Project–Based Learning
At Vocational School of Machinery and Construction Engineering Through the Center of Excellence Program

Yoto [1], Marsono [2], Eddy Sutadji [3], Aji Prasetya Wibawa [4], Felix Andika Dwiyanto [5]

[1,2,3,,4,5] *Universitas Negeri Malang.*
Email: [1] yoto.ft@um.ac.id, [2] marsono.ft@um.ac.id, [3] eddy.sutadji.ft@um.ac.id,
[4] aji.prasetya.ft@um.acid, [5] felix.adwiyanto@gmail.com,

Abstract

The project-based learning (PjBL) method exposes students to real-world situations at DUDIKA (Business World, Industrial World, and World of Work). The adoption of PjBL is projected to prepare graduates to compete in the 4.0 century's industrial transformation. The establishment of the Vocational Center of Excellence (CoE) is the government's approach for establishing a vocational high school capable of producing graduates who meet DUDIKA requirements. The research on the PjBL implementation in the machining and construction sectors through the CoE program aims to examine the following: (1) preparation for PjBL through the CoE program, (2) implementation of PjBL in CoE Vocational Schools, and (3) project evaluation. The research strategy employed was a qualitative approach with a multi-case study design. Veterans Vocational School 1 Tulungagung, Muhammadiyah 7 Gondanglegi Vocational School, and PGRI 1 Gresik Vocational School were taken as research sites. The findings indicated that: 1) vocational high school and DUDIKA prepared PjBL for the center of excellence program; 2) vocational high school and DUDIKA implemented PjBL at CoE Vocational Schools, including: PjBL implementation on practical subjects, the role of vocational high school teachers and DUDIKA experts in implementing PjBL, and the importance of jobsheets in the implementation of PjBL.

Keywords: implementation, vocational high school CoE, project based learning, DUDIKA

I. INTRODUCTION

The industrial revolution offered the capacity to redefine a country's identity. Britain, which was once an agricultural country, has developed into an industrialized country (Kusnandar, 2019; Yu & Schweisfurth, 2020). The industrial revolution 4.0 does undoubtedly introduce new business lines, new jobs, and new professions, and it has the potential to promote labor market competition (Ghufron, 2018). Developed countries that recognize the value of technology and knowledge strive to place each citizen in a position of productive technology and knowledge, enabling them to further raise their level of welfare and benefit from all circumstances (Alcacer & Cruzmachado, 2019).

The industrial revolution paradigm is regenerated on a recurring basis, followed by developments in science and technology that provide justification for transformation. Investments in the sectors of research, innovation, and work can be made to support the progress and changes brought about by the industrial revolution 4.0. (Cholily et al., 2019). In line with this, education should be required in a country to continuously enhance knowledge, skills, and the educational system. Increasing human resource competency (skills, knowledge, and attitudes) has been shown to reduce unemployment and boost economic growth in a country (Bonvin, 2019).

Human resources are more frequently referred to metaphorically as Head, Hand, and Hearing

(H3) competencies or Hardskill, Softskill, and Attitude (HAS) competencies. Meanwhile, competence is a combination of abilities, self-attributes, performance-related behavior, and a willingness to work (Susilo et al., 2018; KBBI, 2020; Darmawang, 2017). In vocational high schools, competencies refer to critical abilities, attitudes, assignments, values, and appreciations that are oriented toward effective performance and are used to perform a job once students graduate (Jatmoko, 2013; Wheelahan & Moodie, 2017). According to Billett (2011), SMK focuses on managing graduates who possess the necessary knowledge, skills, discipline, tenacity, responsibility, and excitement to function well at work. Because graduates of Vocational High Schools are anticipated to have a substantial impact on a country's economic development, each Vocational School must be able to innovate and improve in order to continue to prosper (Arico & Lancaster, 2018; Deutscher & Winther, 2018).

