Ability to Collaborate with Prospective Mechanical Engineering Teachers through Industrial Project Learning Strategies

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ABSTRACT
Prospective mechanical engineering teachers must be able to collaborate in order to improve teaching effectiveness, interpersonal skills, and adaptability, and to expand networks and partnerships. The purpose of this study is to examine how industrial project learning strategies improve the collaboration skills of mechanical engineering teacher candidates. The study employs quantitative methods and a comparison group design with a control and an experimental group. The control group completed the project learning stages using worksheets provided by the lecturer, whereas the experimental group completed the project learning stages using industrial products. Mechanical Engineering Education students from Universitas Negeri Semarang participated in the study. Using the ability to collaborate instruments to collect research data. Techniques for data analysis employ descriptive quantitative and inferential quantitative approaches. The T-Test test is used to compare the differences between groups. The study's findings revealed a difference in the increase in collaboration ability of prospective Mechanical Engineering teachers who used industrial project learning strategies.

Keywords: *Collaboration, Mechanical Engineering Prospective Teachers, Industrial Projects.*

1. INTRODUCTION

There will be difficulties integrating technology into learning when developing 21st-century learning skills. As a mechanical engineering instructor, you must be proficient in the use of technology. Technology has become a very vital aspect of 21st-century learning. By utilizing technology, teachers may improve the learning process and present the principles of mechanical engineering in an engaging manner. The creation of a learning environment that enables students to recognize issues and find answers via cooperation, experimentation, and creativity depends on the teacher's capacity to build problem-solving skills. In order to encourage students to work in groups and establish a learning atmosphere where they can exchange ideas, discuss issues, and learn from one another, mechanical engineering professors must also be able to enable collaborative learning in the 21st century.

Working closely with numerous parties, such as students, fellow instructors, administrative staff, student parents, and industries linked to the vocational field being taught, is required in the teaching profession. With this capability, teachers' efficacy in the classroom can be increased, networks and partnerships expanded, interpersonal skills and flexibility improved, relevant curricula designed, resources and information shared, and effective teaching practices developed. The capacity to collaborate can help prospective instructors enhance their flexibility to changes and obstacles in the field of vocational education. Prospective mechanical engineering teachers must be able to adapt rapidly and construct collaborative, inventive solutions to address the demands of students and industry in an ever-changing environment.

However, potential mechanical engineering teachers face a variety of challenges with their ability to collaborate in practice, including a lack of teamwork experience, individualism, differences in goals and perspectives, and a lack of communication and coordination. Despite the fact that the ability to interact with teachers is intimately tied to professional development, many elements, such as personal, group, process, guidance, organizational, and structural factors, fail to ensure its implementation [1]. Most lack teamwork experience. They struggle to comprehend group dynamics and how to contribute effectively in groups. Some prospective mechanical engineering professors

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have a strong individualist mindset, preferring to work alone rather than in groups. This mindset can impair one's capacity to collaborate effectively in the context of

vocational education. When working in groups, each person has various aims and perspectives. If these disparities are not adequately addressed, they might impede cooperation and lead to conflict. Poor communication and coordination skills can produce uncertainty in the group and impair the capacity to collaborate effectively; this can occur if prospective mechanical engineering teachers do not understand their function in the group or do not interact with other group members. Her research demonstrates a beneficial association between participation in project-based learning courses geared for pedagogical practice and the process of creating perspective teachers' professional identities. Professional identity formation is manifested through six motives: self-confidence, self-agency, sense of belonging, self-awareness, autonomy, and picturing oneself teaching in the future [2].

Mechanical Engineering teachers must be able to implement project-based learning by incorporating 21st-century abilities such as cooperation, creativity, problem-solving, and critical thinking. Industrial project learning is a new teaching paradigm that incorporates students in real-world projects relevant to industry [3]. Its learning engages students in practical and authentic learning situations, allowing them to gain the cooperation skills and knowledge required to operate in the industry. Industrial project learning can assist prospective mechanical engineering teachers enhance their collaboration abilities by including students in real-world projects that require them to work in teams to finish. Project learning provides students with hands-on technical and practical learning experiences in industrial settings [4, 5]. Based on the challenges and problems in implementing 21st-century learning skills in project learning, particularly the ability to collaborate, this research focuses on improving the collaboration skills of prospective mechanical engineering teachers using industrial project learning strategies.

