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The Impact of Implementing The Project-Work Learning Model on Improving The Quality of Learning Outcomes in The Machining Process

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Abstract: The purpose of this study is to examine the effects of project-work learning model on the development ofstudents' soft skills and hard skills in the Machining Process learning.The research was carried out in the equipment manufacturing industry in the Special Region of Yogyakarta, as well as in the machining workshop at the Faculty of Engineering, Yogyakarta State University (YSU).The research design used is research and development and is followed by experimental research.The research population was 108 students. The research sample was 41 students who were determined based on purposive sampling.The posttest-only control design was used, and the research instrument validation was measured by machining and education experts. Data collection was carried out by surveys, observations, and assessment sheets on the learning outcomes of the machining process.They were examined using descriptive statistics and a t-test with a significance threshold of 0.05. According to the research findings, pupils in the project-work learning class have better soft and hard skills than those in the non-model class. Finally, the project-work learning model is appropriate for machiningpProcess learning in vocational education since it has been shown to increase the acquisition of integrated soft and hard skills in machining process learning.
Keywords: Machining Process learning, project-work learning, softskills and hard skills

1. Introduction

As a part of the national education system, vocational higher education plays a strategic role in producing skilled and 'ready-for-work' human resources, whohave not only high academic competence (hard skills) but also interpersonal traits (soft skills)and good characters. In vocational education, workshop courses are a notable characteristic because they have a key role in assuring that future graduates with vocational degree are equipped with the hard skills required for the industry. Nevertheless, the importance of soft skills in the workplace must not be overlooked.

Finally, vocational education must always seek to increase the quality of workshop courses in order to generate such human resources. There must be learning model creation and application that can integrate hard skills and soft skills in the learning process for the courses to operate effectively in teaching both academic competence and character values.

Fundamentally, the products of manufacturing industry, particularly in the machining industry, consist of smaller parts or components which are then assembled into the actual finished products. In order to produce high quality products, there needs to be skilled workers with academic competence involving theoretical and practical mastery concerning the product manufacturing process using machine tools (hard skills), as well as character values such as having a high attention to detail, discipline, caring, independence, confidence, and cooperativeness (soft skills).In addition, there needs to be a good and systematic process, which is often referred to as project work.Furthermore, there must be a good and methodical process, which is commonly referred to as project work. This is why it is critical for students to become accustomed to such a functioning system through the implementation of the project-work learning model in vocational education.

Vocational education is derived from the concepts of vocational and occupational education which refer to individual readiness to join the industry or a supplementary preparation required to pursue a certain career [1]. Vocational education as a means of providing any necessities for students to have access to jobs in order to sustain their lives [2]. Vocational education is crucially needed to prepare students with competencies valuable for their career.Thus, the primary goal of educators and policymakers in the teaching process is to provide core learning values that will eventually generate well-equipped students in terms of academic and conceptual skills to deal with real-world job difficulties.

In addition, Prosser and Allen point out that in order for vocational education to produce well-equipped graduates, it is necessary to consider the following principles: 1) an effective vocational educationcan only be

donewhen studentsare trained to do exercises using the method, tools, and similar to the ones in the workplace, 2) vocational educationwill be effective if individuals are trained directly and specifically in terms of thinking and work habits, 3) an effective work habitcan only be developed if the learning and training processes are in accordance with real jobs and are not merely in the form of exercises [3].It is apparent that the goal of vocational education is to provide students with a set of skills and abilities that will allow them to work or develop themselves in their field of competence. As a result, creating standard skills that are compatible with career or industry needs is crucial. Finally, a comparable standard competency design can contribute to the advancement of vocational education.

Project-work learning is a learning process that intensely focuses on collaborative problem solving [4]. The projectshould be collaborative, unique, and focused on solving real problems related to community needs [5]. Project-based learning is an innovative learning approach which focuses on creating contextual learning through complex activities [6]. The focus of the project-work learning lies in the process of instilling the core concepts and principles of a certain field of study by conducting the following activities: 1) engaging learners in problem-solving investigations, 2) allowing learners to work autonomously, and 3) enabling learners to construct their own knowledge to produce real products [7]. Thus, project-work learning has great potential to create interesting and meaningful learning experiences.