The Government of Indonesia's aim in this regard is to create a number of Vocational Schools into CoE (Centers of Excellence) based on the industrial revolution 4.0 and recognized by DUDIKA (Business World, Industrial World, and World of Work) (Makarim, 2020). According to Ardana (2021), the development of Centers of Excellence in vocational high school institutions includes the following: (1) opportunities to enhance teacher and principal competence, as well as the relevance of DUDIKA's competencies; (2) stakeholder synchronization with DUDIKA in the vocational high school development program; (3) developing vocational high school curriculum in collaboration with DUDIKA; and (4) administering a vocational high school infrastructure by DUDIKA. The development of vocational education learning must be continued by its administrators to ensure that the quality of its graduates meets market expectations (Ulfa et al., 2019).

Project-based learning is a complete instructional strategy in which the student learning environment is built in such a way that students can research actual problems while also increasing their understanding of the subject material and applying others (Triwulandari, 2020). Project-based learning enables students to perform real work at vocational schools and in the workplace, in accordance with the skill program chosen by the students, and enables students to value work as capital for starting their own business once they graduate from vocational high school (Yoto & Widiyanti, 2017). The project-based learning model's effectiveness is contingent upon the presence of a teacher, students, and a job sheet/work/product to be performed. This research article discusses "Implementation of Project-Based Learning at the Mechanical and Construction Engineering Sertor Vocational School through the Center Of Excellence Program," with an emphasis on the following: (1) preparation for project-based learning through the Center Of Excellence program, (2) implementation of project-based learning at vocational high school CoE, and (3) evaluation of project-based learning at vocational high school CoE.

II. METHOD

The research on "Implementing Project-Based Learning in Mechanical and Construction Engineering Sector Vocational Schools Through the Center of Excellence Program" employed a qualitative approach with a multi-case study design conducted at three sites. Data collection was obtained through interviews with informants, reviewing supporting papers for CoE Vocational Schools, and conducting observations at each CoE Vocational School. The data was then provided in the form of individual case studies, followed by cross-case analysis. Triangulation of procedures and data sources was a data analysis methodology. The research was conducted at the CoE Vocational School in East Java Province, which consists of the following: Veterans Vocational School 1 Tulungagung, Muhammadiyah 7 Gondanglegi Vocational School, and PGRI 1 Gresik Vocational School. The Principal, Deputy Principal for Public Relations, Deputy Principal for Curriculum, Deputy Principal for Student

Affairs, Deputy Principal for Infrastructure, Productive Teachers, and Students served as informants for the research. Subsequently, the data was provided in the form of study findings, which are then analyzed in considerable detail using pertinent literature.

III. FINDINGS

The findings of a study conducted at CoE Vocational Schools (Veteran 1 Tulungagung Vocational School, Muhammadiyah 7 Gondanglegi Vocational School, and PGRI 1 Gresik Vocational School) are summarized in

Figure 1 Fishbone Diagram of Project-Based Learning Implementation at CoE Vocational Schools. Learning was implemented through the vocational high school center of excellence program, which was held in 2019 by the Ministry of Cultural Education in some Selected Vocational Schools, and DUDIKA. Project-based learning was implemented at CoE Vocational Schools by SMK and DUDIKA teachers using the concept of practical learning. Then, teachers from vocational high school and DUDIKA evaluated project-based learning.
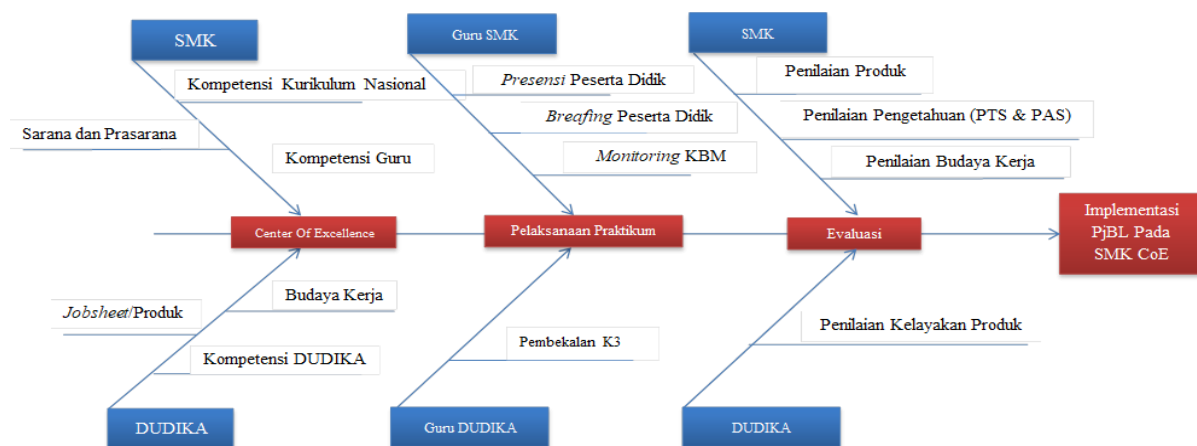

