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Student Perceptions of PAD Class Teaching Method in Mechanical Engineering Practical Training: A Survey-Based Study

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Abstract: This study investigates student perceptions of the PAD (Presentation, Assimilation, Discussion) Class teaching method in mechanical engineering practical training at Weifang University of Science and Technology, Shou Guang, China. Utilizing a quantitative approach with a questionnaire distributed to 260 students across four majors—Vehicle Engineering, Computer Science and Technology, Electrical Engineering and Automation, and Robotics Engineering—the research aims to evaluate overall perceptions, compare responses among different majors, and identify key factors influencing these perceptions. The results indicate positive feedback on participation, autonomy, discussion-based learning, and overall satisfaction, with significant differences among majors. The study highlights the need for tailored implementations of the PAD methodology to maximize its effectiveness across diverse engineering disciplines.

Keywords:PAD Class teaching method, mechanical engineering, student perceptions, practical training, quantitative study, comparative analysis

I. Introduction

1.1 Study Background

The Participatory, Autonomous, and Discussion-based (PAD) class methodology has gained significant attention in recent years for its potential to enhance student engagement and learning outcomes. Originating from educational reforms aimed at fostering active learning, the PAD Class teaching method integrates interactive participation, self-directed learning, and collaborative discussion (Wang, 2017; Zhang & Chen, 2020). This approach contrasts sharply with traditional lecture-based instruction, which often leads to passive learning and limited student interaction (Li et al., 2019).

In the context of engineering education, the application of PAD methodologies presents unique opportunities and challenges. Practical training in fields such as mechanical engineering requires not only theoretical understanding but also hands-on skills and problem-solving abilities (Chen et al., 2021). The incorporation of PAD strategies in such training programs can potentially bridge the gap between theory and practice by encouraging active student involvement and peer learning (Liu & Wu, 2018).

Despite the promising aspects of PAD Class teaching method, empirical research specifically focusing on their implementation in mechanical engineering practical courses remains limited.

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Most existing studies have either concentrated on theoretical courses or have not thoroughly explored the perceptions and experiences of students within practical training contexts (Zhao et al., 2022). This study aims to fill this gap by investigating student perceptions of PAD Class teaching method in mechanical engineering practical training at Weifang University of Science and Technology, China.

1.2 Research Problem

The primary research problem addressed in this study is the lack of comprehensive understanding regarding student perceptions of PAD Class teaching method in mechanical engineering practical training. While the theoretical benefits of PAD Class teaching method are well-documented, there is insufficient empirical evidence on how students from different engineering disciplines perceive and experience these methods in a practical training environment.

1.3 Objectives of the Study

The main objectives of this study are:

- To evaluate the overall perception of PAD Class teaching method among students in mechanical engineering practical training.
- To compare the perceptions of students from different majors (Vehicle Engineering, Computer Science and Technology, Electrical Engineering and Automation, and Robotics Engineering) regarding the effectiveness of PAD Class teaching method.
- To identify key factors influencing student perceptions and experiences of PAD Class teaching method in practical training courses.

1.4 Research Questions

This study aims to answer the following research questions:

- What are the general perceptions of students towards the PAD Class teaching method in mechanical engineering practical training?
- How do perceptions of PAD Class teaching method differ among students from various majors within the engineering discipline?
- What factors contribute to the perceived effectiveness or challenges of PAD Class teaching method in practical training settings?

1.5 Significance of the Study

Understanding student perceptions of PAD Class teaching method is crucial for several reasons. First, it provides insights into the effectiveness of active learning strategies in practical training environments, which can inform curriculum design and instructional practices (Brown et al., 2019). Identifying the differences in perceptions across various engineering majors can help tailor PAD implementations to better suit specific student needs and learning contexts (Johnson & Johnson, 2021). Finally, this study contributes to the broader body of educational research by offering empirical evidence on the applicability of PAD Class teaching method in STEM education, particularly in mechanical engineering (Hattie, 2018).

1.6 Scope and Limitations

This study is limited to undergraduate students enrolled in practical training courses at Weifang University of Science and Technology, specifically those majoring in Vehicle Engineering, Computer Science and Technology, Electrical Engineering and Automation, and Robotics Engineering. The study employs a quantitative approach, utilizing a questionnaire distributed through Wenjuanxin, an online survey platform widely used in China for its efficiency and user-friendly interface.

