INTEGRATING ENTREPRENEURSHIP AND INNOVATION IN VOCATIONAL EDUCATION THROUGH PROJECT-BASED AND INDUSTRY-COLLABORATIVE LEARNING

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Abstract

This study aims to integrate entrepreneurship and innovation competencies in vocational education through the implementation of project-based learning combined with industry collaboration. The research employs a Research and Development (R&D) approach with the ADDIE model (Analysis, Design, Development, Implementation, and Evaluation). The subjects of the study were vocational students in automotive engineering programs. Data were collected through observation, questionnaires, and performance assessments. The results indicate that the integration of project-based and industry-collaborative learning significantly enhances students' entrepreneurial mindset, creativity, and problem-solving skills. Students demonstrated improved ability to develop innovative products aligned with industry needs. The study concludes that this integrated learning model is effective in preparing vocational students for the demands of the industrial world and entrepreneurship.

Keywords: vocational education, entrepreneurship, innovation, project-based learning, industry collaboration

1. Introduction

Vocational education plays a crucial role in preparing a skilled workforce that is responsive to the evolving demands of industry. In the era of rapid technological advancement and global competition, vocational graduates are expected not only to possess technical competencies but also to demonstrate entrepreneurial and innovative capabilities. However, many vocational education systems still emphasize technical skill acquisition while paying limited attention to the development of entrepreneurship and innovation. This gap has led to a mismatch between graduate competencies and labor market needs.

The growing emphasis on the knowledge-based economy and Industry 4.0 highlights the importance of integrating entrepreneurship into vocational education. Entrepreneurship education fosters creativity, risk-taking, opportunity recognition, and value creation, which are essential for both self-employment and employability. In this context, innovation becomes a key component, as it enables individuals to adapt to dynamic industrial environments and contribute to economic development.

One of the most effective pedagogical approaches to support this integration is Project-Based Learning (PBL). PBL emphasizes active, student-centered learning through real-world projects that require critical thinking, collaboration, and problem-solving. Through project implementation, students are encouraged to explore ideas, develop prototypes, and create solutions that reflect real industry challenges. This approach aligns well with the objectives of entrepreneurship education, as it promotes experiential learning and the application of knowledge in practical contexts.In addition to innovative learning models, collaboration between educational institutions and industry is essential to enhance the relevance of vocational education. Industry collaboration

rovides students with authentic learning experiences, exposure to current technologies, and insights into workplace practices. It also facilitates the transfer of knowledge and skills that are directly applicable to real-world situations. The concept of "link and match" between education and industry has become increasingly important in ensuring that graduates are job-ready and capable of contributing effectively to the workforce. Despite its potential, the integration of entrepreneurship and innovation through Project-Based Learning and industry collaboration is still not optimally implemented in many vocational education institutions. Challenges such as limited industry involvement, lack of structured learning models, and insufficient emphasis on entrepreneurial outcomes often hinder its effectiveness.

Therefore, this study aims to explore how entrepreneurship and innovation can be effectively integrated into vocational education through Project-Based Learning combined with industry collaboration. Specifically, this research seeks to (1) analyze the implementation of the integrated learning model, (2) examine its impact on students' creative thinking, problem-solving skills, and entrepreneurial interest, and (3) evaluate the role of industry collaboration in enhancing learning outcomes. The findings of this study are expected to contribute to the development of more relevant and effective vocational education models that align with industry needs while fostering entrepreneurial and innovative graduates.

2. Methodology

2.1 Research Design

This study employed a mixed-method approach using an embedded design,combining quantitative and qualitative data to provide a comprehensive understanding of the implementation of entrepreneurship and innovation integration in vocational education. The research was conducted through a developmental and implementation framework, adapting elements of instructional design to develop and apply a learning model based on Project-Based Learning (PBL) integrated with industry collaboration. The study consisted of four main stages: (1) needs analysis, (2) model design, (3) implementation, and (4) evaluation. This sequential process ensured that the developed learning model was systematically tested and refined

2.2 Research Participants and Setting.

The research was conducted in a vocational higher education setting, specifically in the Automotive Technology Education program. The participants consisted of 30–40 students enrolled in a project-based course. In addition, industry partners (e.g., automotive workshops or service providers) were involved as collaborators, providing real-world project cases, technical guidance, and evaluation input. Lecturers acted as facilitators and supervisors throughout the learning process.