Figure 1. *Fishbone Diagram on The Implementation of Project Based Learning in Vocational High School CoE*
(Researcher's Document, 2021)

1. Project-Based Learning Prepartion through Center of Excellence

The project-based learning model synergizes through the center of excellence program organized by the central government, vocational high school, and DUDIKA. The implementation of project-based learning was implemented by vocational high schools in C3 subjects (practicum) which begins with several preparations, both preparations administered by DUDIKA and preparations carried out by CoE Vocational Schools themselves (see Table 1).

Table 1. *Vocational High School Preparation of Project-Based Learning*

No.	School Preparation	Explanation
1.	National curriculum	Competencies elaborated in the national curriculum
	competence	that has been approved by the Directorate of Vocational High School Development (DPSMK)
2.	Infrastructures and facilities	School buildings, workshops, equipment, machinery, and other supporting tools
3.	Productive teacher competence	Linearity of skill programs, internships at DUDIKA, and certification

(Source: Document of Researchers, 2021)

The following process is the development of a project-based learning model by DUDIKA, which includes the production of skills required by DUDIKA, the development of jobsheets to be completed by students, and an understanding of the work culture adopted by DUDIKA, as indicated in Table 2.

Table 2. Preparation of Project-Based Learning by DUDIKA

No.	Preparation by DUDIKA	Explanation
1.	Competences in DUDIKA	Competence of measuring instruments, including: the use of calipers, micrometers, threaded combs, dial indicators, and so on.
2.	Product/Jobsheet	The products produced by DUDIKA include: clam-c, nuts and bolts, and trackers
3.	Working culture	Implementation of K3 (Health, Safety and Work), Implementation of Work Culture, and 5R Culture (Concise, Neat, Clean, Careful, and Diligent)

(Source: Document of Researchers, 2021)

2. Implementation of Project Based Learning at Vocational High School CoE

At CoE Vocational Schools, the actual execution of skills topics (C3) is centered on the notion of project-based learning. The practicum begins with student attendance activities conducted by vocational high school teachers. The teacher then briefs the students on the following: (1) the product/jobsheet being worked on, (2) the product/jobsheet achievement target, (3) an explanation of successful work stages, and (4) the introduction of K3 and 5R. The instructor oversees and instructs students during the application of learning.

The teacher's role in practical learning activities in the workshop includes the following: (1) the teacher serves as a facilitator of learning, (2) the teacher serves as a determiner of ideas, (3) the teacher serves as an assessor and provides feedback on questions posed by students, (4) the teacher assesses products/jobsheets, (5) the teacher assists students in working independently on projects/products, and (6) the teacher serves as a resource for students. DUDIKA specialists play three roles in practicum learning with project-based learning concepts: (1) they assess students' performance and product results/jobsheets during practicum, (2) they deliver K3 briefings, and (3) they function as supervisors throughout the implementation of learning.