Limitations of this study include its reliance on self-reported data, which may be subject to biases such as social desirability or recall bias. Additionally, the study's findings may not be generalizable to other institutions or disciplines outside of the specified engineering majors. Future research could address these limitations by incorporating qualitative methods, expanding the sample size, or conducting longitudinal studies to track changes in perceptions over time.

2. Literature Review

2.1 Overview of PAD Class teaching method

The PAD Class teaching method, which stands for Participatory, Autonomous, and Discussion-based learning, has emerged as a significant pedagogical approach aimed at enhancing student engagement and learning outcomes. This methodology integrates active participation, encourages autonomous learning, and fosters collaborative discussion among students (Wang, 2017). The core idea is to shift from traditional lecture-based teaching to a more interactive and student-centered learning environment. This approach not only stimulates critical thinking but also promotes deeper understanding by involving students actively in the learning process (Zhang & Chen, 2020).

2.2 Applications of PAD in Engineering Education

In engineering education, PAD methodologies have been applied to bridge the gap between theoretical knowledge and practical skills. Engineering disciplines, especially those involving hands-on training, benefit from the interactive nature of PAD Class teaching method. Studies have shown that PAD Class teaching method can improve problem-solving skills and enhance the application of theoretical concepts in practical scenarios (Chen et al., 2021). For example, in mechanical engineering courses, students engaged in PAD classrooms have demonstrated better retention of knowledge and higher levels of practical competence compared to those in traditional lecture settings (Liu & Wu, 2018).

2.3 Previous Research on PAD Effectiveness

Numerous studies have evaluated the effectiveness of PAD Class teaching method across various educational settings. Research indicates that PAD Class significantly boost student motivation and academic performance (Li et al., 2019). A meta-analysis of active learning strategies found that students in PAD environments exhibited higher engagement levels and better academic outcomes compared to traditional instructional methods (Hattie, 2018). Furthermore, PAD methodologies have been associated with improved collaborative skills and enhanced critical thinking abilities, which are essential for engineering students (Brown et al., 2019).

2.4 Student Perceptions in Educational Research

Understanding student perceptions is crucial for evaluating the success of any educational methodology. Recent studies have highlighted that students generally perceive PAD Class teaching method positively, citing increased engagement and a more enjoyable learning experience (Johnson & Johnson, 2021). However, perceptions can vary based on individual learning styles and the specific implementation of the methodology. In engineering education, where practical application is key, students have reported that PAD Class teaching method helps them better connect theoretical knowledge with real-world applications (Zhao et al., 2022). Differences in perceptions among various engineering disciplines, such as mechanical, electrical, and computer engineering, also suggest the need for tailored approaches to effectively meet the needs of diverse student groups (Chen et al., 2021).

2.5 Summary of Literature

The reviewed literature underscores the potential benefits of PAD Class teaching method in enhancing student engagement, motivation, and academic performance. Particularly in engineering education, PAD approaches facilitate the integration of theoretical and practical knowledge, preparing students for real-world challenges. While student perceptions are generally positive, the effectiveness of PAD Class teaching method can vary based on implementation and discipline-specific requirements. Future research should continue to explore these variations and identify best practices for applying PAD Class teaching method across different educational contexts.

3. Methodology

3.1 Research Design

This study employs a quantitative research design to investigate student perceptions of the PAD Class teaching method in mechanical engineering practical training. A survey-based approach is used to collect data from a sample of students across different engineering majors. The study aims to evaluate overall perceptions, compare differences among majors, and identify factors influencing these perceptions.

3.2 Participants

The study involves 260 undergraduate students from Weifang University of Science and Technology, located in Shou Guang, China. These students are enrolled in various engineering majors, providing a diverse sample for the research.

3.2.1 Demographic Information

Participants include a mix of students from different academic years and genders. Basic demographic information such as age, year of study, and gender is collected to analyze if these factors influence perceptions of PAD Class teaching method.

3.2.2 Majors Involved

Students from the following majors are included in the study:

- Vehicle Engineering
- Computer Science and Technology
- Electrical Engineering and Automation
- Robotics Engineering

3.3 Data Collection Instrument

A structured questionnaire is used to collect data on student perceptions of the PAD Class teaching method. The questionnaire is designed to capture various aspects of the PAD experience, including participation, autonomy, and discussion-based learning.

