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DEVELOPING INDUSTRY-RELEVANT SOFT SKILLS THROUGH PEER-ENGAGED PROJECT APPLICATION MODEL (PEPA): A VOCATIONAL EDUCATION PERSPECTIVE

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ABSTRACT
The development of soft skills remains a critical challenge in vocational education, as the curriculum often prioritises technical competencies while neglecting systematic integration of interpersonal skills. This study aims to develop and evaluate the Peer-Engaged Project Application Model (PePA), a project-based learning framework designed to enhance communication, teamwork, and problem-solving through structured peer engagement. Employing a Research and Development (R&D) approach based on the ADDIE model, the research was conducted in the D4 Mechanical Engineering Program at Yogyakarta State University. The PePA model was tested on a group of 15 students in the Fabrication Construction Practices course. Data were collected through Likert-scale questionnaires, structured observations, and semi-structured interviews, and analysed using descriptive and inferential statistics, along with qualitative techniques. The implementation of PePA resulted in improved performance in soft skills, with average scores increasing from 3.03 to 3.65 (communication), 3.20 to 3.78 (teamwork), and 3.13 to 3.70 (problem-solving). The model was also rated as "very valid" by expert evaluators, with an average validation score ranging from 3.58 to 3.85. These findings suggest that PePA is a feasible and effective learning model for strengthening vocational students' soft skills in alignment with industry expectations. The model has potential applicability beyond engineering education and supports policy recommendations for integrating soft skills into vocational curricula.
Keywords: *Peer-Engaged Project Approach, Vocational Education, Soft Skills, Project-Based Learning.*

1. Introduction

Industry 4.0 has triggered a profound transformation in the world of work, characterised by increasing automation, the application of artificial intelligence, and the utilisation of data-driven systems that radically change the workforce's skill needs (Kurt, 2019; Simoes et al., 2020). While hard skills are essential, they are no longer enough; to compete in an increasingly complex and dynamic work arena, the future workforce must be equipped with critical soft skills, such as practical communication abilities, solid teamwork, and innovative problem-solving skills (Prasetya et al., 2025; The World Economic Forum, 2020). In the context of the manufacturing sector, soft skills have proven to be a key factor in improving work productivity and effectiveness (Askari et al., 2020; Ferreira et al., 2022; Srivastava & Kuri, 2021). However, despite its growing importance, vocational education graduates often exhibit significant skills gaps, especially in soft skills (Fetahu & Lekli, 2023; Kumar Padhi, 2022). A preliminary study conducted by the authors, involving 110 respondents across 75 manufacturing companies in Indonesia, revealed that while graduates are technically competent, they frequently underperform in communication, team collaboration, and autonomous problem-solving. These results echo international findings which show that vocational graduates in Indonesia exhibit lower proficiency in soft skills compared to their counterparts in countries like Germany and Finland, where vocational education is closely integrated with workplace learning and soft skills training through dual systems and work-based learning frameworks (Bischoff & Hauschildt, 2021; Kärkkäinen et al., 2025).

The dominance of technical skills-based learning leads to an imbalance between hard and soft skills in vocational education. In contrast, developing soft skills is often only supplementary,

such as through internships or leadership training (Kozlovsky et al., 2022; Kuregyan & Khusainova, 2022; Sugiarti et al., 2021). Although several project-based learning (PjBL) approaches have been adopted to integrate practical competencies, few have systematically embedded peer engagement as a core instructional component for fostering soft skills.

To address these limitations, this study develops and evaluates the Peer-Engaged Project Application Model (PePA), a model designed to integrate peer collaboration and project-based learning in a structured and repeatable framework. Unlike traditional models, PePA emphasises continuous peer interaction throughout all stages of learning, from task planning to reflection, thereby operationalising key dimensions of Vygotsky's social learning theory. Specifically, this study focuses on: (1) developing the PePA model for application in fabrication construction practice; (2) evaluating its effectiveness in improving students' communication, teamwork, and problem-solving skills; and (3) assessing the model's feasibility and acceptability from both student and educator perspectives.

