

# Project-Based Learning In Vocational Technology Education: Study Of Literature

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**Abstract:** The world of education, especially vocational technology education, is never finished to be discussed, ranging from skills-based to values-based education. One of the approaches in practical education is project-based learning. It is an educational approach that focuses on creative thinking, problem solving, and interaction between students and peers to create and use new knowledge. Through project-based learning, students will work in teams; discover skills in planning, organizing, negotiating, and making consensus on issues of assignment to be done; appoint who is responsible for each task; and decide how information will be collected and presented scientifically.

**Index Terms:** project-based learning, vocational technology education, study of literature

## 1. INTRODUCTION

Nowadays, there are plenty of studies that seek to determine which skills every engineer should possess. Communication and teamwork are some of the most recurrent ones associated with knowledge of engineering sciences. However, their application is not straight forward, due to the lack of educational approaches that contributes to develop experience-based knowledge. A detailed depiction of the course structure, as well as strong evidence for its potential, is provided to improve the students' soft skills like the ability to successfully communicate technical issues, cooperate effectively, and the general capability of putting theory into practice [1]. Technical Vocational Education and Training (TVET) was often judged as a place for those who only fated to do menial and dirty jobs resulted from their poor academic achievement [2]. Project-based learning (PBL) allows the learner to be involved in the analysis of a given project and the search for possible solutions. Proposed projects usually have problems related to practical facts about the content of the proposed course [3]. In addition, PBL has become an ideal method to anticipate future professional practice for training engineers [4]. PBL is a method developed based on a constructivist finding, its application is centered on project development as the learning tool catalyzing knowledge discovery [5], and it has been traditionally designed and implemented on a know-how and trial-and-error basis, but tasks and decisions taken during the design phases of the training modules have a substantial effect on its quality and outcomes [5]. In almost similar tone, PBL can be defined as an innovative approach to learning that teaches a multitude of strategies critical for success in the twenty-first century [6], hence well-designed and well-implemented project-based learning experiences may be a significant catalyst to gain students' critical thinking and problem solving skills, and finally to train them as scientifically literate individuals in accordance with the science curriculum requirements of 21st century [7]. PBL stresses on education that gives odds on the learner-based learning system and collaboratively integrates the real and practical issues and effective teaching in building knowledge and creativity [8].

Thus, PBL is an innovative student-centered learning and places lecturers as motivators and facilitators, where students are given an opportunity to work autonomously to construct their learning. PBL is very suitable to be integrated with machining and manufacturing technology courses. Based on the learning activities listed in the syllabus, machining and manufacturing technology courses require students to be active (student-centered learning), while lecturers act as facilitators and motivators; students work together with various materials provided. When students work in teams, they discover the skills of planning, organizing, negotiating, and making consensus on the issues of the task to be done, appointing who is responsible for each task, and deciding how information will be collected and presented. The skills that have been identified by these students are very important for the success of their life, and for workforce they are very important skills in the workplace. Because the nature of project work is collaborative, the development of these skills takes place among students. In group work on a project, individual strengths and ways of learning are referred to strengthen teamwork as a whole. Students use inquiry, research, planning skills, critical thinking and problem solving skills in the process of completing a project. Actually, working on a project does not guarantee learning. To ensure that the learning takes place, projects need to be carefully selected and designed to cover the required content. For this reason, in PBL: (1) students are involved in complex issues and problems in the real world, and if possible, it is students who choose and define issues or problems that are meaningful to them; (2) students use inquiry, research, planning skills, critical thinking, and problem solving skills when completing projects; (3) students learn and apply specific skills/standards about content and knowledge in various contexts when working on projects; (4) students have the opportunity to practice a number of skills needed for their future life and career (for example: skills to allocate time and resources; interpersonal skills, etc.); (5) the activity ends with a product or presentation that demonstrates learning and assessment. Engineering education should, in addition to providing sufficient theories, also need to provide examples of solving real projects by utilizing learning strategies that support engineering education. Today's knowledge age wants a learning paradigm that is oriented to projects, problems, inquiry, discovery and creation [9],[10]. One of the learning strategies that can help students to have creative thinking, problem solving, and interaction as well as assist them in investigations that lead to solving real problems is project-based learning or PBL [11],[12],[13],[14]. PBL can stimulate

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motivation, process, and improve student's learning achievement by using problems related to specific subjects in real situations. The results showed that 90% of students who took part in the learning process by implementing PBL were confident and optimistic that they could implement PBL in the world of work and could improve their academic achievement [15]. Besides, the results of the survey research done by [16] showed 78% of students said that curriculum based on PBL can help equip students for preparation for entering the workforce, because students do not only learn theories but also practice those theories in the field.

