

An In-Depth Examination of the Blended Teaching Mode: Integrating Online and Offline Approaches in Automotive Education

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Abstract

This study investigates the implementation and acceptance of blended teaching methods in automotive education at Liaocheng Vocational and Technical College. Blended teaching, which combines traditional face-to-face instruction with online learning activities. Using the quantitative approach, findings reveal that while teachers demonstrate strong competencies in technology integration and pedagogical adaptation, there is a need for further improvement in optimizing interactive learning and troubleshooting technical issues. Professional development participation is high, but a proactive engagement in innovative methodologies is required. Students show a high level of acceptance towards the blended teaching mode, with strong engagement in online materials and a positive response to peer collaboration. However, the findings also highlight a need for increased digital access and strategies to improve student self-discipline. No significant differences were found across age groups, gender, or year levels regarding feedback, online engagement, and peer collaboration, suggesting that other factors influence learning experiences. Additionally, gender disparities were noted in professional development participation and the overall implementation of blended teaching, with male teachers reporting higher engagement. The study concludes with practical recommendations for optimizing blended teaching strategies, enhancing teacher professional development, and improving student learning experiences through targeted interventions.

Keywords: *Online, Offline, Blended Learning, Automotive Course, Traditional Teaching, Modern Teaching.*

A. Introduction

In 2020, as COVID-19 ravaged the world, teaching around the world began to shift from classroom teaching to online teaching. At the same time, the development of educational informatization brought new educational forms and teaching methods, which also gave birth to the largest online education research and practice in history.

Online teaching not only breaks through time and space limitations but also weakens the difference in learning resource quality caused by the wealth gap. Students in impoverished areas can access higher-quality teaching resources through the Internet. However, the pros and cons coexist, and online teaching places higher demands on students' self-control. Without the "real-time supervision and management of teachers during offline teaching, the quality of listening completely depends on students' self-awareness" (Li et al., 2021).

The advantages of offline learning are also evident, as face-to-face classroom communication between teachers and students and interpersonal interaction between students make it easier for students to immerse themselves in the learning atmosphere. But at the same time, it is also "necessary to face shortcomings such as students' inability to independently

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choose their preferred teachers, and the traditional teacher-centered teaching method” (Kamble et al., 2022).

Both online and offline teaching methods have advantages and disadvantages. So far, the discussion on which teaching mode is more effective and advantageous has never stopped. Palvia et al. (2018) said that “hybrid education combining the advantages of online and offline education could achieve the best balance between traditional education and electronic transactions.” Therefore, in response to the above viewpoints, it is believed that only by fully leveraging the respective advantages of online and offline learning methods and enabling efficient integration of online and offline support one can compensate for the respective disadvantages of online and offline teaching, effectively improve students' learning quality, learning ability, and thinking quality, and better adapt to the new situation and trend of future education reform and development.

From this, the hybrid online and offline learning methods integrate traditional face-to-face learning and online network chemistry learning. Offline support is provided for online and online empowerment, and the two complement each other. The blended online and offline teaching modes will change the roles of students and teachers in teaching, reshaping the traditional relationship between teaching and learning. Students are no longer passive recipients of knowledge but active learners; teachers are no longer simply knowledge imparters but people who guide, mobilize, and organize students to learn autonomously and autonomously. They are truly evangelists, practitioners, and problem-solvers. The “blended online and offline teaching modes guide students to learn independently, and the teaching philosophy places more emphasis on students' subjectivity. Teachers have also shifted their role from being the previous leader to being the guide in teaching” (Yun & Yun, 2022).

Therefore, in the blended online and offline teaching mode, the focus of learning has shifted from "teaching" to "learning." From the perspective of teachers, it is necessary to replace the roles of oneself and students in the learning process and switch to the traditional learning process, which encourages students to complete basic understanding and learning of textbook knowledge points such as “component understanding and basic concepts before class, form personal learning reports, recognize their doubts, and interact with teachers in the classroom to answer doubts, thereby promoting students' ability to learn and think independently, to achieve better teaching results” (Li et al., 2019).