The contributions of this study are threefold: (1) Theoretically, PePA expands the discourse on project-based vocational learning by embedding structured peer engagement to support soft skill development; (2) Practically, it provides a scalable instructional framework adaptable for diverse vocational fields; and (3) Methodologically, it introduces a validated evaluation instrument for measuring soft skill outcomes through observation and Likert-scale self-assessment. Overall, PePA aims to narrow the skill gap between education and employment, supporting graduate readiness in the Industry 4.0 era.

2. Research Method

This research employs the Research and Development (R&D) approach in conjunction with the ADDIE development model (Analysis, Design, Development, Implementation, Evaluation), offering a systematic framework for designing and evaluating learning models. This model was chosen because it can ensure that each stage of development is carried out in a structured manner, from needs analysis to evaluation of its effectiveness. Oriented towards industry and vocational education, this approach enables project-based learning that is more relevant and applicable. The stages of applying the ADDIE model in this research are presented in Figure 1.

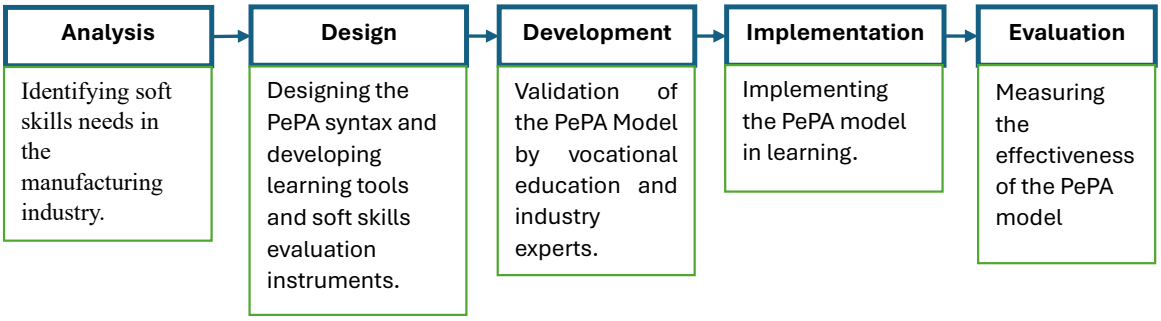

Fig. 1. ADDIE model

2.1 Participants and Sampling

Participants involved in this study were students enrolled in the Fabrication Construction Practices course in the D4 Mechanical Engineering Program at Yogyakarta State University. The sampling used purposive techniques, targeting students with a foundation in fabrication and active experience in project-based learning. The model feasibility test involved 14 students and four instructors, focusing on the practical implementation and gathering of feedback. The effectiveness test involved 15 students, assessing the model's impact on communication, teamwork, and problem-solving during the learning cycles.

2.2 Data Collection Techniques and Instruments

Data were obtained from both primary and secondary sources to ensure a comprehensive understanding of the soft skills needed in vocational education. Primary data were collected directly from practitioners, students, and lecturers through various field techniques. In contrast,

secondary data were derived from an extensive literature review to identify relevant emerging soft skills required in the manufacturing sector. The data collection process involved several complementary methods: interviews with industry practitioners, vocational program coordinators, and students to explore current soft skill demands; surveys distributed to vocational graduates working in manufacturing industries to triangulate findings; and Focus Group Discussions (FGDs) with key stakeholders to refine the PePA model and its instructional instruments. Additionally, expert judgments from professionals in vocational education, human resource development, and educational technology were utilised to validate the content and structure of the model components. Questionnaires were used to evaluate the feasibility and practicality of the model from both the educator's and student's perspectives. Observation sheets were applied throughout the implementation to measure students' development of soft skills in real-time learning environments, while document analysis of student project reports provided supporting evidence for data triangulation and validation.

2.3 Procedure and Model Development

The development of the PePA model followed the structured stages of the ADDIE framework: Analysis, Design, Development, Implementation, and Evaluation.