Based on the foregoing, it is the obligation of education, particularly vocational education, to produce graduates with not only excellent academic competency but also good character. As a result, it is critical to increase workshop course quality by incorporating both hard and soft skills.Developing a character-based project-work learning model for vocational education is an attempt to integrate character values into the workshop teaching. The problem adressed in this paper is “Does the application of the project-work learning model in the Machining Process course affect students’ soft and hard skills?”

2. Research Method

The research and development designed by Borg & Gall and experimental research design were employed in this study [8]. This research's output passed through several stages, including conceptual, theoretical, hypothetical, and final models. The model was created utilizing focus group discussions (FGD), Delphi methodologies, and an experiment.

The model of development is presented in Figure 1 and the final model of this study is shown in Figure 2.

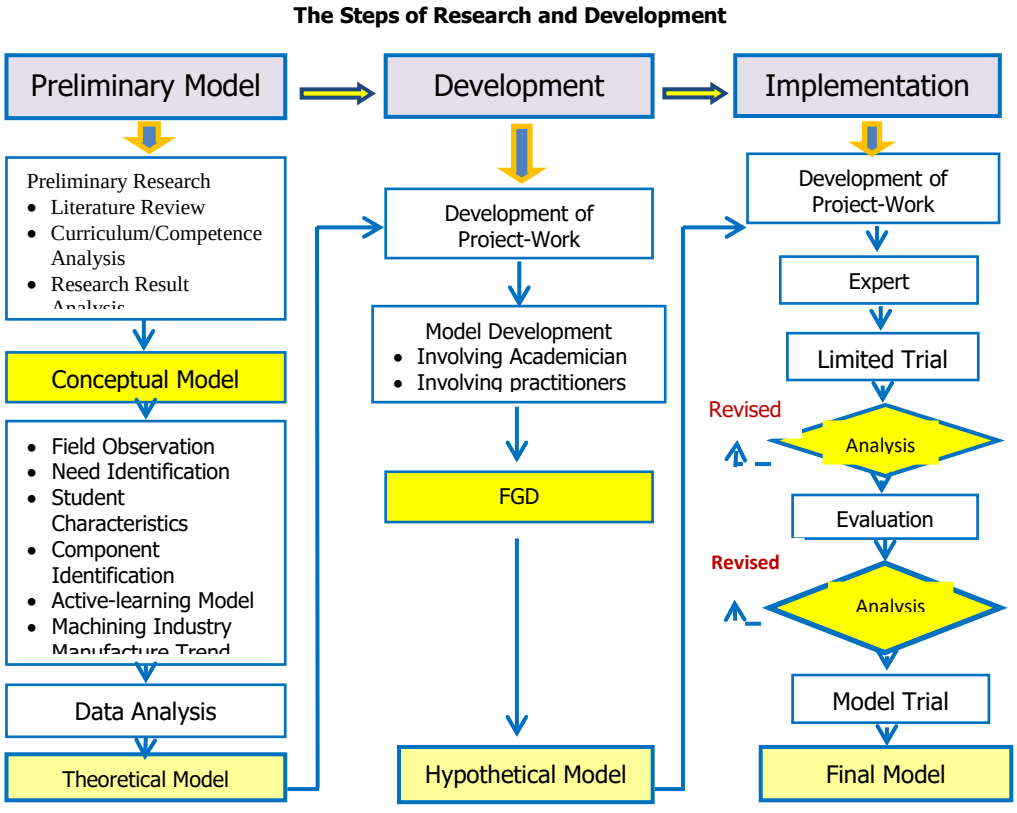

Figure 1. The step of research and development

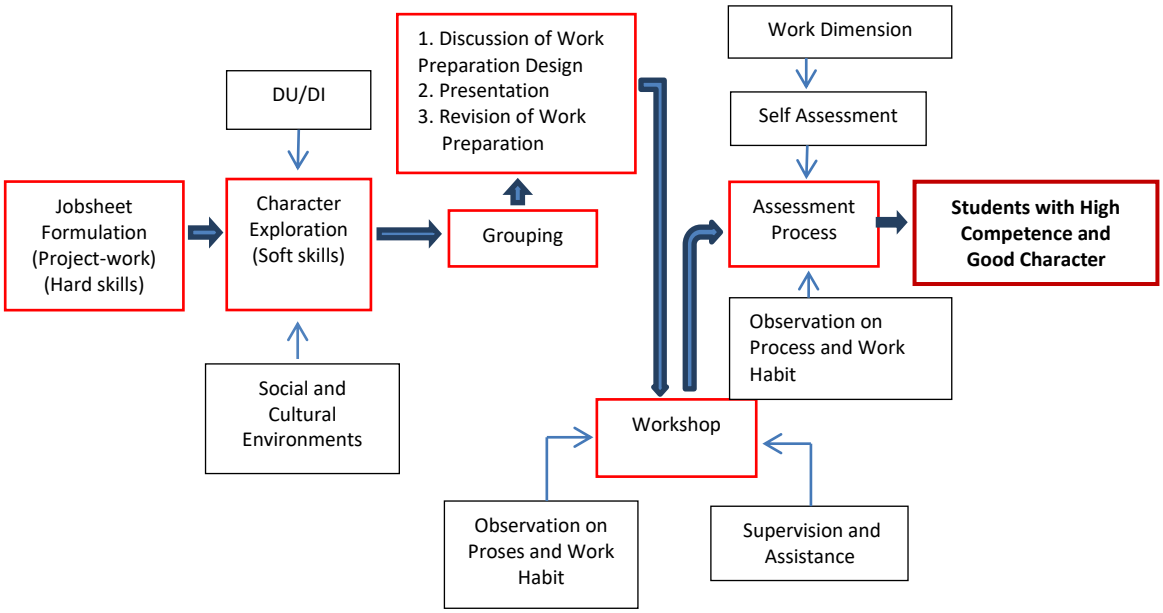

Figure 2. The Final Model

The posttest-only control design was used to apply the project-work learning paradigm in the machining workshop course. The design was chosen with the characteristics of the workshop course in mind, where students' achievement is judged by their work-piece, so no pretest is required. The research design can be seen in Figure 3 below.

R X O2
R O4

Figure3. The Posttest-Only Control Design

Description:
R = Control and experimental classes which are taken randomly
O2= Posttest of the experimental class
O4= Posttestof the control class