3.3.1 Questionnaire Design

The questionnaire consists of multiple sections, each targeting specific dimensions of the PAD methodology. Questions are formulated based on a Likert scale to quantify student responses. The design includes items on:

- Student engagement and participation
- Autonomy in learning
- Effectiveness of discussion sessions
- Overall satisfaction with the PAD approach

3.3.2 Use of Wenjuanxin Platform

The Wenjuanxin platform is utilized for distributing and collecting the questionnaire. Wenjuanxin is a widely used online survey tool in China, known for its efficiency and user-friendly interface.

Wenjuanxin is a professional online survey, examination, assessment, and voting platform. It offers powerful, user-friendly features for designing questionnaires, collecting data, creating custom reports, and analyzing survey results. The platform is extensively used by businesses and individuals due to its quick, easy-to-use, and cost-effective nature.

Using Wenjuanxin for this study provides several advantages:

- Quick and efficient distribution of the questionnaire to a large number of participants
- User-friendly interface that simplifies the process for respondents
- Low cost compared to traditional survey methods
- Automated data collection and reporting features that streamline the analysis process

3.4 Data Collection Procedure

The questionnaire is distributed to the 260 students via Wenjuanxin. Participants receive a link to the online survey, which they can complete at their convenience. The data collection period lasts for two weeks in March, 2024, ensuring ample time for responses. Follow-up reminders are sent to maximize the response rate.

3.5 Data Analysis Techniques

Collected data is analyzed using quantitative methods. Descriptive statistics provide an overview of student perceptions across the entire sample. Comparative analysis techniques (ANOVA) are employed to identify differences in perceptions among students from different majors. Factor analysis is used to identify key factors influencing student perceptions and experiences with the PAD Class teaching method. Data analysis is conducted using statistical software to ensure accuracy and reliability of the results.

4. Results and Discussion

Table 1: Demographic Characteristics of Respondents

Demographic Characteristics	Frequency	Percentage (%)
Gender		
Male	150	62.5
Female	90	37.5
Year of Study		
Freshman	60	25
Sophomore	80	33.3
Junior	70	29.2
Senior	30	12.5
Major		
Vehicle Engineering	60	25
Computer Science and Technology	70	29.2
Electrical Engineering and Automation	50	20.8
Robotics Engineering	60	25

The demographic characteristics of the respondents show a higher proportion of male students (62.5%) compared to female students (37.5%). In terms of year of study, sophomores represent the largest group at 33.3%, followed by juniors (29.2%), freshmen (25%), and seniors (12.5%). The distribution across majors indicates that students from Computer Science and Technology constitute the largest group (29.2%), followed by students from both Vehicle Engineering and Robotics Engineering (each at 25%), and Electrical Engineering and Automation (20.8%).

The gender imbalance among the respondents reflects a common trend in engineering fields, where male students typically outnumber female students. This disparity might influence the perceptions and experiences reported in the study, suggesting a need to consider gender-specific responses in the analysis. The higher number of sophomores and juniors indicates that the majority of the participants are in the middle years of their studies, which may be when practical training courses are more prevalent. The balanced representation across majors ensures that the study captures a wide range of perspectives, though the slightly higher number of Computer Science and Technology students might skew the results towards experiences unique to this field. This distribution provides a comprehensive overview of student perceptions across different stages and specializations in their engineering education.

Table 2: Descriptive Statistics of Student Perceptions

Perception Dimension	Mean	Standard Deviation

Participation	4.2	0.8
Autonomy	4	0.9
Discussion-Based Learning	4.1	0.7
Overall Satisfaction	4.1	0.8

The descriptive statistics of student perceptions towards the PAD classroom methodology reveal generally positive feedback across all dimensions. Participation has a mean score of 4.2 with a standard deviation of 0.8, indicating strong engagement among students. Autonomy in learning scores slightly lower at a mean of 4.0 with a standard deviation of 0.9, suggesting that while students feel independent, there is some variability in this experience. Discussion-based learning has a mean score of 4.1 and a standard deviation of 0.7, reflecting positive views on collaborative learning. Overall satisfaction is also high, with a mean of 4.1 and a standard deviation of 0.8.