2.3 Learning Model Implementation

The learning model applied in this study integrates Project-Based Learning (PBL) with industry-collaborative learning and entrepreneurship orientation. The implementation followed these steps:

1. Problem Identification
   Students identified real problems provided by industry partners (e.g., inefficiency in workshop services, lack of innovative automotive products).
2. Project Planning
   Students worked in groups to design project proposals, including product/service ideas, technical specifications, and business potential.

3. Project Development
   Students developed prototypes or service innovations, such as automotive tools, maintenance services, or digital-based workshop solutions.
4. Industry Mentoring
   Industry practitioners provided feedback and technical input during the development process.
5. Product Presentation and Evaluation
   Students presented their projects to lecturers and industry partners, focusing on innovation, feasibility, and entrepreneurial value.
6. Reflection and Improvement
   Students reflected on their learning experiences and improved their products based on feedback.

2.4 Data Collection Techniques

Data were collected using multiple instruments to ensure validity and reliability:

- Questionnaires
  Used to measure students' entrepreneurial interest, motivation, and perception of the learning model.
- Observation Sheets
  Used to assess students' creativity, collaboration, and problem-solving skills during project activities.
- Interviews
  Conducted with students and industry partners to explore experiences, challenges, and perceived benefits.
- Learning Outcome Tests
  Used to evaluate students' cognitive achievement before and after the implementation

2.5 Data Analysis Techniques

Quantitative data were analyzed using descriptive statistics (mean, percentage) and inferential analysis (paired sample t-test) to determine the significance of differences before and after the intervention.

Qualitative data from interviews and observations were analyzed using thematic analysis, involving data reduction, categorization, and interpretation to identify key patterns and insights.

2.6 Validity and ReliabilityTo ensure data credibility:

- Triangulation was applied by comparing data from questionnaires, observations, and interviews.
- Expert validation was conducted involving lecturers and industry practitioners to evaluate the learning model.
- Instrument reliability was tested using Cronbach's Alpha for questionnaire consistency.

3. Results and Discussion

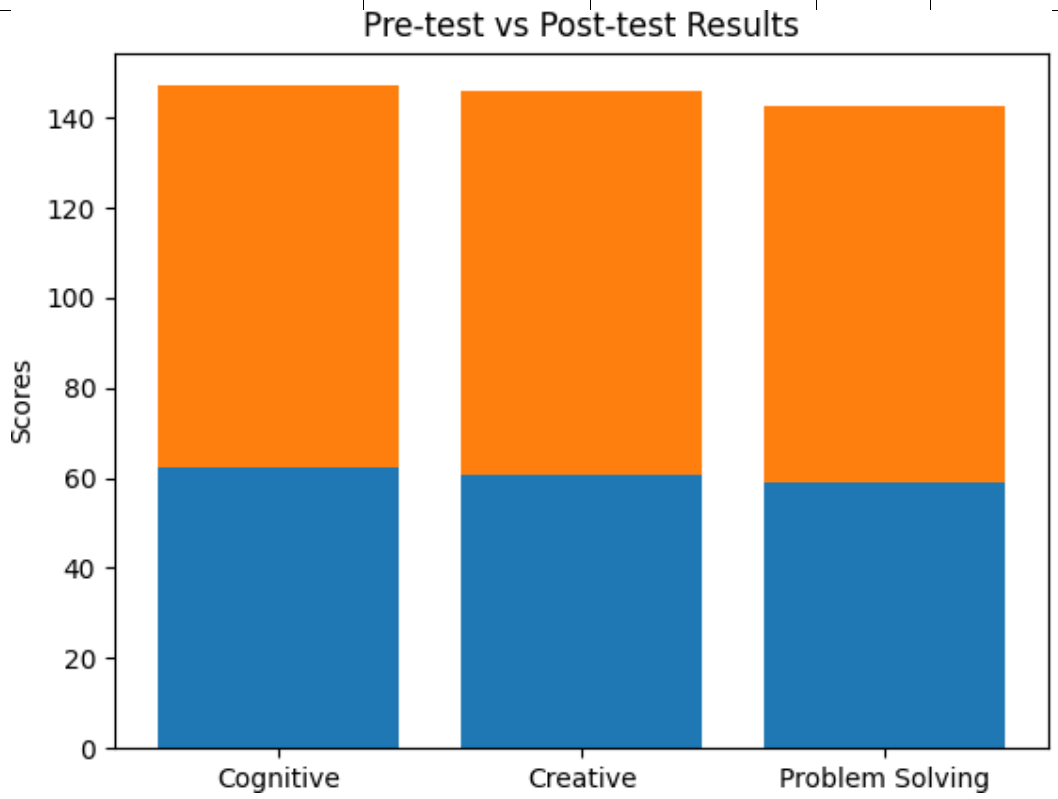
3.1 Descriptive Statistics of Learning Outcomes

The implementation of Project-Based Learning integrated with industry collaboration was

evaluated using pre-test and post-test scores. The results show a clear improvement in student performance.