The population of this study includes all the three-year Diploma Program of Mechanical Engineering students of the Faculty of Engineering, Yogyakarta State University who took the course of Complex Machining Process. There were are total of 108 pupils in the class. The sample of 41 students was drawn using the purposive sampling technique and divided into two groups: control and experimental. The experimental class had 20 pupils, whereas the control class had 21 people.

The study was conducted at Mechanical Engineering Department, Faculty of Engineering, Yogyakarta State University and the machinery manufacturing industries located in Yogyakarta. The instrument validation was measured by the experts at machining and education. The data were collected by means of (1) observation sheet, (2) documentation, (3) questionnaire, (4) assessment sheet of process and product of students' work-piece. The data were analyzed by using the qualitative and quantitative methods. In order to measure the effectiveness of the model, the developed model was compared to the last model and then t-test was conducted.

3. Findings and Discussion

3.1. Findings

The project-work learning paradigm was applied throughout the Complex Machining Process and was carried out over the course of eight meetings. The first and second meetings focused on describing and planning the learning process. The third through eighth sessions should be focused on research, therefore both hard and soft abilities should be thoroughly observed. In accordance with the characteristics of the course, students' soft skills were measured from the following aspects: discipline, diligence, meticulousness, independence, care, hard work, and cooperation. Meanwhile, the hard skill aspect was measured from students' competencies and the quality of their job sheets in producing a speed-reducer.