During the Analysis phase, a comprehensive needs assessment was conducted through interviews and surveys with industry stakeholders, complemented by an in-depth literature review. This stage aimed to identify critical soft skills—particularly communication, teamwork, and problem-solving—that are essential for graduates entering the manufacturing sector.

During the Design phase, a preliminary prototype of the PePA model was developed, encompassing the formulation of key instructional components, including job sheets, implementation guides, and assessment rubrics. The instructional blueprint was developed based on insights obtained during the analysis phase to ensure contextual alignment with vocational learning environments.

The Development stage involved rigorous validation of the model and its instruments. Internal validation was performed by three experts in vocational education, educational technology, and human resource development. In contrast, external validation was conducted through Focus Group Discussions (FGDs) involving industrial practitioners and vocational lecturers. Content validity was established through expert judgment, with validation scores ranging from 3.42 to 4.00, indicating a high degree of appropriateness and clarity across the model components and instruments.

During the Implementation stage, the PePA model was applied in three iterative learning cycles using an equivalent time series design. Instruction was delivered collaboratively by course lecturers and laboratory assistants. The development of students' soft skills was systematically monitored and assessed throughout each learning cycle.

In the Evaluation phase, both the model's practicality and its effectiveness were examined using a combination of pre-tests, mid-cycle assessments, and post-tests. Instruments such as Likert-scale questionnaires, structured observation sheets, and semi-structured interviews were utilised to evaluate students' progress in communication, teamwork, and problem-solving. This multi-method approach ensured a robust and comprehensive assessment of the model's impact.

2.4 Instrument Validation and Reliability

All measurement instruments used in this study underwent expert validation to ensure their content relevance, clarity, and alignment with the intended constructs. The PePA instructional manual and course syllabus (RPS) received "very valid" ratings, with average expert scores ranging from 3.58 to 3.85. Similarly, the teacher and student questionnaires yielded mean scores between 3.42 and 3.77, reflecting a high level of content validity. The soft skills observation rubric achieved a mean score of 4.00, indicating excellent validity.

Instrument reliability was examined through internal consistency analysis using Cronbach's Alpha, which is suitable for Likert-type instruments. The teacher and student questionnaires yielded coefficients of 0.677 and 0.674, respectively. These values exceed the minimum reliability threshold ($\alpha > 0.60$), suggesting the instruments possess acceptable internal consistency for educational research contexts.

2.5 Data Analysis Techniques

Qualitative data were analysed following the analytical framework proposed by Miles & Huberman (1994), which comprises three core procedures: data reduction, data display, and conclusion drawing/verification. This approach was applied to multiple qualitative sources, including transcriptions from semi-structured interviews, summaries of focus group discussions (FGDs), and open-ended questionnaire responses. The process ensured that emerging patterns and insights were systematically extracted, organised, and interpreted to maintain analytical rigour and credibility.

Quantitative data were processed using both descriptive and inferential statistical methods. Descriptive statistics were utilised to summarise the development of students' soft skills across different intervention phases. Before inferential testing, the data were subjected to assumption checks:

- Normality was examined using the Kolmogorov–Smirnov test.
- Homogeneity of variance was tested via Levene's Test.

The resulting significance values ($p > 0.05$) indicated that the data met the parametric assumptions, allowing for the application of further inferential analyses. To assess the effectiveness of the PePA model, paired sample t-tests were conducted to compare students' soft skills performance before and after model implementation. This procedure provided robust statistical evidence regarding the model's contribution to enhancing students' communication, teamwork, and problem-solving competencies.

2.6 Trustworthiness To ensure research credibility:

To ensure the credibility and trustworthiness of the findings, several strategies were employed. Triangulation was conducted by integrating data obtained from questionnaires, classroom observations, semi-structured interviews, and document analyses to corroborate findings across multiple sources. Member checking was carried out by presenting the interpreted data to participants for verification, thereby enhancing the accuracy and authenticity of the qualitative results. Furthermore, an audit trail was maintained throughout the research process to ensure procedural transparency and enable external scrutiny of methodological decisions.