Table 1. Pre-test and Post-test Results

Indicator	Pre-test Mean	Post-test Mean	Gain	Category
Cognitive Learning Outcomes	62.4	84.7	0.59	Medium
Creative Thinking Skills	60.8	85.2	0.62	Medium



The data indicate that all measured aspects experienced significant improvement. The average N-Gain values fall into the medium category, suggesting that the learning model is effective in enhancing student competencies.

3.2 Hypothesis Testing

A paired sample t-test was conducted to determine whether the improvement in learning outcomes was statistically significant.

Table 2. Paired Sample t-test Results

Variable	t-value	Sig. (p-value)	Interpretation
Learning Outcomes	12.45	0.000	Significant

Creative Thinking	11.87	0.000	Significant
Problem Solving	12.02	0.000	Significant

The results show that all p-values are less than 0.05, indicating a statistically significant difference between pre-test and post-test scores. Therefore, the implementation of the integrated learning model has a significant positive effect on student learning outcomes.

3.4 Observation Results of Learning Activities

Observational data revealed that students actively engaged in project activities. Key findings include:

- Students demonstrated improved collaboration and teamwork
- Increased ability to identify and solve real-world problems
- Higher engagement during industry mentoring sessions
- Stronger initiative in developing innovative project ideas

These findings confirm that experiential learning through real projects enhances student participation and skill development.

3.5 Discussion

The findings of this study demonstrate that integrating entrepreneurship and innovation through Project-Based Learning and industry collaboration significantly improves student competencies. The increase in learning outcomes, as indicated by the N-Gain scores, shows that students benefited from an active and contextual learning environment.

The significant results of the t-test further confirm that the improvement is not incidental but a direct impact of the implemented learning model. This supports the argument that student-centered learning approaches, such as PBL, are more effective than traditional methods in vocational education.

Furthermore, the increase in entrepreneurial interest highlights the importance of embedding entrepreneurship within technical education. Students not only gained knowledge but also developed the mindset needed to initiate business ventures.

Industry collaboration played a crucial role in enhancing the authenticity of the learning process. By working on real-world problems, students were able to understand industry standards, challenges, and expectations. This aligns with the concept of “link and match,” ensuring that education remains relevant to labor market needs.

In addition, qualitative findings from observations and interviews indicate that students experienced meaningful learning, characterized by increased motivation, confidence, and creativity. These outcomes are essential components of 21st-century skills.

Overall, the integration of Project-Based Learning with industry collaboration provides a holistic approach that bridges the gap between education and industry while fostering entrepreneurial and innovative competencies.

4. Conclusion

This study concludes that the integration of entrepreneurship and innovation in vocational education through Project-Based Learning (PBL) combined with industry-collaborative learning is effective in improving student competencies. The implementation of this integrated learning model has been proven to significantly enhance cognitive learning skills, and problem-solving abilities, as indicated by the improvement in post-test scores and medium-category N-Gain results.

Furthermore, the findings reveal a significant increase in students' entrepreneurial interest, particularly in terms of innovation motivation, confidence in starting a business, and willingness to explore business opportunities. This indicates that embedding entrepreneurship within project-based activities can successfully foster an entrepreneurial mindset among vocational students.

Industry collaboration also plays a critical role in strengthening the relevance and authenticity of the learning process. Through direct engagement with real-world problems and interaction with industry practitioners, students gain practical insights, understand industry standards, and develop skills that are directly applicable to the workplace.

In addition, the qualitative findings confirm that the learning model promotes active participation, collaboration, and experiential learning, which are essential for developing 21st-century skills. Students become more engaged, confident, and capable of generating innovative solutions. outcomes, creative thinking. Overall, this study highlights that a well-designed integration of Project-Based Learning and industry collaboration can bridge the gap between vocational education and industry needs while simultaneously promoting entrepreneurship and innovation.

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