The result of the observation on the attitude and activity of 32 students in the experimental class is presented in Table 1 below.

Table 1. Soft skills of the students in the experimental class

Soft-skill Aspects	The number of students of each meeting					
	3	**4**	**5**	**6**	**7**	**8**
Discipline	13	15	17	18	19	20
Diligence	11	14	18	19	20	20
Meticulousness	12	15	17	18	18	20
Independence	11	14	16	17	17	18
Hard work	14	16	18	19	20	19
Cooperation	12	15	16	18	19	20
Care	13	17	18	19	20	20
Percentage	61 %	76 %	86 %	91 %	95 %	98 %

Figure 4 shows more specific information on the attitudes and performance of the students in the experimental class.

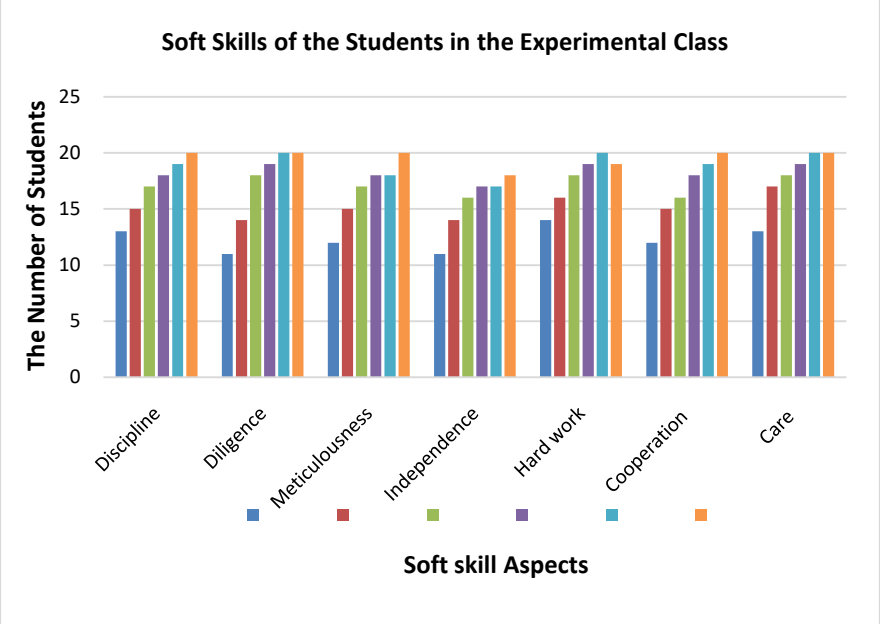

Figure 4. The Histogram of the Activity of the Students in the Experimental Class

It can be seen from the data in Table 1 that all students' soft skill aspects in third and eighth meetings consistently improve. The soft skills aspects of discipline, diligence, cooperation, and care are 100%. It means that all of the students, 20 in total, have good soft skill aspects. Meanwhile the other aspects of soft skills namely independence and hard work consistently improve on the third to eighth weeks, but two of the students did not possess the independence aspect, and one student did not possess the hard work aspect.

The result of the observation on the soft skills in the course of Machining Process of the students in the control class can be seen in Table 2 below.

Table 2. Soft Skills of the students in the Control Class

Soft-skill Aspects (Attitude and Behavior)	The number of students of each meeting					
	3	4	5	6	7	8
Discipline	11	11	12	14	12	15
Diligence	8	9	10	10	12	14
Meticulousness	9	10	10	8	10	10
Independence	9	9	10	10	11	11
Hard work	10	10	11	10	9	9
Cooperation	9	10	12	13	12	14
Care	9	8	9	10	9	10
Percentage	44 %	46 %	50 %	51 %	51 %	56 %