These strategies collectively strengthened the rigour of the research and provided a solid foundation for evaluating the PePA model. Consequently, the model was not only systematically developed but also rigorously validated in alignment with the demands of Industry 4.0, contributing significantly to the enhancement of soft skills education within vocational learning environments.

3. Results and Discussion

3.1. Soft Skills Gap in Vocational Education and Industry Needs

The preliminary study results indicate that vocational education graduates continue to experience gaps in soft skills, particularly in communication, teamwork, and problem-solving. This was reinforced by interviews with industry representatives, who stated that graduates often struggle to convey ideas, work in interdisciplinary teams, and face technical challenges that require collaborative solutions.

A survey was also conducted to evaluate workers' perceptions of the importance of soft skills in the manufacturing industry. The survey was conducted online using Google Forms with 110 respondents who are graduates of vocational colleges, spread across 75 companies and representing 31 universities in Indonesia. Data was collected using a Likert scale-based questionnaire. The survey results presented in Figure 2 show that more than 95% of respondents recognised soft skills as a significant factor in supporting their career development. These findings underscore the importance of soft skills in supporting career success in the manufacturing sector, which aligns with the interview results and the findings of a previous literature review.

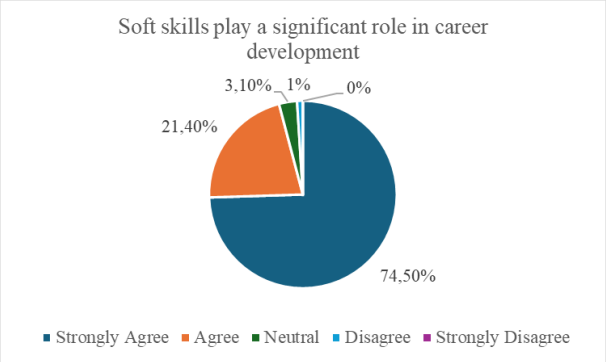

Fig. 2. The Role of Soft Skills in Career Development

However, this survey also indicates that the development of soft skills in vocational college learning is not yet optimal. 33% of respondents strongly agreed that learning in vocational colleges has facilitated the development of students' soft skills, while 21% agreed, 31% were neutral, 12% disagreed, and 3% strongly disagreed. This indicates that the implementation of soft skills development in vocational colleges still needs improvement, with 46% of respondents showing a neutral to disagreeing attitude towards such facilitation. Therefore, this research developed the Peer-Engaged Project Approach (PePA) to overcome these limitations.

However, the survey results also indicate that developing soft skills in vocational college settings is still not optimal. Fifty-four per cent of respondents stated that learning in vocational colleges facilitated the development of soft skills. On the other hand, 46% of respondents were neutral in disagreeing with the facilitation, as presented in Figure 3. This finding suggests that, despite efforts to develop soft skills, nearly half of the respondents still believe that vocational education has not adequately addressed these needs. This finding is in line with research conducted by Rajan and Pandita (2019), which shows that vocational education in many countries focuses on mastering technical skills without systematically integrating soft skills. Therefore, improvements and more systematic integration in learning models are needed so that soft skills become a structured part of vocational education.

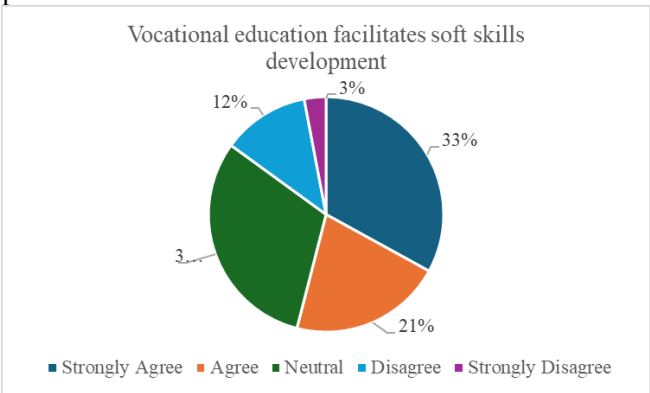

Fig. 3. Percentage of graduates' perception of soft skills development

In terms of emerging soft skills, which refer to interpersonal skills, intrapersonal skills, thinking skills, and learning skills that are increasingly needed in the workplace, the survey results revealed that all aspects of soft skills asked about received an average score of more than 4, indicating that these skills are considered necessary by workers beyond technical skills. Further analysis reveals that communication, problem-solving, and teamwork are the top three essential soft skills required to support performance in the manufacturing industry. Table 2 presents the perceived level of urgency for various aspects of soft skills among industrial workers.