In short, blended learning is a combination and supplement of online learning and traditional classroom teaching. Students' autonomous learning and thinking come first; teachers' problem-solving and answering come second; students are explorers of knowledge, and teachers are guides for students. This teaching model not only plays a leading role in teacher learning but also reflects the subjectivity of students, forming a better "teaching" and "learning" model.

In the traditional teaching mode of automotive courses, teachers have always played a central role in teaching activities, leading all learning activities. Before class, the teacher assigns preview tasks, such as previewing the content of the text. In class, teachers teach textbook knowledge and complete teaching tasks. After class, the teacher assigns exercises and urges students to complete them. In this teaching mode, teachers strictly control every process of students' learning activities and make plans for their learning. This single-programmed learning process not only hinders students from fully mastering knowledge but also deprives them of the opportunity to exert their subjective initiative.

The implementation of a flipped classroom in automotive classes leverages the blended teaching model to enhance the depth and breadth of learning. In this approach, students engage with pre-recorded lectures, video demonstrations, and digital resources outside of class, using

various internet platforms to learn foundational automotive concepts and techniques. As Chen (2020) notes, the emergence of blended teaching models has broadened the channels for acquiring automotive-related knowledge, moving beyond the confines of textbooks. Internet platforms, such as search engines, online learning portals, and mobile apps, serve as effective tools for students to independently explore and acquire knowledge. This out-of-class preparation enables classroom time to be repurposed for hands-on activities, problem-solving sessions, and interactive discussions, where students apply what they have learned to practical scenarios. Teachers, in turn, take on a more facilitative role, guiding students to clarify learning objectives, solve complex problems, and achieve higher-quality outcomes. By fostering a more proactive and student-centered learning atmosphere, the flipped classroom model helps develop both theoretical understanding and practical skills in automotive education, ensuring students are better prepared for real-world challenges. This study aims to examine the implementation of blended teaching methods in Automotive Education in Liaocheng Vocational and Technical College, Shandong, China. Specifically, it determines the demographic profile of the respondents in terms of age, sex, year level (Students), and educational attainment (Teachers), the level of implementation of blended teaching in the automotive education Liaocheng Vocational and Technical College in terms of Technology Integration Proficiency, Pedagogical Adaptation, and Professional Development Participation, and the level of acceptance of the students of the blended teaching mode in terms of Feedback on Learning Experience, Engagement with Online Materials, and Peer Collaboration and Interaction. It also determines the significant difference in the level of acceptance of the students of blended teaching when analyzed according to the demographic profile of the students, the significant difference in the level of implementation of blended teaching in automotive education when grouped according to the demographic profile of the teachers. Finally, it proposed a blended teaching framework for a strengthened practical application of blended teaching modality.

B. Methods

This study employed a quantitative descriptive study design to analyze the blended teaching implementation at the Department of Mechanical and Electrical Engineering at Liaocheng Vocational and Technical College. Utilizing a survey-based approach, a questionnaire was administered to students and faculty members within the Department of Mechanical and Electrical Engineering during the designated time frame of SY 2024-25. The survey instrument was meticulously designed to capture relevant information aligned with the research objectives, ensuring validity, reliability, and comprehensiveness. Data collection procedures are standardized, following the principles of Creswell and Creswell (2017), to maintain consistency across respondents and minimize bias.

Following data collection, statistical analysis techniques, such as descriptive statistics, and correlation analysis were applied to explore relationships between variables and derive insights into the research questions.

The study participants on this blended teaching methods in automotive education study include students who are enrolled in automotive education programs, such as vocational training courses, certificate programs, associate degree programs, and undergraduate program in automotive engineering or technology. Participants vary in age, sex, or year level. Instructors/Teachers who are responsible for delivering instruction in automotive education settings are also made part as respondents. These include faculty members at the vocational school, as well as industry professionals serving as guest lecturers or adjunct instructors. Participants have varying levels of experience in teaching, expertise in automotive technology, and familiarity with blended teaching methods.