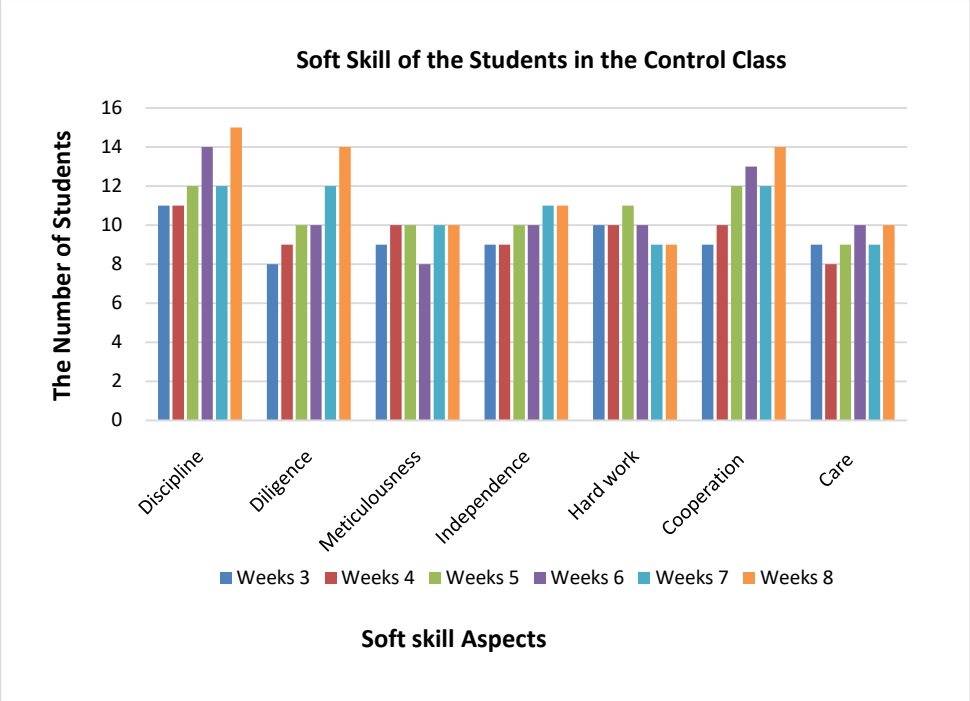

Figure 5. Histogram of the Activities of the Students in the Control Class

According to the data, 56% of the students performed soft skill components from the third to eighth week meetings/the last week. According to the research findings, students do not consistently demonstrate all characteristics of soft skills such as discipline, determination, meticulousness, independence, hard effort, cooperation, and care.

The data of the students' hard skills are measured from students' competencies and the quality of their job sheets in producing speed-reducer. The product assessed in this study consists of three kinds of components, namely: 1) worm gear, 2) worm gear shaft, and 3) worm shaft. The data on the hard skills of the students in the experimental class can be seen in Table 3 below.

Table 3. Hard Skills of the Students in the Experimental Class

Students	Workshop Activities			Means
	I	II	III	
1	82	78	81	80.33
2	80	80	80	80.00
3	81	85	85	83.67
4	79	80	82	80.33
5	79	83	79	80.33
6	80	82	82	81.33
7	82	85	80	79.00
8	77	80	80	79.00
9	78	80	79	79.00
10	80	79	82	80.33
11	80	85	80	81.67
12	82	85	80	82.33
13	85	85	85	85.00
14	80	82	82	81.33
15	82	80	81	81.00
16	80	79	82	80.00
17	81	82	85	82.67
18	85	85	85	85.00
19	86	85	85	85.33
20	80	80	82	80.67
	The Sum of Students' Hard Skills Mean Values			81.60

The results indicate that the students' hard skills have relatively high mean values(81.60). Then, the hard skills of the students in the control class are presented in Table 4 below.