Table 1 - Soft Skills Aspects According to the Perspective of Industry Workers

Rank	Research source	Average Score
1	Communication	4.79
2	Problem-solving	4.76
3	Teamwork	4.76
4	Self-management	4.75

5	Adaptability	4.73
6	Resilience	4.64
7	Critical thinking & decision-making	4.63
8	Leadership	4.60
9	Networking	4.56
10	Creativity	4.54

Thus, the survey results indicate that workers in the manufacturing industry require soft skills such as communication, problem-solving, and teamwork, which are top priorities for enhancing their performance in the Industry 4.0 era.

3.2. Implementation of the PePA Model in Practical Learning

The PePA model is implemented through three learning stages in the Construction Fabrication Practicum course. Its primary objective is to improve students' soft skills, particularly communication, teamwork, and problem-solving, through a project-based approach that emphasises active peer engagement. The application of this model is designed not only to strengthen technical competencies but also to foster awareness of work safety, risk control, and collaborative responsibility in a vocational workshop environment. This approach is in line with findings that emphasise that effective communication and procedural discipline are essential prerequisites for minimising potential hazards and improving the safety culture in vocational machining practices (Djatmiko et al., 2020). The Peer-Engaged Project Approach (PePA) model consists of seven main stages: (1) team formation, (2) project design, (3) project assignment and role distribution, (4) development of the Work Preparation Sheet, (5) product implementation, (6) presentation of results, and (7) reflection. These seven stages are applied across three learning treatment cycles, as shown in Figure 4. Evaluations of soft skill development are conducted at each treatment stage to assess improvements in students' communication, collaboration, and problem-solving abilities. The details of activities performed by students at each stage of the PePA model are systematically presented in Table 2.

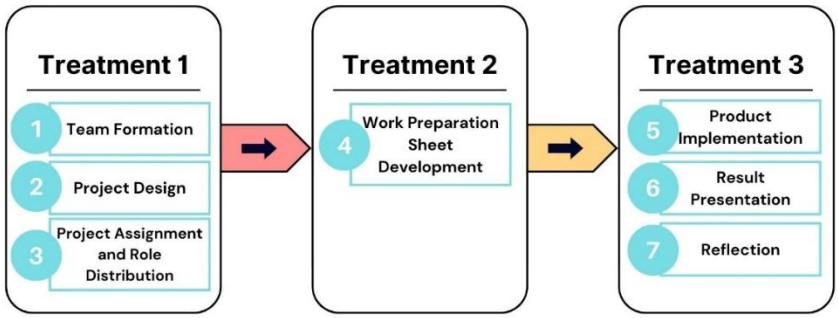

Fig. 4. Stages of The PePA Learning Model

Table 2 - Student Activity in The PePA Learning Model

SN	Steps	Activities	Treatment
1	Team Formation	Students are grouped into heterogeneous teams of 3-4 members, based on their diverse skills and backgrounds. This approach aims to optimise collaborative learning and create synergy within the team.	
2	Project Design	Each team designs a job sheet according to the learning objectives, which include identifying the functions, benefits, materials, and machining processes required. The design is done using engineering software with detailed product specifications. The job sheet is then given to other teams, allowing students to design and evaluate their work based on predetermined standards.	I
3	Project Assignment	Each team will work on a project randomly selected from the other teams' designs. After receiving the project, teams distribute roles based on the skills and interests of each	

