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THE HYPOTHETIC MODEL OF INTEGRATED PRODUCTION-BASED LEARNING WITH THE 21ST CENTURY LEARNING SKILLS IN MECHANICAL ENGINEERING

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ABSTRACT

Vocational education building and development must consider the needs of the industry and the demands of 21st-century skills graduates. For these two requirements, it is necessary to innovate the learning model to improve the students' learning experience and graduates' performance. This study aims to develop a production-based learning model that is integrated with 21st-century learning skills to improve skills in mechanical engineering. The study employed focus group discussion and experts' judgment. This study involved the mechanical engineering lecturers, the head of laboratory at the mechanical engineering department, the head of the department of mechanical engineering, the head of mechanical engineering vocational education, the head of the mechanical laboratory at the vocational schools, mechanical engineering teachers, vocational technology education experts, and curriculum specialists. The results show that the utility, feasibility, propriety, and accuracy of the production-based learning model integrated with 21st-century learning skills met the expected criteria and could be used to improve mechanical engineering skills.

Keywords: 21st century learning skills, mechanical engineering skills, production-based learning

INTRODUCTION

Vocational education in the 21st century requires students to be able to produce innovative, inventive, self-motivated, self-directed, and creative problems solvers to confront more complex global problems. Vocational education is demanded to have economic and strategic functions in increasing economic growth. Therefore, vocational education implementation must be in favor of the creation of more jobs, economic activities, economic growth, economic equity, and welfare pros [1].

Human resources which are employable and successful on the 21st century must be able to have knowledge, skills, and expertise such as life and career skills, learning and innovation skills, and information, media, and technology skills [2] The need in society to think and work together on issues of critical concern has increased, shifting the emphasis from individual efforts to group works, from independence to community [3].

One of the measures to meet the 21st-century demands is by the implementation of the appropriate learning models. The implementation of the suitable learning model determines the experience learning level and the performance of the students after completing the learning process. Educational success or failure of the vocational education depends on the teaching and learning process resulting from the choice and implementation of appropriate learning models because the graduates must be ready to work [4]. The production-based learning concept now becomes a new learning paradigm in vocational education, in which it integrates the learning based on the academic and industry. The production-based learning concept aims to provide experience in technical learning

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and an opportunity for the students to practice directly in the industry [5]. The use of product-based learning can improve and facilitate the learning process by improving skills, the quality of learning and the learning outcomes [6]. Vocational education becomes effective if the students practice using similar tools and machinery as applied in the industry [7].

The teacher must have an effective learning strategy demanding the higher order of thinking and knowledge to develop the life skill and the career of the students [8]. Ideally, the development and building of vocational education should consider the needs of the industry. Therefore, the alignment of productive competence with the industry is highly required to support the experience and performance of the students and to increase the vocational ability of the graduates [9].

METHOD

This study employed a research and development design. This design required three stages of implementation namely the preliminary study, the model development, and the validity study of the model. The preliminary study was performed by analyzing the needs and reviewing the related reference. The model development was through focus group discussion and expert judgment. The model validation was using four criteria for educational products developed by the Borg & Gall [10], i.e., utility, feasibility, propriety, and accuracy.

This study involved the lecturers, the head of the laboratory, the head of the Mechanical Engineering Department Universitas Negeri Semarang, the head of machinery program, the teachers of the vocational schools, experts in educational technology at vocational education, and experts in the vocational education curriculum.

RESULTS AND DISCUSSION

The study aimed to get a hypothetical model for the production-based learning integrated with the 21st-century learning skills was performed using the focus group discussion and experts' judgment. Table 1 shows the results of the model assessment using the criteria of utility, feasibility, propriety, and accuracy in Table 1.

Table 1. The Utility of the Production-Based Learning Integrated with the 21st Century Learning Skills

No. Respondents	Item Score					Total
	a	b	c	d	e	
1	3	3	3	4	3	16
2	4	3	4	4	4	19
3	4	4	3	3	4	18
4	4	3	4	4	4	19
5	4	4	4	4	4	20
6	4	4	4	4	4	20
7	4	4	4	4	4	20
8	4	3	3	4	4	18
Total	31	28	29	31	31	150

Table 1 shows that the utility of production-based learning model integrated with learning skills in the 21st century is 0.9375 or 93.75% of the expected criteria. The utility score of the model based on the assessment of the model source identification was 0.9688 or 96.88% of the expected criteria. The credibility of the stakeholder accounted for 0.875 or 87.5% of the expected criteria. The scope of the model (planning, implementation, and evaluation) accounted for 0.9063 or 90.63% of the expected criteria. The accuracy of the results information accounted for 0.9688 or 96.88%. Finally, the development of the students' competence accounted for 0.9688 or 96.88%. Table 2 presents the feasibility of production-based learning integrated with 21st-century learning skills.