## II. THE CONCEPT OF PROJECT-BASED LEARNING

Project-based learning (PBL) is a model or innovative learning approach, which emphasizes learning through activities contextually complex [17],[11]. PBL focuses on the concepts and principles of the main (central) of a discipline, involves students in problem-solving activities and other significant tasks, provides opportunities for learners to work autonomously in reconstructing their own learning, and ultimately helps learners produce valuable and realistic work product [18]. Unlike the models of traditional learning which are generally characterized by the practice of a class of short duration, insulated/drop-off, and teacher-centered learning activity. In addition, the model of PBL puts more emphasis on learning activities in relatively long duration, holistic model, interdisciplinary learner-centered approach, and model integrated with practice and real-world issues. In PBL, learners learn the real problem, which can generate permanent knowledge and organize projects to learning [19]. PBL is an effective educational approach that focuses on creative thinking, problem solving, and interaction between students and their peers to create and use new knowledge. Specifically this is done in the context of active learning, scientific dialogue with active supervisors as researchers [20],[21],[22]. Based on these opinions, PBL is a learning strategy developed based on constructivist learning that requires students to compile their own knowledge [23]. Constructivism is a theory of learning that has broad support relying on the idea that students build their own knowledge in the context of their own experience [9]. The PBL approach can be seen as one of the approaches developed to create a learning environment that can encourage students to construct knowledge and skills personally. [24] states that PBL has several characteristics, namely: (a) students are decision makers who make the frameworks, (b) there are problems whose solutions are not predetermined, (c) students are designers of the process of achieving results, (d) students are responsible for obtaining and managing the information collected, (e) evaluations are conducted continuously, (f) students regularly look back on what they are doing, (g) the final product evaluates the quality, and (h) class has an atmosphere that tolerates errors and changes. PBL has great potential to make the learning experience interesting and meaningful for the students to enter the workforce. According to [25], in the PBL that is applied to develop competence of learners working in the company, they become more active in learning, and they hold many skills that have been built from the project in the class, such as team building skills, decision making, cooperative group work, problem solving, and team management. These skills have great value when they enter the working environment, but they might be difficult skills when taught through traditional learning

approach.

## III. PROJECT-BASED LEARNING PLATFORM

The tendency of the 21st century was marked by the increasing complexity of technological equipment, and the emergence of a corporate restructuring that emphasizes a combination of technology and human quality, causing the world of work will need people who can take initiatives and have critical thinking, creativity, and capability to solve the problem. The relation of "man-machine" is no longer a mechanistic relationship but a communicative interaction that requires high-level thinking skills. These tendencies began to be responded by the world of education in Indonesia, which since 2000 has applied four educational approaches, namely (1) life skills-oriented education, (2) curriculum and competency-based learning, (3) production-based learning, and (4) broad-based education. The new orientation of education is willing to establish educational institution as a life skills-oriented educational institution, develop education with the aim at achieving competence (hereinafter referred to as a competency-based education), make learning process authentic and contextual that can produce valuable and meaningful results to learners, and provide educational services in a broad way through various flexible and multi-entry-multi-exit educational pathways and levels [26]. The learning process in life skills-oriented education and competency-based learning is expected to produce valuable products and demand a rich and real learning environment (rich and natural learning environment), which can provide a learning experience in an integrative competence dimension. The learning environment is characterized by:

- a. Learning situations, environments, contents and tasks that are relevant, realistic, authentic, and present the natural complexity of the "real world"
- b. Primary data sources that are used to guarantee the authenticity and complexity of the real world
- c. Developing life skills and not simply the reproduction of knowledge
- d. The development of the skills in an individual context and through social negotiation, collaboration, and experience
- e. Previous competencies, beliefs, and attitudes which are considered as prerequisites
- f. Emphasis on problem solving skills, high-level thinking, and deep understanding
- g. Students who are given the opportunity to learn in an apprenticeship where there is an increase in the complexity of the task, the acquisition of knowledge and skills
- h. The complexity of knowledge which is reflected by the emphasis of learning on conceptual connectedness and interdisciplinary learning
- i. Cooperative and collaborative learning which is preferred in order to expose students to alternative views, and
- j. Measurement which is authentic and becomes an inseparable part of learning activities [26].

Noting its unique and comprehensive characteristics, PBL model is potential enough to meet the demands of the learning. The PBL model helps learners: (1) to learn knowledge and skills that are robust and meaningful built through the authentic tasks and works[17],[27],[28],[29]; (2) to expand knowledge through authentic curricular activities which are supported by a process of learning planning (designing) or open-ended investigation, with the results or answers that are not predetermined by a particular perspective; and (3) to build

their knowledge through real-world experience and cognitive interpersonal negotiation that take place in an atmosphere of collaborative work.

#### IV. STEPS IN THE PROJECT-BASED LEARNING

The workshop of project-based learning (PBL) for tutors according to [30] consists of: (1) creating questions that will be used as the project, (2) selecting the main questions or determining the projects, (3) reading and searching for the materials relevant to the issue, (4) designing the problems, (5) designing appropriate methods to solve the problems, (6) writing a project proposal, (7) implementing and documenting creation tasks, (8) analyzing the data and making inferences, (9) making a final report, (10) presenting the final project. The shorter steps for setting learners in implementing the PBL are proposed by [31] and [19]. The first step is preparing the formulation of the problem (choosing a theme project, asking a question, making a list, creating a definition, choosing and deciding the project, and formulating the problems and hypotheses). This is a standard introductory phase of learning in which information and schedules are made by students trying to understand each other by introducing themselves and collecting their expectations in the overall project. The second step is integration, which is a process consisting of a number of activities with respect to the preparation and execution of the project important step.