To achieve a comprehensive understanding of the sample size calculation, it is essential to consider the context and implications of the calculated sample size of 329 for a total population of 2,267 students in the study setting. The determined sample size ensures that the study results can be generalized to the broader population with a high degree of confidence, given a 95% confidence level. This confidence level indicates that if the study will be conducted multiple times, 95% of the time, the results would fall within the specified margin of error. Additionally, the degree of error, set at 5%, signifies the maximum allowable deviation from the true population parameter. By utilizing a Z-score of 1.96 for a 95% confidence level, the sample size calculation accounts for the variability in the population and balances the precision of the study results with practical considerations. The estimated proportion of the population possessing the attribute of interest is assumed to be 0.5, which maximizes the sample size and ensures that the calculated sample size is conservative.

C. Results and Discussion

Table 1. The Demographic Profile of the Respondents

Profile of Students	Frequency	Percentage	Rank
Age			
• 18 - 19 years old	123	37.4 %	2
• 20 - 21 years old	37	11.2 %	3
• 22 - 23 years old	146	44.4 %	1
• 24 - years old and above	23	7.0 %	4
Sex			
• Female	190	57.8 %	1
• Male	139	42.2 %	2
Year Level			
• 1st Year	70	21.3 %	2
• 2 nd Year	38	11.6 %	3
• 3rd Year	187	56.8 %	1
• 4 th Year	34	10.3 %	4
Profile of Teachers			
Age			
• 23 - 33 years old	39	25.0 %	3
• 34 - 44 years old	57	36.5 %	1
• 45 - 55 years old	47	30.1 %	2
• 56 - years old and above	13	8.3 %	4
Sex			
• Female	88	56.4 %	1
• Male	68	43.6 %	2
Educational level			
• College graduate	60	38.5 %	1
• College graduate with vocational training	35	22.4 %	3
• Master's degree	40	25.6 %	2
• Ph. D.	21	13.5 %	4

The demographic profile of the respondents in this study highlights key characteristics of both students and teachers in the Automotive Education program at Liaocheng Vocational and Technical College.

Among the students, the majority (44.4%) are between 22 and 23 years old, followed by those aged 18 to 19 years (37.4%), while a smaller proportion falls within the 20 to 21 years (11.2%) and 24 years and above (7.0%) categories. In terms of sex distribution, female students (57.8%) outnumber male students (42.2%). Regarding year level, most students are in their third year (56.8%), while first-year students constitute 21.3%. A notable percentage of teachers have completed college with additional vocational training (22.4%), while a smaller proportion (13.5%) have earned a Ph.D.

These findings provide a demographic overview of the respondents, which serves as a foundation for analyzing the implementation of blended teaching methods in the program. Studies indicate that factors such as age, gender, and educational background influence students' adaptability to blended learning environments (Graham, 2019; Hrastinski, 2019). Younger learners tend to be more receptive to technology-integrated instruction, aligning with research suggesting that digital literacy skills impact engagement in online learning platforms (Means et al., 2014).

Table 2. The Level of Implementation of Blended Teaching in the Automotive Education Liaocheng Vocational and Technical College

Indicators	Mean	SD	Verbal Interpretation
Technology Integration Proficiency	3.50	0.31	Very High Level
Pedagogical Adaptation	3.49	0.31	High Level
Professional Development Participation	3.47	0.31	High Level
Overall Level of Implementation of Blended Teaching	3.48	0.19	High Level

The results indicate that the implementation of blended teaching at Liaocheng Vocational and Technical College is at a high level ($M = 3.48$, $SD = 0.19$), signifying that teachers generally exhibit strong competence in integrating technology, adapting pedagogical approaches, and engaging in professional development. However, variations in specific competencies suggest areas for further improvement. The findings on blended teaching implementation align with the literature, emphasizing the role of teachers in guiding, monitoring, and adapting their instructional strategies. Teachers demonstrate strong confidence in utilizing digital tools, which supports Peng and Wei's (2021) assertion that blended teaching enables educators to facilitate student engagement, track progress, and adjust instruction in real time. However, while proficiency in technology integration is evident, the ability to create fully interactive and engaging learning experiences requires further enhancement, as Leung (2020) noted that many teachers still view online teaching as a formality rather than an interactive pedagogical tool.