The product/jobsheet serves several functions in the project-based learning model, including the following: (1) it serves as a medium for learning, (2) it creates a more meaningful learning environment, (3) it provides real experience for students, (4) it provides experience in determining the proper work steps, and (5) it serves as the center of learning for students. The objectives for students in project-based learning are as follows: (1) students are able to think creatively when determining work steps, (2) students are able to collaborate with colleagues when determining solutions to problems, (3) students are able to think multidisciplinary when solving problems, (4) students are able to take ownership of the product/jobsheet that is completed, and (5) students are able to think critically when solving problems.
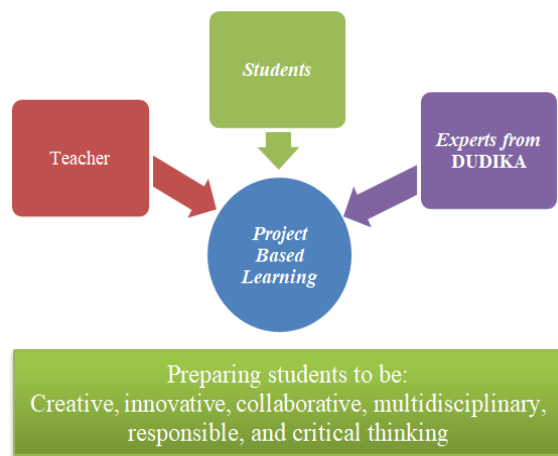
Figure 2. *Project Based Learning Interaction at CoE Vocational High School*
(Source: Research Findings, 2021)

3. Evaluation of Project Based Learning at CoE Vocational High School

Evaluation is a process or activity of assigning value that provides direction for accomplishing learning objectives. The CoE Vocational School's project-based learning strategy was evaluated by SMK and DUDIKA teachers. The following evaluations are conducted by vocational school teachers: (1) product/project assessment by students, which includes dimensions of size, precision, feasibility, and usability functions; (2) knowledge assessment via a knowledge test administered during the Mid-Semester Assessment (PTS) and Final Semester Assessment (PAS); and (3) work culture assessment throughout the semester. DUDIKA experts conduct evaluations of student-created products/projects using indicators of product precision, feasibility, and usability functions, as well as comparisons of product quality criteria developed by DUDIKA and SMK.

IV. DISCUSSION

1. Preparation of Project Based Learning through the Center of Excellence program

Currently, project-based learning is gaining prominence in the world of education. According to psychological research, traditional methods of instruction (lectures), memorizing, and reading book texts require far too little cognitive thinking on the part of students, necessitating the need for actual and regulated learning (Chen & Yang, 2019; Oguz-Unver & Arabacioglu, 2014). Project-based learning is a systematic and structured teaching method that engages students in completing complex real-world tasks and presenting their work, allowing them to acquire relevant knowledge and skills competencies for real-world situations (Chen & Yang, 2019; Barron & Chen, 2008; Thomas, 1998).

Project-based learning is a type of learning activity that involves students individually searching for information that must be sought, based on the premise that "I must know" rather than "I acquire" in relation to what the teacher provides (Oguz-Unver & Arabacioglu, 2014; Weiss & Belland, 2016). The term "project" is an educational term that refers to the implementation of project-based learning in practical learning. A project/jobsheet enables students to work with work steps or stages, discuss projects/jobsheets, and present their findings (Johnson et al., 2013). The expert opinion of the education model above can be summarized as follows: project-based learning is a systematic and structured teaching method designed by the teacher that incorporates research subjects; in this case, students are able to complete and produce projects/jobsheets independently and in collaboration with colleagues.

Project-based learning is a type of learning that incorporates projects/jobsheets, problems with problem-solving exercises, decision-making, the process of identifying work stages, allowing students to participate, and delivering the products generated (Rati et al., 2017). Project-based learning focuses on fundamental principles in the application of discipline, on resolving a problem or on completing a project/jobsheet, and on students producing products (Qur'ani, 2020). This is consistent with the findings of research conducted at the CoE Vocational School that the project-based learning model synergizes when applied to practical topics (skills domain) that use projects/jobsheets as a guide for practicum

activities. Thus according Eliza et al., (2019), project-based learning has an effect on the following: (1) increasing students' assessment results, (2) increasing their enthusiasm and motivation to learn, (3) increasing activity to complete problems and projects/jobsheets, and (4) adjusting the teacher's paradigm as the primary source of learning.