Table 2. The Feasibility of Production-Based Learning Integrated with the 21st-Century Learning Skills

No. Respondents	Item Score			Total
	a	b	c	
1	4	3	3	10
2	3	4	3	10
3	4	3	3	10
4	3	2	4	9
5	4	4	4	12
6	4	4	4	12
7	4	4	4	12
8	4	3	4	11
Total	30	27	29	86

The feasibility of the production-based learning integrated with the 21st-century learning skills is 0.8958 or 89.58% of the expected criteria as seen in Table 2. The assessment of the feasibility of the model based practicality is 0.9375 or 93.75% of the expected criteria, the integration of the model components is 0.8438 or 84.38% of the expected criteria, while cost efficiency of the model implementation is 0.9063 or 90.63 % of the expected criteria. Table 3 shows the propriety of production-based learning integrated with 21st-century learning skills.

Table 3. The Propriety of the Production-Based Learning Integrated with the 21st Century Learning Skills

No. Respondents	Item Score					Total
	a	b	c	d	e	
1	4	2	3	4	4	17
2	3	3	4	3	4	17
3	3	3	3	3	3	15
4	3	3	2	4	4	16
5	4	1	3	4	3	15
6	4	2	3	3	4	16
7	4	2	3	3	4	16
8	3	3	3	4	4	17
Total	28	19	24	28	30	129

Table 3 shows that the propriety of production-based learning model integrated with 21st-century learning skills is 0.8063 or 80.63% of the expected criteria. The assessment on the propriety of the model based on the written agreement/ partnership is 0.875 or 87.5% of the expected criteria. The conflict of interests between parties involved in the partnership is 0.5938 or 59.38% of the expected criteria. The dissemination of the partnership is 0.750 or 75.00 % of the expected criteria. The balance in reporting the partnership is 0.875 or 87.5% of the expected criteria. Lastly, the responsibility for financing the partnership is 0.9375 or 93.75%. Table 4 shows the accuracy of production-based learning integrated with 21st-century learning skills.

Table 4. The Accuracy of Production-Based Learning Integrated with 21st-Century Learning Skills

No. Respondents	Item Score					Total
	a	b	c	d	e	
1	4	3	4	4	3	18
2	4	3	3	4	3	17
3	3	4	4	4	3	18
4	3	4	3	3	4	17
5	4	4	4	4	4	20
6	4	4	4	4	4	20
7	4	4	4	4	4	20
8	3	4	4	4	4	19
Total	29	30	30	31	29	149

The accuracy of production-based learning Integrated with 21st-century learning skills is 0.9313 or 93.13% of the expected criteria. The accuracy of the model based on the object identification is 0.9063 or 90.63 % of the expected criteria. The content analysis is 0.9375 or 93.75% of the expected criteria. The clarity of the aim and procedure is 0.9375 or 93.75 % of the expected criteria. The accuracy of success assessment is 0.9687 or 96.87% of expected criteria. Finally, the systematic of the models is 0.9063 or 90.63%. Figure 1 presents the hypothetical model of production-based learning integrated with 21st-century learning skills.