SN	Steps	Activities	Treatment
	and Role Distribution	member, aiming to optimise individual contributions and improve teamwork dynamics.	
4	Work Preparation Sheet Development	Each team develops a work preparation sheet, which includes a timetable, milestones, individual tasks, and a mechanism for periodic evaluation. This work plan ensures a more organised production process, enables progress monitoring, and increases accountability in task completion.	II
5	Product Implementation	Students work collaboratively, adhering to predetermined roles, and focus on effective communication to solve technical challenges. Educators act as facilitators who provide monitoring, assistance, and alternative solutions to ensure the project goes according to plan.	
6	Result Presentation	Each team presented their product to the other groups and the educator. This process not only practises communication skills but also provides an opportunity to share experiences, discuss challenges, and receive constructive feedback to improve the quality of teamwork and reflective skills.	III
7	Reflection	Students reflect on their experiences in teamwork, problem-solving, and learning achievements. Guided discussions help them identify strengths and weaknesses and deepen their understanding of the importance of emerging soft skills for self-development and work readiness.	

Determining the effectiveness category of the PePA learning model is based on the data analysis results from observation sheets, which measure the extent to which this model is effective in developing students' emerging soft skills, including communication, cooperation, and problem-solving. Measuring the achievement of emerging soft skills uses a score of 1-4. The results of this analysis are classified into the following criteria:

Table 3 - PePA model effectiveness categories

Score range	categories
$1 \leq X \leq 1{,}75$	Not Effective
$1{,}75 < X \leq 2{,}5$	Less Effective
$2{,}5 < X \leq 3{,}25$	Effective
$3{,}25 < X \leq 4$	Highly Effective

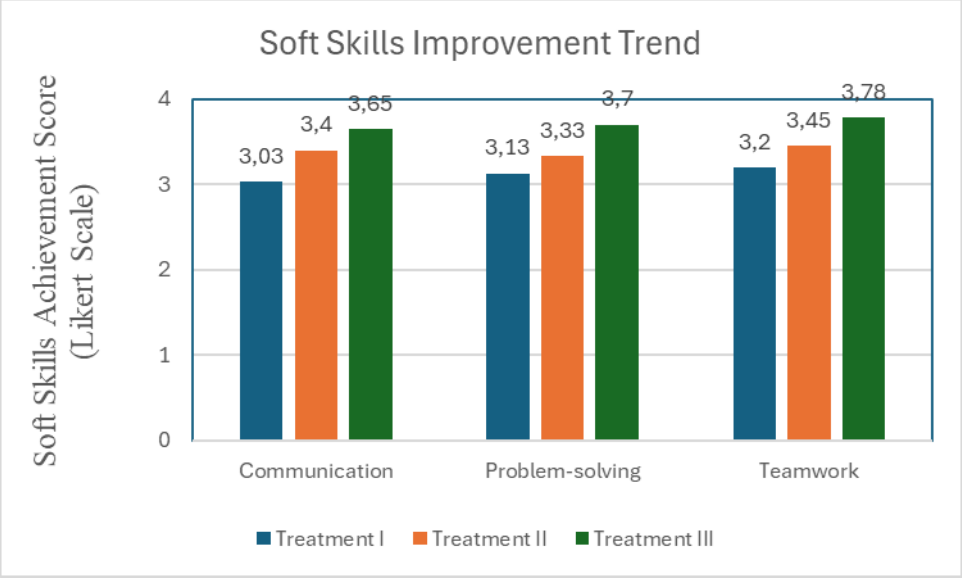

Fig. 5. Soft skills improvement trend

The increasing trend in soft skill achievement across each treatment is evident in Figure 5. In Treatment I (Project Design), students work in teams to design projects and exchange design

results with other groups. Communication scores (3.03), teamwork (3.20), and problem-solving (3.13) indicate that students continue to struggle with conveying ideas and dividing work roles effectively.

In Treatment II (Work Preparation Sheet Development), students design work procedures before fabrication. Communication scores increased to 3.40, teamwork to 3.45, and problem-solving to 3.33. This indicates that students are becoming more structured in planning their work, documenting processes, and resolving technical issues within the team.