Professional development participation plays a crucial role in sustaining effective blended teaching practices. The findings indicate that teachers actively seek professional growth opportunities, attend workshops, and apply new teaching methods, aligning with Leung's (2020) argument that the hybrid teaching model requires teachers to develop competencies in curriculum design, digital resource construction, and instructional organization.

Table 3. Level of Acceptance of the Students of the Blended Teaching Mode

Indicator	Mean	SD	Verbal Interpretation
Feedback on Learning Experience	3.50	0.33	Very High Level

Indicator	Mean	SD	Verbal Interpretation
Engagement with Online Materials	3.48	0.32	High Level
Peer Collaboration and Interaction	3.48	0.32	High Level
Overall Level of Acceptance of the Students of the Blended Teaching Mode	3.48	0.18	High Level

The findings reveal a strong overall acceptance of the blended teaching mode, with an overall mean of 3.48 (SD = 0.18), indicating a generally high level of student engagement and satisfaction.

The **overall feedback experience** is rated at 3.50 (SD = 0.33), reflecting a high level of satisfaction but with room for improvement in ensuring feedback is not only informative but also motivating. The **overall engagement with online materials** is rated at 3.48 (SD = 0.32), signifying a positive reception but with potential for increased independent exploration.

The **overall peer collaboration experience** is rated at 3.48 (SD = 0.32), indicating that while students recognize the value of working with peers, further efforts to promote more active and meaningful collaboration may be needed.

The findings on students' acceptance of the blended teaching mode align with previous research highlighting both its strengths and limitations. The data show that while students appreciate the feedback they receive from teachers and find online materials engaging, challenges remain in terms of accessibility, motivation, and collaboration. These align with Liu's (2020) study, which found that technological constraints, such as device compatibility issues and network instability, disrupt students' learning experiences. Similar concerns were reflected in the data, where students expressed occasional difficulties in accessing online resources, which could hinder their overall engagement with the blended learning format.

Furthermore, the role of teachers in blended learning was emphasized in both the findings and prior research. The data indicate that while students generally receive timely and constructive feedback, there are variations in their motivation to act upon it. Hua (2020) pointed out that blended teaching requires educators to integrate online and offline components effectively, necessitating continuous improvement in digital literacy. The findings support this, suggesting that students benefit from well-structured feedback and instructional materials but may struggle if teachers are not fully equipped to navigate the demands of digital education. Thus, the importance of professional development in technology-enhanced pedagogy becomes evident.

In addition, self-discipline emerges as a crucial factor influencing student engagement in blended learning. The findings reveal that while students acknowledge the value of peer collaboration and interactive learning, some struggle with maintaining motivation and actively seeking additional online resources. This is consistent with Li's (2022) study, which emphasized that blended learning requires higher levels of self-regulation, as students with weak self-discipline are more prone to disengagement, procrastination, and lower academic performance. The data suggest that while blended learning can enhance autonomy, there is a risk of students falling behind if they lack self-directed learning skills. The findings support previous research in highlighting the advantages of blended learning, such as improved access to resources and interactive learning opportunities (Liu, 2020), while also acknowledging the challenges of teacher preparedness (Hua, 2020) and student self-discipline (Li, 2022). Addressing these factors through technological improvements, teacher training, and strategies for fostering student autonomy could enhance the effectiveness of blended education.