2. Implementation of Project Based Learning at Vocational High School CoE

In vocational high schools, project-based learning can be implemented across all curriculum areas. According to Omnguez & Jaime (2010), project-based learning delivers real-world experiences and has been shown to boost students' passion for learning activities. There are several critical components to project-based learning, including questions that regulate and encourage learning activities, as well as projects/jobsheets that serve as guidelines for determining work steps and the product outcomes of student learning activities or activities (Kelly, 2014; Krauss & Boss, 2013). The characteristics of project-based learning used in vocational high schools are as follows: (1) inquiry-based learning, (2) active learning (which will generate multiple new questions), and (3) investigative activities. (4) Students are free to work, (5) Activities are reviewed and improved, (6) Students receive feedback, (6) Collaborative Learning is encouraged, and (7) Increase student excitement for completing the object being worked on (Dado & Bodemer , 2017; Thomas, 1998).

Implementation of project-based learning requires vocational school students to be capable of completing projects/jobsheets by discussing work stages, examining failures, collecting and analyzing data, and communicating with peers (Hope & Allen, 2009; Chen & Yang, 2019). The majority of parents and instructors believe that implementing project-based learning will take an inordinate amount of time, yet this is equivalent to the results produced by students during the learning process (Miller, 2018). Collaboration, or collaboration in project-based

learning, is critical, and teachers must develop a learning plan that facilitates collaborative activities, teamwork, and collaborative evaluation and revision (Chen & Yang, 2019; Bender, 2012). Collaborative activities in project-based learning include collecting facts for review during learning activities, presenting projects/jobsheets in front of the class, and developing final project results/jobsheets (Johnson et al., 2013).

Project-based learning can be defined as an ongoing process of learning about connected subjects (Wolpert-Gawron, 2016). When project-based learning is implemented in vocational schools, the teacher guides students through projects/jobsheets, ensuring that students are actively engaged in the projects/jobsheets they are working on (Capraro et al., 2013). Implementing project-based learning will engage students in active learning activities such as problem solving, project/jobsheet completion, collaboration with peers, and creation of genuine solutions (Sumarni et al., 2019). Project-based learning is a type of learning activity in which students complete tasks using a jobsheet provided by the teacher, in order to reduce the amount of time spent on traditional learning (memorization) (Mohamadi, 2018).

According to the expert opinion above, the project-based learning model is consistent with the findings of research conducted at CoE Vocational School, which indicate that practicum subjects are implemented using a project-based learning model with the goal of engaging students actively in the learning process. Project-based learning is a type of learning that includes students actively and results in more effective learning outcomes than passively pouring knowledge (Azizah & Widjajanti, 2019). Students who are familiar with the notion of project-based learning in practicum courses will have a greater sense of drive and enthusiasm for learning, will have a variety of various ideas for completion, and will be able to expand on the knowledge learned during the learning process (Uziak, 2016; Bender, 2012). Collaboration, or collaboration

in project-based learning, is critical, and teachers must develop a learning plan that facilitates collaborative activities, teamwork, and collaborative evaluation and revision (Chen & Yang, 2019; Bender, 2012).

At the CoE Vocational School, the practicum begins with the teacher conducting student attendance activities. The teacher briefs the students on the following topics: (1) the product/jobsheet being worked on, (2) the product/jobsheet achievement target, (3) an explanation of successful work steps, and (4) an introduction to K3 and 5R. Then, Prodea et al. (2019) discussed how briefing activities might impact motivation, direction, process explanations, target attainment, and work productivity, all of which have an effect on effective performance. The K3 briefing exercise during the workshop practicum is designed to increase students' knowledge of potential threats that may develop during the practicum (Jilcha Sileyew, 2020).

Teachers are instructors whose primary responsibility is to direct, guide, train, and evaluate students' learning activities (Mohamadi, 2018). The following scheme can be used to implement the project-based learning model: (1) the teacher guides students through the identification process through observation, experimentation, and effectively and efficiently developing project completion solutions; (2) the teacher encourages students to demonstrate the selected work steps through collaboration, collaboration, and presentation of work steps to other students (Wolpert-Gawron, 2016).