Table 4. Hard Skill of the Students in the Control Class

Students	Workshop Activities			Means
	I	II	III	
1	65	66	70	67.00
2	60	65	65	63.33
3	70	68	68	68.67
4	72	70	70	70.67
5	68	70	66	68.00
6	72	60	60	64.00
7	68	62	65	65.00
8	70	65	62	65.33
9	70	60	66	67.33
10	65	65	72	67.33
11	60	72	68	66.67
12	70	66	60	65.33
13	65	70	65	66.67
14	60	65	65	63.33
15	70	66	60	65.33
16	72	60	60	64.00
17	72	70	70	70.67
18	70	70	68	69.33
19	71	70	70	70.33
20	67	68	65	66.67
21	65	62	65	64.00
	The Sum of Students' Hard Skills Mean Values			66.54

According to the findings of this study, the students' hard skills have a relatively low mean value (66.54). As a result, students who are taught using the traditional way do not perform well in the Machining Process.

Testing of Assumptions

The assumptions must be tested in accordance with the procedures used to examine the data. Furthermore, a t-test was used to determine the difference in the students' knowledge of both soft and hard skills in both experimental and control classes. The normality and homogeneity tests were used in this study to examine assumptions.

Normality test

Skewness and Kurtosis ratio tests were performed to examine the data distribution. If the ratio is larger than -2 and less than +2, the data is normal. The skewness ratio (-1.748) and kurtosis ratio (0.288) of the data on the hard skills of the students in the experimental class are shown by the results of the normalcy test. The data of students' hard skills in the form of Machining Process course activities in the experimental class can be declared to be in the normal distribution.

The normality test values on the softskills scores of the students in the control class are greater than -2 and less than +2. The skewness ratio is 0.821, and the kurtosis ratio is -0.370. It can be inferred that students' soft skills scores are in normal distribution.

Homogeneity Test

Students' Hard skills

The result of homogeneity test on students' hard skills scores is presented in Table 5.

Table 5. The Result of the Homogeneity Test of Students'Hard skills Scores

	Levene Statistic	df1	df2	Sig.
Hard-Skill_Scores				
Based on Mean	.802	1	39	.189
Based on Median	.546	1	39	.465
Based on Median and with adjusted df	.546	1	39	.467
Based on trimmed mean	1.578	1	39	.218

Levene test was used to check the data, and it is shown that students' hard skill scores are homogenous since the value of Based on Mean is higher than 0.05. The significance value of the Machining Process Course is 0.189.

Students' Soft Skills

The results of the homogenity test on the students' soft skills can be seen in Table 6.

Table 6. The Result of the Homogeneity Test of Students'SoftSkills Scores

	Levene Statistic	df1	df2	Sig.
Soft-skills_Scores				
Based on Mean	.776	1	39	.394
Based on Median	.166	1	39	.690
Based on Median and with adjusted df	.166	1	39	.690
Based on trimmed mean	.734	1	39	.407

The Lavene test shows thatthe-based-on-Meansignificance value is 0.394. Since the value is higher than 0.05, it can be concluded that the scores of students' soft skills are homogenous. Then, in accordance with the testing of assumption, the parametric test, t-test is used to analyze the data. The results of the t-test analysisare as follows:

Students' Hard Skills

The results of t-test on the hard skills scores in the Machining Process workshop course of the students in both experimental and control classes are presented as follows. The results of t-test on the students' hard skills can be seen in Table 7.

Table 7. The Result of t-test of Students' Hard Skills Scores

	Levene's Test for Equality of Variances		t-test for Equality of Means						
	F	Sig.	t	df	Sig. (2tailed)	Man Difference	Std. Error Difference	95% Confidence Interval of the Difference	
								Lower	Upper
Hard-skills_Scores Equal variances assumed	1.802	.189	9.623	39	.000	9.707	.9265	7.927	11.700
Equal variances not assumed			9.350	26.245	.000	9.707	.9366	7.887	11.729

Based on the t-test, the tvalue is 9.623 at the significance level of 0.000. This means that hard skill scores of the students in both experimental and control classes are significantly different. The mean value of the experimental class is higher than that of the control class ($X_{experiment} = 81.60 > X_{control} = 66.54$).