2. METHOD

The study makes use of quantitative approaches, such as a Pretest - Posttest Control Group Design with a control and an experimental group. The control group learning treatment employed a job sheet provided by the lecturer, whereas the experimental group used products from the industry to be finished according to the stages of project learning. Mechanical Engineering Education students from Universitas Negeri Semarang served as research subjects. The experimental group learning control treatment contained the same equipment and infrastructure, the same research subjects, lectures in the same semester, and those who had taken mechanical

technology courses. Techniques for collecting research data rely on the ability to work with indicators: 1) establish trust via mutual respect; 2) align expectations within the group; 3) create an atmosphere of open, honest, and respectful communication; 4) instill an attitude of belonging in the group; 5) see the positive side of the group from different perspectives; and 6) provide feedback to the group. Data analysis strategies employ descriptive quantitative and inferential quantitative approaches. The T-Test test is used to compare differences across groups. Normalized Gain (N-Gain) is used to calculate improved collaboration. N-gain calculations are performed using the following equation borrowed from Hake [6]:

$$\mathrm{N-Gain} = \frac{\mathrm{Posttest\ Score} - \mathrm{Pretest\ Score}}{\mathrm{Max\ Score} - \mathrm{Pretest\ Score}} \qquad (1)$$

Table 1 shows the normalized gain category.

Table 1. Normalized gain criteria.

N-Gain Score	N-Gain Criteria
0.000 < N-Gain < 0.300	Low
0.300 ≤ N-Gain ≤ 0.700	Medium
N-Gain > 0.700	High

Source: Hake (2002)

3. RESEARCH RESULT

The N-Gain increase in ability to correlate with the control group average of 0.601 and refer to the Hake criteria, this number is in the N-Gain range of 0.300 to 0.700, indicating the criterion is "Medium". Overall, it

Table 2. T-test results in cooperation with the control group.

Paired Samples Test

		Paired Differences					t	df	Sig. (2-tailed)
		Mean	Std. Deviation	Std. Error Mean	95% Confidence Interval of the Difference				
					Lower	Upper			
Pair 5	Pretest Collaborated Control - Posttest Collaborated Control	-3.514	2.077	.341	-4.206	-2.821	-10.292	36	.000

Table 3. Results of the T-test in conjunction with the experimental group.

Paired Samples Test

		Paired Differences					t	df	Sig. (2-tailed)
		Mean	Std. Deviation	Std. Error Mean	95% Confidence Interval of the Difference				
					Lower	Upper			
Pair 9	Pretest and Posttest Collaborating Experiments	-3.108	3.502	.576	-4.276	-1.940	-5.398	36	.000

can be stated that for low N-Gain criterion (0.000 N-Gain 0.300) of 8.11%, medium criteria (0.300 N-Gain 0.700)

of 48.65%, and high criteria (N-Gain > 0.700) of 43.24%. The average control group pre-test score was 18.297, and the average post-test score was 21.811.

Based on Table 2, the output of the "Paired Sample Test" is known to have a Sig (2-tailed) value of 0.000 < 0.05, and it can be concluded that there is an average difference in the ability to work together between the pre-test and post-test in the control group, indicating that there is a difference in the ability to work by using an industrial project-based learning model for prospective vocational educators.

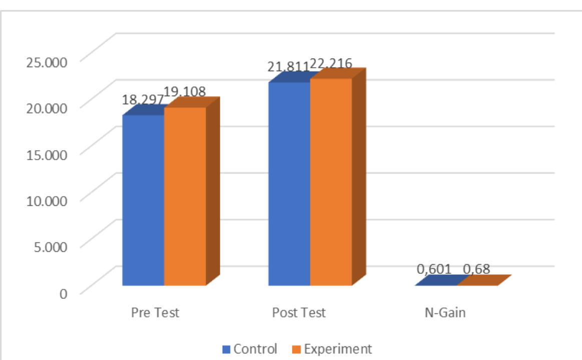

Figure 1. Depicts the N-gain ability to collaborate.

When referring to Hake's criterion, the results of the N-Gain calculation of the ability to work with the experimental group averaged 0.680, which implies it is included in the "Medium" category. The results of these calculations are spread at a score of 0.000 < N-Gain < 0.300 of 2.70%, around 0.300 ≤ N-Gain ≤ 0.700 of 51.35%, and an N-Gain score > 0.700 of 48.65%. While the experimental group's pre-test results averaged 19.108, the post-test results averaged 22.216. The trial part of collaborative learning implementation utilizing industrial projects saw an increase in both the control group with moderate criteria and the experimental group with high criteria. Figure 1 depicts the outcomes.