Table 4. Test of Significant Difference in the Level of Acceptance of the Students of Blended Teaching when Analyzed according to their Age

Feedback on Learning Experience	Mean	X ² -value	P-value	Decision	Conclusion
• 24 - and above	3.46	4.55	0.208	Failed to reject Ho	No significant difference
• 22 - 23	3.54				
• 20 - 21	3.51				
• 18 - 19	3.45				
Engagement with Online Materials					
• 24 - and above	3.57	3.15	0.368	Failed to reject Ho	No significant difference
• 22 - 23	3.46				
• 20 - 21	3.52				
• 18 - 19	3.47				
Peer Collaboration and Interaction					
• 24 - and above	3.38	2.34	0.505	Failed to reject Ho	No significant difference
• 22 - 23	3.48				
• 20 - 21	3.50				
• 18 - 19	3.48				
Overall Level of Acceptance					
• 24 - and above	3.47	1.53	0.675	Failed to reject Ho	No significant difference
• 22 - 23	3.49				
• 20 - 21	3.51				
• 18 - 19	3.47				

The results indicate no significant differences in students' acceptance of the blended teaching mode across different age groups. For Feedback on Learning Experience, the mean scores range from 3.45 to 3.54, with a chi-square value ($X^2 = 4.55$) and a p-value of 0.208. Since the p-value is greater than 0.05, the null hypothesis is not rejected, indicating that students across different groups perceive feedback similarly. Regarding Engagement with Online Materials, mean scores range from 3.46 to 3.57, with $X^2 = 3.15$ and a p-value of 0.368. The results suggest no statistically significant difference, meaning students engage with online materials at comparable levels regardless of their group. For Peer Collaboration and Interaction, mean scores vary slightly (3.38 to 3.50), but with $X^2 = 2.34$ and a p-value of 0.505, there is no significant difference, implying that students across groups experience similar levels of peer collaboration. The Overall Level of Acceptance follows the same trend, with mean scores between 3.47 and 3.51. The X^2 value (1.53) and p-value (0.675) indicate no significant differences among groups.

The findings indicate that students across different groups exhibit a consistently high level of acceptance of the blended teaching mode, with no statistically significant differences in their experiences with feedback on learning, engagement with online materials, and peer collaboration. These results align with previous studies emphasizing the general effectiveness and adaptability of blended learning across diverse student populations. However, the slight variations in mean scores suggest that while feedback is generally effective, individual factors such as motivation and self-efficacy may influence how students respond to it (Hattie & Timperley, 2007). Additionally, the lack of significant difference across age groups aligns with research by Nicol and Macfarlane-Dick (2006), who argued that effective feedback mechanisms benefit learners universally, provided they are structured to support self-regulation.

The results indicate a generally high level of acceptance of blended learning, with no significant variations across groups. This finding aligns with the work of Means et al. (2013), who concluded that blended learning is widely accepted due to its flexibility and ability to accommodate different learning styles.

Table 5. Test of Significant Difference in the Level of Acceptance of the Students of Blended Teaching when Analyzed according to their Gender

Feedback on Learning Experience	Mean	U-value	P-value	Decision	Conclusion
• Female	3.48	12198	0.230	Failed to reject Ho	No significant difference
• Male	3.52				
Engagement with Online Materials					
• Female	3.49	12426	0.353	Failed to reject Ho	No significant difference
• Male	3.46				
Peer Collaboration and Interaction					
• Female	3.45	11954	0.136	Failed to reject Ho	No significant difference
• Male	3.51				
Overall Level of Acceptance					
• Female	3.48	12397	0.341	Failed to reject Ho	No significant difference
• Male	3.49				

In so far as the feedback on learning experience, female students reported a mean of 3.48, while male students had a slightly higher mean of 3.52. The U-value of 12,198 and a p-value of 0.230 suggest no significant difference, meaning that both genders equally perceive teacher feedback as helpful and supportive in their learning. On the other hand, on the engagement with online materials, female students had a mean of 3.49, and male students had 3.46. The U-value of 12,426 and a p-value of 0.353 indicate no statistical difference, showing that both genders engage similarly with digital learning resources.