In Treatment III (Product Implementation), students apply designs and work plans in production in the workshop. Significant score increases were seen in communication (3.65), teamwork (3.78), and problem-solving (3.70). Interviews with students confirmed that they felt more confident in discussions, were more proactive in solving problems, and had a better understanding of team collaboration in the work environment.

" At first, I was awkward to talk and share tasks, but after working on this project several times, I am more confident in conveying ideas and discussing with friends." (Student, post-implementation PePA interview)

3.3. Evaluation of the Feasibility and Effectiveness of the PePA Model

Feasibility testing was conducted through expert validation and field implementation. Three experts with backgrounds in vocational education, educational technology, and human resource development reviewed the model's conceptual and instructional components. The PePA model, along with its supporting materials (Course Syllabus, guidebooks, instruments), was rated as "Very Valid," with validation scores ranging from 3.42 to 4.00.

Additionally, 14 students and four instructors participated in a practical test, affirming the model's clarity, relevance, and applicability in real classroom settings. Student feedback emphasised that the model encouraged peer collaboration, enhanced communication, and promoted reflective learning.

Industrial feedback was also gathered—a Human Resource Manager at PT. Mega Andalan Kalasan noted:.

" *We see that students who study with this method are more proactive in solving problems and more confident in working in teams.*" (Human Resources Manager, PT. MAK)

These results are consistent with studies that have found a project-based learning approach with active student involvement increases employability skills by up to 20% compared to traditional methods. (Ferreira et al., 2022; Sousa, 2024; Upadhye et al., 2022).

3.4. Theoretical, Practical, and Methodological Implications

The results of this research have three main contributions to vocational education. First, theoretically, this research strengthens the concept of social learning theory, which emphasises that active involvement with peers can improve understanding and interpersonal skills (Arishaba, 2024; Ghio, 2023; Vygotsky, 1978). Second, practically, the PePA model can serve as a reference for vocational education institutions in systematically integrating soft skills into their practical curricula. Third, methodologically, this research produces an observation-based soft skills evaluation instrument, which can measure the development of students' skills in project-based learning.

This research further suggests that the PePA model can be applied in mechanical engineering and other fields, including technology, business, and healthcare. In addition, this model can serve as the basis for vocational education policies that emphasize developing interpersonal skills as part of graduate competency standards.

In conclusion, the PePA model presents a pedagogical innovation that addresses the persistent gap between the competencies of vocational graduates and the evolving demands of the industry. Its application demonstrates that technical excellence must be accompanied by robust soft skills to ensure graduate readiness for the challenges of Industry 4.0.

4. Conclusion

This study concludes that the Peer-Engaged Project Application Model (PePA) is effective in enhancing the soft skills of vocational students, particularly in communication, teamwork, and

problem-solving. By integrating peer engagement within a structured project-based learning framework, PePA fosters not only technical proficiency but also the interpersonal and cognitive skills that are increasingly demanded in the Industry 4.0 landscape.

Theoretically, the findings support the principles of social constructivism and cooperative learning by demonstrating how peer collaboration can catalyze the development of soft skills in vocational settings. Practically, PePA provides a replicable instructional model that can guide vocational institutions in embedding soft skills systematically into hands-on learning environments. Methodologically, the study contributes a validated observation-based instrument that can be employed to assess students' soft skills progression in project-based activities.

Although the results are promising, this study acknowledges certain limitations, particularly the limited scope of implementation and the absence of a control group, which may limit generalizability. Therefore, further studies are recommended to examine the effectiveness of PePA across diverse disciplines, institutional settings, and cultural contexts. Future research should also consider incorporating technology-enhanced assessment tools and conducting longitudinal studies to evaluate the sustained impact of PePA on graduates' employability and workplace performance.

In summary, PePA provides a strategic and pedagogically sound solution to bridge the persistent gap between the competencies of vocational graduates and evolving industry expectations, thereby contributing to the advancement of vocational education reform in the era of digital transformation.

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