Students' Soft Skills

The t-test result on students' soft skills which include discipline, preserverance, meticulousness, independence, hard work, cooperation, and carein the course of Machining Process of both experimental and control classes is presented in the following.The results of t-test on the students' soft skills can be seen in Table 8.

Table 8. The Result of t-test on Students' Characters

	Levene's Test for Equality of Variances		t-test for Equality of Means						
	F	Sig.	t	df	Sig. (2-tailed)	Man Difference	Std. Error Difference	95% Confidence Interval of the Difference	
								Lower	Upper
Obs_Soft_skills Equal variances assumed	.776	.394	7.211	12.00	.000	5.429	.753	3.789	7.070
Equal variances not assumed			7.211	11.420	.000	5.429	.753	3.780	7.079

The t-test result on students' soft skills which include discipline, preserverance, meticulousness, independence, hard work, cooperation, and carein the course of Machining Process of both experimental and control classes is presented in the following.

The value of t is 7.211at the significance level of 0.000. Therefore, it is concluded that there is a significant difference between the character aspects of the students in both experimental and control classes. Each aspect score percentage in the experimental class is higher than that in the control class ($X_{experiment} = 98\% > X_{control} = 56\%$).

3.2. Discussions

The character-based project-work learning paradigm evolved from an existing competency-based training (CBT) learning model and incorporated components of attitude and behavior. Both models are commonly utilized in workshop courses, where the learning processes are centered on the students' practical competence and skills. The models' incorporated soft skill aspect is tailored to the workshop course's personalities.

After the implementation of the model, it is proven that the project work-based learning model successfully integrates soft skill aspects into the course activities as shown by the students' learning attitude. Based on the observation conducted during the model implementation (the exploration stage), the project work model is effective. It can make the students participate in learning and raise their awareness of the importance of character building in the Machining Process course. At the exploration stage, the students are required to convey

their opinions related to aspects of essential work attitude, which are particularly related to Machining Process. This is intended to make sure that students have theoretical awareness of the character aspects which are shown from the ways they share their opinions about the character aspects during FGD. It isassumed that they will wholeheartedly carry out the various aspects of character in theMachining Process. Therefore, the characters that have been believed, understood, and done in the learning process will eventually be implemented when are at work.

The findings from observations of students' activities during the teaching and learning of the Machining Process show that students who actively express their opinions during the character or soft skills exploration process are more persistent in implementing the instilled soft skills. Thus, exploring soft skill components in the project-work learning paradigm is efficient in incorporating them into the Machining workshop course learning process.

The next stage in the character-based project-work learning model is the discussion of the Work Preparation Sheet. At this stage,the students are required to work in groups to solve problems and at the same time they have to respect the opinions of others,either friends of their own group orof other groups. Through this stage, they are expected to have the following soft skills: having the courage to communicate their thoughts, respecting others' opinions, cooperating with others, thinking critically, and being able to solve problems. Further, critical thinking leads to another skill, namely wisdom. Critical thinking allows someone to analyze information thoroughly and to make the right decisions when dealing with controversial issues. Therefore, teachers are expected to familiarize the students with critical thinking skill through such activities including (1) defining statements or questions clearly, (2) reasoning, (3) searching for correct information, (4) using credible sources, (5) taking into account the whole situation, (6) looking for alternative possibilities, (7) being open-minded, (8) changing position when the evidence is reliable, (9) seeking as much precision as the subject permits, and (10) being sensitive to the feelings, level of knowledge, and degree of sophistication of others [9].

The students' self-assessment is the next step in the process of soft skill integration. Before the instructor examines the students' work piece, the students are given the opportunity to independently assess their own work piece and afterwards fill out the accompanying assessment form, which is then crosschecked by the teacher. The amount of honesty of the students can be assessed with this task.