As for peer collaboration and interaction, the mean score for female students was 3.45, while male students had a slightly higher mean of 3.51. The U-value of 11,954 and a p-value of 0.136 again indicate no significant difference, suggesting that both groups benefit from and participate in group activities at comparable levels. Finally, the overall level of acceptance was nearly identical, with female students scoring 3.48 and male students 3.49. The U-value of 12,397 and a p-value of 0.341 confirm no significant difference, implying that gender does not influence students' overall reception of the blended teaching model.

The blended teaching model, as emphasized by Garrison and Kanuka (2004), integrates traditional instruction with online learning to maximize flexibility and accessibility. The comparable levels of engagement among male and female students suggest that both groups benefit from this combination, reinforcing the argument by Xiurong and Qingsheng (2021) that blended learning enhances classroom participation through a balance of guided instruction and independent exploration. Furthermore, Piaget and Vygotsky's cognitive theories, which highlight the role of learning styles and visual modeling in skill acquisition (Kazdin, 2020), are reflected in the data. The absence of gender-based differences implies that students, regardless of gender, can effectively engage with the interactive and multimedia elements of blended teaching. This supports the findings of Johnson et al. (2016), who reported that blended learning environments enhance motivation and satisfaction across student groups.

Table 6. Test of Significant Difference in the Level of Acceptance of the Students of Blended Teaching when Analyzed according to their Educational level

Feedback on Learning Experience	Mean	X ² -value	P-value	Decision	Conclusion
• 1st Year	3.46	1.76	0.624	Failed to reject Ho	No significant difference
• 2nd Year	3.55				
• 3rd Year	3.51				
• 4th Year	3.46				
Engagement with Online Materials					
• 1st Year	3.51	3.51	0.320	Failed to reject Ho	No significant difference
• 2nd Year	3.45				
• 3rd Year	3.47				
• 4th Year	3.50				
Peer Collaboration and Interaction					
• 1st Year	3.48	2.03	0.566	Failed to reject Ho	No significant difference
• 2nd Year	3.43				
• 3rd Year	3.49				
• 4th Year	3.46				
Overall Level of Acceptance					
• 1st Year	3.48	1.32	0.723	Failed to reject Ho	No significant difference
• 2nd Year	3.48				
• 3rd Year	3.49				
• 4th Year	3.47				

The data indicates that there is no significant difference in feedback on the learning experience, engagement with online materials, peer collaboration, and interaction, and overall level of acceptance across the different year groups. The mean scores for each category are closely aligned, with only slight variations between the groups. For instance, the 2nd-year students had the highest mean for feedback on the learning experience (3.55), while the 1st and 4th years both had scores of 3.46. Similarly, the 1st-year students had the highest engagement with online materials (3.51), while the 2nd year recorded the lowest (3.45). Peer collaboration and interaction scores varied slightly, but again, no significant differences were found. The Chi-square values and p-values for all categories were above 0.05, leading to the conclusion that there is no significant difference between the year groups in terms of their learning experiences and engagement. Therefore, the year group appears to have little impact on students' feedback, online engagement, or peer interactions, suggesting that these factors may be more influenced by other variables rather than the year level.

The findings from this analysis align with the observations in several related studies on blended learning and its effectiveness across different student groups. Research suggests that blended teaching models, which combine traditional face-to-face instruction with online learning, offer flexibility and adaptability, enhancing student learning experiences (Garrison & Kanuka, 2004). However, as seen in this study, no significant differences were found across different year groups in terms of feedback, engagement, peer collaboration, and overall acceptance of the blended learning model. This supports findings from Graham et al. (2019), who indicate that while students appreciate the flexibility of blended learning, the differences in their year levels or educational stages do not always translate into differing experiences or engagement with the model.