Based on Table 3, which shows that the output of the "Paired Sample Test" has a Sig (2-tailed) value of 0.000 < 0.05, it can be concluded that there is an average difference in the ability to work together in the experimental group between the pre-test and post-test, indicating that there are differences in the ability to work together using an industrial project-based learning model for prospective vocational educators. Meanwhile, Table 4 shows the different N-Gain tests of collaboration ability between the control and experimental groups. The results of the "Paired Sample Test" are shown in the table. Because the value of Sig (2-tailed) is 0.024 < 0.05 and there is a difference in N-Gain ability to work together between the control group and the experimental group, it can be concluded that there is a difference in improving the ability to work with prospective mechanical engineering teachers using industrial project-based learning models.

Table 4. The results of the T-test N-gain cooperation ability.

Paired Samples Test

		Paired Differences					t	df	Sig. (2-tailed)
		Mean	Std. Deviation	Std. Error Mean	95% Confidence Interval of the Difference				
					Lower	Upper			
Pair 1	Collaborative Experiments and Control	-.11549	.29863	.04909	-.21505	-.01592	-2.352	36	.024

4. DISCUSSION

The study's findings demonstrated that there were disparities in how mechanical engineering teacher candidates improved their capacity to collaborate utilizing industrial project-based learning models. Improving cooperation skills is a vital component of becoming a professional teacher. Collaboration is becoming increasingly crucial in teachers' professional learning [7]. Increasing cooperation skills through project learning can be contrasted with traditional learning, which is primarily focused on individual learning and is theoretical in nature. The emphasis on establishing collaborative skills in project-based learning is specifically meant to increase prospective Mechanical Engineering teachers' ability to interact with team members to achieve common goals. Training and learning techniques for engineering students should integrate theoretical technical knowledge and skills in collaborative work practices to give learning experiences that assist the development of industrial skills and competencies [8]. Positive impacts of teacher cooperation have been recorded, including increased moral support and mutual trust among teachers, promotion of reflection, and contribution to school development [9].

Project learning emphasizes active and exploratory learning, in which potential mechanical engineering teachers learn by doing and attempting new things in order to gain new learning experiences. Improved social and interpersonal abilities allow for more opportunities to communicate with team members, create relationships, and learn new social and interpersonal skills. Meanwhile, traditional learning is more individualistic and lays less emphasis on building social skills. Enhancing creativity and innovation through project learning allows for the exploration of new ideas and the development of creative and inventive solutions. Improved problem-solving skills in project learning create chances for collaborative learning to solve complicated problems. The project-based learning strategy has a positive impact on students' problem-solving skills, learning accomplishments, and attitudes and opinions of the teaching profession [10]. Because it provides a more active, social, and creative learning experience and hones problem-solving skills, industrial project-based learning may be a more effective alternative in strengthening the cooperation skills of aspiring mechanical engineering teachers. Children that are creative have a good impact on the overall learning environment, including their peers and lecturers [11].

Prospective mechanical engineering teachers can create trust and mutual respect by improving their capacity to collaborate. Individuals and groups with good collaboration abilities can help each other create trust and mutual respect. In order to achieve common goals, each member of the group must trust each other's abilities and knowledge while also respecting other points of view and viewpoints. Good cooperation abilities can assist individuals or groups in aligning expectations within the group. Each member of the group must have the same expectations and understand their separate duties in order to operate successfully and efficiently toward common goals. Individuals or groups with good cooperation abilities can also help to foster an environment of open, honest, and respectful communication. Each member of the group must be able to communicate openly and honestly, as well as respect other points of view and beliefs. Effective communication is critical in developing a common understanding and is the key to achieving the vision and goals that are intended to have a beneficial influence on organizational performance [12, 13].

Collaboration with good mechanical engineering teacher candidates can aid individuals or groups in instilling a sense of belonging inside the group. To be able to work well together and achieve common goals, each member of the group must feel accountable for reaching common goals. Furthermore, each member of the group must be able to tolerate differences of opinion and discover the best answer by taking into account many points of view. Good teacher collaboration abilities can also assist individuals or groups in providing feedback to the group. The most important aspect influencing collaborative performance is feedback [14, 15]. Each group member must be able to provide constructive input and accept feedback honestly and with mutual respect when working together. The key to enhancing performance, communication, motivation, learning, cooperation, and collaboration creativity is to provide constructive, transparent, and courteous criticism.

5. CONCLUSION

Some conclusions that may be drawn from the application of research connected to the ability to collaborate with future mechanical engineering teachers through industrial project learning methodologies are as follows:

a. In the control group, there is an average difference in cooperation capacity between the pre-test and post-test.
b. In the experimental group, there is an average difference in collaboration capacity between the pre-test and post-test.
c. There is a difference in strengthening the ability to collaborate with potential mechanical engineering teachers through industrial project learning methodologies.

AUTHOR CONTRIBUTIONS

The authors of this study contributed to research planning, data collection and processing, and publishing of research results.

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