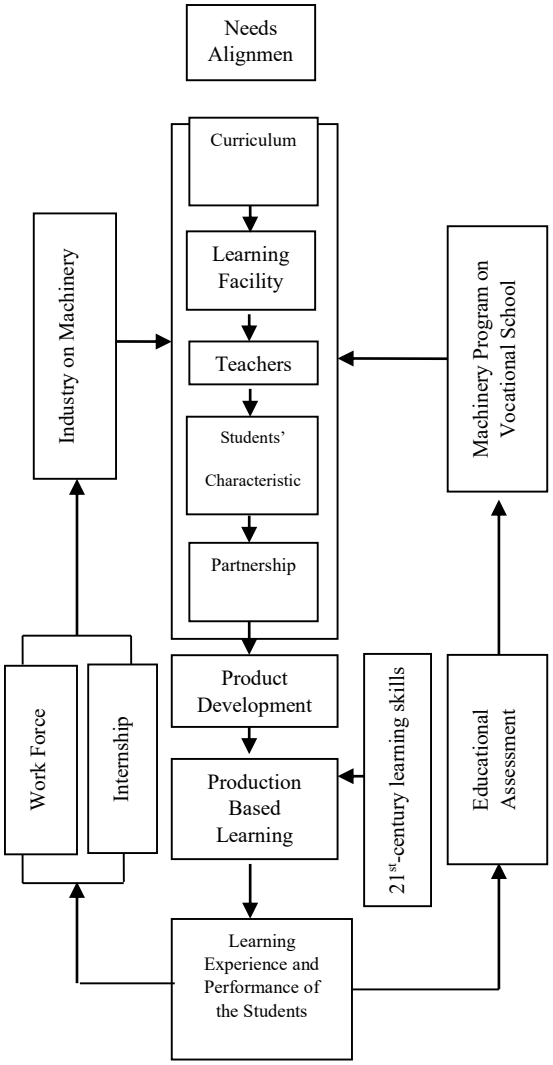

Figure 1. Hypothetical Model of Production-Based Learning Integrated with 21st-Century Learning Skills

The hypothetical model of production-based learning model integrated with 21st - century learning skills refers to needs alignment between the industry and vocational education. The alignment was on the criteria of curriculum, infrastructure and learning facilities, the needs of the students, the characteristics of the students, and the analysis on the ability of the teacher in facing learning obstacles. The hypothetical model is presented in Figure 1.

The results of the study show that utility, feasibility, propriety, and accuracy of production-based learning model integrated with 21st-century learning skills meet the expected criteria of the students' experience and performance. The utility of the model is 0.9375 or 93.75% on the criteria of the identification of the model resources, the credibility of the stakeholders, the scope of the model (planning, organizing, implementing, and evaluation), and the usability of the model for the competence development. The feasibility of the model was 0.8958 or 89.58% of the expected criteria as the practicality of the procedure, the integration of the model components, and cost efficiency of the model implementation. The propriety of the model is 0.8063 or 80.63% of the expected criteria of team partnership, reporting the results of the performance, and financing the team. The accuracy of the model is 0.9313 or 93.13% for the criteria of object identification, content analysis, the clarity of the aim and procedure, the accuracy of success assessment, and systematic of the model.

This model was developed based on the needs alignment between industry and the learning process using 21st-century learning skills approach. Therefore, students gain learning and performance experience by prioritizing areas of expertise, partnership, critical thinking, creating, and communicating. Achieving 21st-century learning skills requires a new approach and method using the principles of the instructional design to meet the needs of the 21st century [11]. Production-based learning is an alternative learning model of vocational education and training which is relevant to the needs of learners to develop their knowledge, attitude, and skills in the learning process [12]. Many skills gained from production-based learning are highly sought by industry because the students will be able to work well with others, handle interpersonal conflicts, make wise decisions, and practice and solve complex problems [13]. The category of collaborative student projects allows students to work together to solve real problems or challenges [14].

Product-based learning-process can be designed with a focus on the relevant

competencies to the needs of industry to expand sufficiency of the competence [15]. The contribution of product-based learning to self-development of learners general and subject competencies has been widely acknowledged [16].

Stages in the implementation of the model with the accompaniment of the educator included needs alignment for the product, determination product, analysis and identification of the product, designing the finishing process of the products, the scheduling of the product implementation, product development, evaluation process and product, and marketing plan of the product. The model implementation is accompanied by educators to implement the 21st-century learning skills concept. Educator accompaniment aspects include learning plan, learning resource utilization, media utilization, facilitating students learning needs, ability to create learning evaluation instrument, and following up the learning outcomes [17]. Implementation of product-based learning puts a motivating and meaningful real-world task in the center of the students' attention [18]. Learning factories have proven to be an essential means for educating students and professionals regarding the practical application of production management principles [19].

CONCLUSION

Utility, feasibility, propriety, and accuracy of production-based learning model integrated with 21st-century learning skills met the expected criteria in the experience and performance of students in machinery skills. The hypothetical model was developed based on the needs alignment between industry and the learning process using 21st-century learning skills approach. Therefore, students gain learning and performance experience by prioritizing areas of expertise, partnership, critical thinking, creating and communicating.

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