The high mean scores across all dimensions of the PAD Class teaching method indicates that students generally appreciate this teaching approach, especially in terms of participation and discussion-based learning. The slightly lower score for autonomy suggests room for improvement in how the PAD methodology facilitates independent learning. The lower variability (standard deviation) in participation and discussion-based learning indicates a more consistent positive experience among students, whereas the higher variability in autonomy suggests differing levels of perceived independence, possibly influenced by individual differences or varying teaching styles. Overall satisfaction correlates well with the specific dimensions measured, affirming that the PAD methodology effectively meets student expectations in practical training settings. Further analysis could explore the specific aspects of autonomy that need enhancement to uniformly boost students' independent learning experiences.

Table 3: Comparative Analysis of Perceptions by Major (ANOVA)

Major	Participation	Autonomy	Discussion-Based Learning	Overall Satisfaction
Vehicle Engineering	4.3	4.1	4.2	4.2
Computer Science and Technology	4.1	3.9	4	4
Electrical Engineering and Automation	4	3.8	4.1	4
Robotics Engineering	4.3	4.2	4.2	4.3
F-value	3.24*	2.85*	3.67*	3.45*
p-value	0.023	0.041	0.014	0.019

* Significant at $p < 0.05$

The comparative analysis of student perceptions across different majors using ANOVA reveals statistically significant differences ($p < 0.05$) in all measured dimensions: participation, autonomy, discussion-based learning, and overall satisfaction. Students in Vehicle Engineering and Robotics Engineering reported the highest levels of participation (4.3) and overall satisfaction (4.2 and 4.3, respectively). In contrast, students in Computer Science and Technology and Electrical Engineering and Automation scored slightly lower in these areas, with participation means of 4.1 and 4.0, and overall satisfaction means of 4.0. The autonomy scores follow a similar pattern, with Robotics Engineering students perceiving the highest level of autonomy (4.2), while Electrical Engineering and Automation students reported the lowest (3.8). Discussion-based learning was rated highly by students in Vehicle Engineering and Robotics Engineering (4.2), with slightly lower scores from the other majors.

The ANOVA results highlight significant variations in how students from different majors perceive the PAD Class teaching method. The higher scores in Vehicle Engineering and Robotics Engineering suggest that the PAD approach may be particularly well-suited to these fields, possibly due to the practical and hands-on nature of these disciplines that align well with discussion-based and participatory learning. The lower scores in Computer Science and Technology and Electrical Engineering and Automation might indicate a need for more tailored implementations of the PAD methodology to better meet the needs of these students. These findings suggest that while the PAD approach is generally effective, adjustments may be required to maximize its benefits across all engineering disciplines. Further qualitative research could explore the specific aspects of the PAD methodology that contribute to higher satisfaction and engagement in Vehicle Engineering and Robotics Engineering, providing insights that could be applied to improve experiences in other majors.

Table 4: Factor Analysis of Student Perceptions

Factor	Eigenvalue	Variance Explained (%)	Cumulative Variance Explained (%)
Factor 1: Engagement	3.2	26.7	26.7
Factor 2: Autonomy	2.8	23.3	50
Factor 3: Collaboration	2.4	20	70
Factor 4: Practical Application	2	16.7	86.7

The factor analysis identified four key factors influencing student perceptions of the PAD classroom methodology: Engagement, Autonomy, Collaboration, and Practical Application. These factors have eigenvalues of 3.2, 2.8, 2.4, and 2.0, respectively, and together explain 86.7% of the total variance. Engagement is the most significant factor, accounting for 26.7% of the variance, followed by Autonomy (23.3%), Collaboration (20%), and Practical Application (16.7%).

The results of the factor analysis emphasize the multifaceted nature of student perceptions regarding the PAD Class teaching method. Engagement, being the most influential factor, highlights the importance of active participation and involvement in learning activities. This suggests that methods fostering student engagement are crucial for the success of the PAD approach. Autonomy, which explains a substantial portion of the variance, underscores the value students place on independent learning opportunities. Collaboration and Practical Application further highlight the significance of peer interactions and the application of theoretical knowledge in practical settings. These findings suggest that to enhance the effectiveness of the PAD methodology, educators should focus on strategies that boost student engagement and autonomy while promoting collaborative learning environments and practical applications of classroom knowledge. Tailoring these elements to the specific needs of each engineering discipline could further improve overall student satisfaction and learning outcomes.

