.18517/ijaseit.10.3.12067

Bhattarai, P. C. (2020). Technical and Vocational Education and Training (TVET): What Next? *International Journal of Multidisciplinary Perspectives in Higher Education*, *5*(1), 106–112. https://doi.org/10.32674/JIMPHE.V5I1.2505

Chen, C. H., & Yang, Y. C. (2019). Revisiting the effects of project-based learning on students' academic achievement: A meta-analysis investigating moderators. *Educational Research Review*, *26*, 71–81. https://doi.org/10.1016/J.EDUREV.2018.11.001

Choi, J., Lee, J. H., & Kim, B. (2019). How does learner-centered education affect teacher self-efficacy? The case of project-based learning in Korea. *Teaching and Teacher Education*, *85*, 45–57. https://doi.org/10.1016/J.TATE.2019.05.005

Culclasure, B. T., Longest, K. C., & Terry, T. M. (2019). Project-Based Learning (Pjbl) in Three Southeastern Public Schools: Academic, Behavioral, and Social-Emotional Outcomes. *Interdisciplinary Journal of Problem-Based Learning*, *13*(2). https://doi.org/10.7771/1541-5015.1842

Gessler, M., & Sebe-Opfermann, A. (2018). Project-based learning in German vocational education and training: a structured approach to developing self-determined, cooperative problem-solving competence. *Boletim Técnico Do Senac*, *44*(3). https://doi.org/10.26849/bts.v44i3.715

Huang, W., Li, X., & Shang, J. (2023). Gamified Project-Based Learning: A Systematic Review of the Research Landscape. *Sustainability (Switzerland)*, *15*(2). https://doi.org/10.3390/su15020940

Jalinus, N., & Nabawi, R. A. (2017). Implementation of the PjBL model to Enhance Problem Solving Skill and Skill Competences of Community College Student. *Jurnal Pendidikan Vokasi.*, *7*(3), 304–311.

Jalinus, N., & Nabawi, R. A. (2018). The instructional media development of welding practice course based on PjBL model: enhancing student engagement and student competences. *Int. J. Innovation and Learning.*, *24*(4), 383–397.

Jalinus, N., Nabawi, R. A., & Mardin, A. (2017). The Seven Steps of Project Based Learning Model to Enhance Productive Competences of Vocational Students. *Proceedings of the International Conference on Technology and Vocational Teachers (ICTVT 2017)*. https://doi.org/10.2991/ictvt-17.2017.43

Jalinus, N., Sukardi, S., Wulansari, R. E., Heong, Y. M., & Kiong, T. T. (2023). Teaching activities for supporting students' 4cs skills development in vocational education. *Journal of Engineering Researcher and Lecturer*, *2*(2), 28–37. https://doi.org/10.58712/jerel.v2i2.95

Jalinus, N., Syahril, Nabawi, R. A., & Arbi, Y. (2020). How project-based learning and direct teaching models affect teamwork and welding skills among students. *International Journal of Innovation, Creativity and Change*, *11*(11), 85–111.

Kamdi, W. (2009). Active Learning di antara Idealisasi dan Realitas Praktik Pendidikan. *Peningkatan Kualitas Pembelajaran Melalui Active Learning Menuju Profesionalisme Guru*, 1–12.

Krajcik, J. S., & Shin, N. (2014). Project-Based Learning. The Cambridge Handbook of the Learning. *The Cambridge Handbook of the Learning Sciences, Second Edition*.

Latifa, D. K., Syahril, S., Jalinus, N., & Ridwan, R. (2022). Development of Mesin Teknologi Terapan Textbook Based on Project Tasks from Regional Potentials. *Jurnal Pendidikan Teknologi Kejuruan*, *5*(2), 57–61. https://doi.org/10.24036/JPTK.V5I2.27523

Megayanti, T., Busono, T., & Maknun, J. (2020). Project-based learning efficacy in vocational education: Literature review. *IOP Conference Series: Materials Science and Engineering*, *830*(4), 042075. https://doi.org/10.1088/1757-899X/830/4/042075

Nabawi, R. A., Syahril, Jalinus, N., Wulansari, R. E., Ambiyar, Refdinal, & Nurdin, H. (2024). *Creative thinking: Project-based learning with regional potential-based project tasks for engineering students*. 020012. https://doi.org/10.1063/5.0218735

OECD, & ADB. (2015). Education in Indonesia. In *Far Eastern Survey* (Vol. 20, Issue 15). OECD. https://doi.org/10.1787/9789264230750-en

Oey-Gardiner, M., & Gardiner, P. (2013). Indonesia'S Demographic Dividend or Window of Opportunity? *Masyarakat Indonesia*, *39*(2).

Rachman, T. A., Latipah, E., Supiana, S., & Zaqiah, Q. Y. (2022). Education Development in Utilizing Indonesian Demographic Dividend: The Road to Become a Developed Country. *Proceedings of the 4th International Conference on Educational Development and Quality Assurance (ICED-QA 2021), 650*. https://doi.org/10.2991/assehr.k.220303.060

Schwab, K. (2016). *The Fourth Industrial Revolution*. World Economic Forum.

Syahril. (2020). Effectiveness of the project task based on potential of student's region on student engagement. *Opcion, 36*(91), 886–1005.

Syahril, Purwantono, Wulansari, R. E., Nabawi, R. A., Safitri, D., & Kiong, T. T. (2022). The Effectiveness of Project-Based Learning On 4Cs Skills of Vocational Students in Higher Education. *Journal of Technical Education and Training, 14*(3), 29–37. https://doi.org/10.30880/jtet.2022.14.03.003

Syahril, S., Nabawi, R. A., & Safitri, D. (2021). Students' perceptions of the project based on the potential of their region: A Project-based learning implementation. *Journal of Technology and Science Education, 11*(2), 295. https://doi.org/10.3926/jotse.1153

Thomas, J. W., & D, P. (2000). A REVIEW OF RESEARCH ON PROJECT-BASED LEARNING. *Learning*.

Zhang, Z. (2013). Application of Project-Based Learning in Teaching of the Curriculum of Combining Study with Work of Higher Vocational Education. *Proceedings of the 2013 the International Conference on Education Technology and Information Systems*. https://doi.org/10.2991/icetis-13.2013.165