The benefits of implementing project-based learning in schools include the following: (1) incorporating meaningful learning with real-world contexts; (2) increasing student engagement through direct involvement in the learning process; and (3) intensifying active learning while reducing memorising and verbalism learning activities (Tsiplakides & Fragoulis, 2009). Project-based learning can help students develop their critical and creative thinking abilities (Sumarni et al., 2019). The benefits of implementing project-based learning are as follows: (1) students demonstrate a positive attitude, (2) students develop metacognitive abilities (self-actualization and learning independence), and (3) students attain higher levels of learning achievement (Tseng et al., 2013).

3. Evaluation of Project Based Learning at CoE Vocational High School

Evaluation is the act or process of assigning value to something in order to use it as a reference point for achieving goals. Learning evaluation is a technique that teachers use to assess and monitor learning outcomes and student progress throughout instructional activities (Ulum et al., 2021). Learning assessment is a process that is used to analyze and assess students' performance in learning and learning activities in order to increase their academic accomplishment, interest in learning, and motivation to follow the teacher's directions (Sidik et al., 2019; Sukardi, 2011). The teacher's learning evaluation activities have the following aims: (1) reviewing students' achievement of learning objectives, (2) reviewing students' deficiencies, and (3) comparing students' assessment results to the KKM (Minimum Completeness criteria) (Purwanto, 2013).

Learning evaluation is a technique for assessing and rewarding students for completing the learning process in a manner consistent with the learning objectives (minimum completeness criteria) (Arikunto, 2013). KKM is one of the instructional units' learning outcomes. Bestary (2018) reports that at one school, the KKM is decided through a teacher council decision and communicated to students prior to the commencement of new teaching activities. The instructor can determine the KKM in one of three ways: (1) based on many cognate subjects, (2) based on the complexity of the learning content, or (3) based on all existing evaluation criteria at the school (Arikunto, 2013; Djemari, 2008).

Assessment in the process of project-based learning encompasses assessments in the form of assignments, performance, project reports, and reflection on the application of process

analysis to results while taking ethical considerations and the learning context into account (Henderson et al., 2019). This is consistent with the findings of research conducted at CoE Vocational Schools, which indicate that the evaluation of project-based learning at CoE Vocational Schools is conducted by SMK teachers in collaboration with DUDIKA teachers, with the goal of ensuring that the products produced by students are marketable. The purpose of the learning assessment is to determine the effectiveness and efficiency of learning activities as measured by assignment grades, performance, project reports, and deliverables, as well as the Mid-Semester and Final Semester Assessments (PTS and PAS) (Ulum et al., 2021).

V. CONCLUSION

Project-based learning complements the Vocational High School CoE program, which is a collaboration between the Indonesian government, Vocational High School, and DUDIKA. At SMK CoE, project-based learning is used to teach practical subjects. CoE Vocational School and DUDIKA prepared for the adoption of project-based learning by: (1) preparing national curriculum competencies, infrastructure, and productive teacher competences; and (2) preparing DUDIKA's competencies, jobsheets/products, and work culture.

The practicum is implemented using the project-based learning paradigm and begins with a briefing about the product/jobsheet to be worked on. The inclusion of a worksheet in this learning paradigm is critical since it can help students develop their creativity in choosing effective and efficient work procedures. Additionally, students are expected to think cross-disciplinary, inventively, collaboratively, responsibly, and critically in order to complete the product/jobsheet. In a practicum with a project-based learning approach, Vocational High School teachers serve as facilitators, appraisers, and determiners of ideas; and (2) DUDIKA specialists analyze student work products, deliver OSH briefings, and function as supervisors.

Evaluation serves as a benchmark for determining whether or not learning objectives have been met. Assessments conducted by CoE Vocational School teachers include product outcomes, knowledge assessments via Mid-Semester and Final Semester Assessments (PTS and PAS), and assessments of work culture application. DUDIKA experts evaluate student-produced items using assessment indicators such as product precision, feasibility, and usefulness, as well as a comparison of product quality criteria developed by DUDIKA and Vocational High School CoE.

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