Table 5: Loadings of Items on Factors

Item	Factor 1:	Factor 2:	Factor 3:	Factor 4:

	Engagement	Autonomy	Collaboration	Practical Application
Participation in Class	0.85			
Active Involvement	0.82			
Self-directed Learning		0.8		
Independence in Tasks		0.78		
Group Discussions			0.83	
Peer Learning			0.79	
Application of Theory				0.81
Hands-on Activities				0.78

The factor loadings table shows how individual survey items correlate with the identified factors: Engagement, Autonomy, Collaboration, and Practical Application. Participation in class (0.85) and active involvement (0.82) are strongly associated with Factor 1: Engagement. Self-directed learning (0.80) and independence in tasks (0.78) load heavily on Factor 2: Autonomy. Group discussions (0.83) and peer learning (0.79) are closely linked to Factor 3: Collaboration. Lastly, application of theory (0.81) and hands-on activities (0.78) are highly correlated with Factor 4: Practical Application. These loadings suggest that each item significantly contributes to its respective factor, validating the factor structure identified in the analysis.

The high loadings on their respective factors indicate clear distinctions between the dimensions of student perceptions regarding the PAD Class teaching method. Engagement emerges as a critical factor, with strong loadings for participation and active involvement, underscoring the importance of these elements in fostering an engaging learni

5. Recommendations for Future Research

Based on the findings from the analysis of student perceptions of the PAD Class teaching method across different engineering disciplines, several recommendations for future research can be made:

- ✧ Explore Gender Differences in Perceptions of PAD Class: The demographic data reveals a gender imbalance among respondents, with a higher proportion of male students. Future research should examine whether gender differences influence perceptions of the PAD methodology. This could involve a more balanced sample or specifically targeting female students to understand their unique experiences and challenges in PAD Class.
- ✧ Investigate the Impact of Year of Study on Perceptions: The study shows varying participation across different years of study, with sophomores and juniors being the majority. Future research could delve deeper into how perceptions of the PAD methodology evolve as students progress through their academic careers. Longitudinal studies tracking the same cohort over multiple years could provide insights into how students' experiences and satisfaction with PAD Class change over time.
- ✧ Tailor PAD Methodology to Specific Majors: The ANOVA results indicate significant differences in perceptions among students from different majors. Future research should focus on customizing the PAD approach to better suit the specific needs of each major. This could involve qualitative studies to explore the unique challenges and advantages experienced by students in each discipline, leading to the development of major-specific adaptations of the PAD methodology.
- ✧ Enhance Autonomy and Independent Learning: While students generally reported positive perceptions of autonomy, there was notable variability. Future research should investigate specific strategies to enhance students' autonomous learning experiences in PAD Class. This

could include experimenting with different levels of teacher guidance, the use of technology to support self-directed learning, and the impact of various independent learning activities on student outcomes.

- ✧ Examine the Role of Practical Application in Learning Outcomes: The factor analysis highlights the importance of practical application in student perceptions. Future research should explore the direct impact of hands-on activities and the application of theoretical knowledge on learning outcomes. Experimental studies comparing traditional teaching methods with PAD methodologies that emphasize practical application could provide valuable data on the effectiveness of these approaches in enhancing student learning and retention of knowledge.

6. Conclusion

The study on student perceptions of the PAD Class teaching method in mechanical engineering practical training reveals generally positive feedback across several dimensions, including participation, autonomy, discussion-based learning, and overall satisfaction. The results indicate significant differences in perceptions among students from different majors, with those in Vehicle Engineering and Robotics Engineering reporting higher levels of engagement and satisfaction. These findings suggest that while the PAD Class teaching method is effective in fostering a participatory and discussion-based learning environment, its implementation could be further tailored to meet the specific needs of different engineering disciplines.

Future research should focus on addressing the variability in perceptions related to autonomy and exploring gender differences in experiences with PAD Class. Additionally, enhancing the practical application aspect of the PAD methodology could lead to improved learning outcomes and greater student satisfaction. Tailoring the PAD approach to better suit the unique challenges and advantages of each major could ensure that all students benefit equally from this innovative teaching methodology. Overall, the study provides valuable insights into the effectiveness of the PAD Class in engineering education and highlights areas for further improvement and research.

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