- a. Designing and setting up the equipment for the project and determining the method, place, and symptoms.
- b. Defining the formation of the group and the selection of projects in which students are expected to honestly solve the problems they have in small groups.
- c. Collecting the information which consists of a brief presentation and discussion of individual projects and supports the collection of a variety of views on the project.
- d. Formulating the project planning steps which serves as an important part of the work group.

The project planning steps should consider the learners' motivation to follow the project-based learning, their way of doing problem-solving, and the collaborative process between students and professors, as well as independent learners, in completing the project.

Meanwhile, step-by-step project based learning developed by [13] consists of:

- a. Determining the basic question (It is suggested to start with the essential question)  
Learning begins with essential questions, those that can give assignments to students in conducting the activity. The assignment topic is relevant both to the real world and to the students, and begins with an in-depth investigation.
- b. Planning the project (Designing a plan for the project)  
Planning is done collaboratively between the teacher/lecturer and the students. Thus, students are expected to have a feeling of "ownership" or sense of belonging of the project. Planning contains rules and selected activities that can support in answering the essential questions by integrating a variety of possible subjects and knowing the tools and materials that can be accessed to help complete the project.
- c. Arranging the schedule (creating the schedule)  
The teacher/lecturer and the students collaboratively arrange the schedule of activities in completing the project. The activities at this stage include making a timeline (time allocation) to complete the project, making a deadline of

the project completion, directing the students to plan new ways, guiding the students when the ways they make are not related to the project, and asking the students to provide an explanation (reason) about the ways they have chosen.

- d. Overseeing the path and progress of the project (This is done by monitoring the students and the progress of the project)  
The teacher/lecturer is responsible for monitoring the students' activities while completing the project. Monitoring is done by facilitating the students in each process. In other words, the teacher/lecturer acts as a mentor for the students' activities. In order to simplify the monitoring process, a rubric is created which is helpful to record all important activities.
- e. Assessing the product (Assessing the outcomes)  
The assessment is carried out to assist the teacher/lecturer in measuring the achievement of the standards, play a role in evaluating the progress of each student, provide feedback about the level of understanding that has been achieved by the students, and help teachers in developing the next learning strategy.
- f. Evaluating (Evaluating the experience)  
At the end of the lesson, the teacher/lecturer and the students make a reflection on the activities and results of the projects that have been carried out. The reflection process is done both individually and collaboratively. Project appraisal is an activity of evaluating the task that must be completed within a certain period/time. The task is in the form of investigation that includes planning, data collection, organizing, processing and presenting the data. Project appraisal can be used to determine understanding, the ability to apply, the ability to investigate and the ability to inform students clearly on certain subjects [32].

#### V. WORK OUTCOMES ASSESSMENT PROJECT

Evaluation phase is an important stage in the project-based learning (PBL), i.e. in order to know the extent to which the teacher/lecturer has achieved the learning objectives. The assessment is performed through the tasks that the learners have done individually or in groups for a certain period. The task is often associated with the collection of data/materials, data analysis, presentation of data or materials, and report preparation. The assessment tasks can be performed on the task or process during execution of the final test. Thus, teachers/lecturers can assign things that need to be assessed. The implementation of the assessment may use a checklist or a rating scale. The successful implementation of PBL on the learners depends on the design of the learning phases. The learning phases are designed to enable students to dig their own inventions, and the role of the teacher/lecturer in this study is as a mediator and facilitator. Therefore, in implementing the PBL, teachers/lecturers should be able to motivate learners to express their opinion in a democratic manner during the project presentations. In assessing the project, there are three points to consider: (1) management ability, i.e. the learners' ability in choosing a topic, finding information and managing time in data collection and report writing; (2) relevance, i.e. the project's relevance to the subject by taking into account the stage of knowledge, understanding and skills in learning; and (3) authenticity, i.e. the project as the reflection of the results of their own work, taking into account the contribution of teachers/lecturers in the form of



guidance and support for the learners' project [32]. The other step is evaluation (interpreting and making comparisons, concluding and creating project reports). The things that need to be prepared in PBL are curriculum, project equipment, physical environment, social environment, and the interaction of these aspects. This pattern shows the kind of activities in assessing the learners. Feedback helps teachers/lecturers in interpreting the learners' mastery of the project they have done.

## VI. CONCLUSIONS

Project-based learning is a cooperative learning model that accommodates the ability of children to practice the process of free and creative thinking. Implementation of PBL is the participation of learners in understanding the reality of life from the concrete to the abstract one. The reality of life is a source of inspiration and creativity in analyzing and developing a vision of life. Learning requires strategies that can synergize academic skills such as understanding the theory and soft skills (problem solving, teamwork, self-reliance, self-confidence, responsibility, honesty, and communication skills to convey ideas and concepts through presenting the group project). One of the strategies offering such synergy is project-based learning. It stresses on education that facilitates the practice of student-centered learning system by collaboratively integrating real and practical problems and effective teaching in building knowledge and creativity.

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