According to the implementation results, there is a difference in the activities of the experimental and control classes during the teaching and learning process. Students in the experimental class appear more excited and engaged in their learning than those in the control group. In terms of learning results, the experimental class with greater classroom interaction outperforms the control class.This is in accordance with the results of a study conducted by Berkowitz, which indicates an increase in students' motivation to have better academic achievement when character education model is implemented at their school [10]. Character education seminars demonstrate a significant reduction in students' negative habits, which might eventually jeopardize academic progress. The risk factors that contribute to student failure are not exclusively based on IQ, but also on personal characteristics such as self-confidence, cooperation, sociability, concentration, empathy, and communicativeness [11].

The project-work learning model is a comprehensive learning approach as the method used in the teaching and learning process includes the aspects of inculcation, modeling, and facilitation [9]. The inculcation aspect involves the following characteristics: (1) communicating beliefs with their underlying reasons, (2) appreciating other people's opinion, (3) making social and emotional experiences about the desired values, and (4) defining rules, giving rewards, and providing reasonable consequences. The modeling part might help kids enhance their assertiveness and listening abilities. These abilities are necessary for developing interpersonal and intergroup relationships. The assertive skill is related to one's capacity to express one's perspective in a way that does not damage other people's feelings, whereas the listening skill is tied to one's ability to critically grasp things. Further, assertive and listening skills are described as *yin* and *yang* which must be developed in a balanced way as it is a vital component of communication.

The facilitation aspect involves giving assistance or guidance to the students in solving problems. This facilitation activity proves to have a positive impact on both the teacher and the students. The activity includes: (1) improving teacher-student relationship, (2) helping students deepen their understanding, (3) encourage students to think more about the inculcated value, to search for insights into their own, and to ultimately realize the positive values conveyed by their teachers, (4) giving teachers a better understand of the students' thoughts and feelings, and (5) encourage students to relate certain issues with their lives, beliefs, and feelings.

It has been effectively demonstrated that the project-work learning model can incorporate soft and hard skills during the Machining Process. As a result, this strategy can help pupils develop their skills and personalities. Character education (soft skills) consists of three major components: knowing what is good, loving what is good, and doing what is good [12].There are four ways to facilitate students with sufficient competencies and good characters, i.e value 262 realization, character education, civic education, and moral

education [9]. Important values that need to be implemented and cultivated among students are: self-understanding, self-esteem, goal-setting skill, thinking skill, decision-making skill, communication skill, social skill, as well as academic and transcendental knowledge. Respect, responsibility, compassion, discipline, loyalty, bravery, tolerance, open-mindedness, work ethic, and belief in and love of God are all qualities that must be imparted.

Meanwhile, the most important parts of civic education that must be instilled are awareness of what it means to be a good citizen, respect for democratic systems and citizenship values, critical thinking abilities, communication skills, and dispute resolution skills. Finally, moral education includes knowledge, attitudes, beliefs, skills, good behavior, honesty, and compassion. The main reason for implementing moral education is to generate autonomous individuals who understand moral values and are committed to do things which are in accordance with those values.

4. Conclusions

1. There is a significant difference in terms of softskills between students who were taught using the project-work learning model and those who were not, in Machining Process learning (t= 7.21 ; p= 0.000). The percentage of soft skills value implementation in the class taught using the character-based project-work learning model is higher ($X_{experiment}$ = 98% > $X_{control}$ = 56%).
2. There is a significant difference in terms of hard skills between students who were taught using the project-work learning model and those who were not, in Machining Process learning (t=9.62; p= 0.000). The average value of students' hard skills scores taught using the project-work learning model is higher ($X_{experiment}$ = 81.15 > $X_{control}$ = 66.33).

Therefore, this learning model is suitablefor increasingthe quality of teaching machining workshop course in vocational education.

5. Recommendations

Some suggestions which can be drawn from the discussions are as follows.

1. The character-based project-work learning model has been proven to be an effective model to integrate soft skills and hard skills aspects in machining process learning. To check its suitability, this model is recommended to be applied to other courses.
2. This learning model focuses more on student activities during the teaching and learning process, so lecturers/teachers need to focus more on mentoring and providing guidance to students.

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