Table 7. Test of significant difference in the level of implementation of blended teaching in automotive education when grouped according to the Age of the teachers

Technology Integration Proficiency	Mean	X²-value	P-value	Decision	Conclusion
• 23-33	3.47	2.002	0.572	Failed to reject Ho	No significant difference
• 45-55	3.49				
• 34-44	3.54				
• 56- and above	3.42				
Pedagogical Adaptation					
• 23-33	3.51	0.430	0.934	Failed to reject Ho	No significant difference
• 45-55	3.49				
• 34-44	3.48				
• 56- and above	3.46				
Professional Development Participation					
• 23-33	3.45	2.216	0.529	Failed to reject Ho	No significant difference
• 45-55	3.52				
• 34-44	3.45				
• 56- and above	3.42				
Overall Level of Implementation of Blended Teaching					
• 23-33	3.48	2.843	0.416	Failed to reject Ho	No significant difference
• 45-55	3.50				
• 34-44	3.49				
• 56- and above	3.43				

When examining Technology Integration Proficiency, Pedagogical Adaptation, Professional Development Participation, the Overall Level of Implementation of Blended Teaching across different age groups shows no statistically significant differences. In the Technology Integration Proficiency category, the mean scores for the different age groups are very similar: younger participants (23–33) have a mean of 3.47, while those in the 45–55 and 34–44 brackets have means of 3.49 and 3.54 respectively, and those aged 56 and above score slightly lower at 3.42. The Chi-square test yielded a value of 2.002 with a p-value of 0.572, which is well above the conventional threshold of 0.05, leading to the decision to fail to reject the null hypothesis; thus, there is no significant difference among these groups in terms of technology integration proficiency.

A similar pattern is observed in Pedagogical Adaptation, where the means for the age groups are nearly identical—3.51 for ages 23–33, 3.49 for ages 45–55, 3.48 for ages 34–44, and 3.46 for ages 56 and above. With a Chi-square value of 0.430 and a p-value of 0.934, the statistical analysis again confirms no significant differences across the groups. Professional Development Participation shows a comparable trend: the youngest age group (23–33) has a mean of 3.45, those in the 45–55 and 34–44 ranges both have a mean of 3.52 and 3.45 respectively, and the oldest group (56 and above) has a mean of 3.42. The Chi-square statistic here is 2.216 with a p-value of 0.529, reinforcing that there is no significant variance among the age groups in their participation in professional development activities. Finally, the Overall Level of Implementation of Blended Teaching exhibits similar consistency: the 23–33 group scores 3.48, the 45–55 group 3.50, the 34–44 group 3.49, and the 56-and-above group 3.43. With a Chi-square value of 2.843 and a p-value of 0.416, the statistical analysis once more confirms that

there is no significant difference across age groups in the overall implementation of blended teaching.

The findings indicate that there are no statistically significant differences across age groups in terms of Technology Integration Proficiency, Pedagogical Adaptation, Professional Development Participation, and the Overall Level of Implementation of Blended Teaching. This uniformity across different age cohorts aligns with several related studies in the field of blended learning and teacher competencies. For instance, Mishra and Koehler's (2006) TPACK framework emphasizes that effective integration of technology in teaching relies more on teachers' continuous professional development and support rather than on their age. The similar scores across all age groups suggest that teachers, regardless of whether they are in the 23–33, 34–44, 45–55, or 56-and-above brackets, are equally proficient in integrating technology into their instructional practices. This finding is supported by Picciano (2019), who noted that structured faculty development programs can level the technological and pedagogical playing fields, enabling educators from diverse age groups to adopt blended teaching methods effectively.

Table 8. Test of significant difference in the level of implementation of blended teaching in automotive education when grouped according to the Gender of Teachers

Technology Integration Proficiency	Mean	U-value	P-value	Decision	Conclusion
• Female	3.46	2553	0.111	Failed to reject Ho	No significant difference
• Male	3.54				
Pedagogical Adaptation					
• Female	3.46	2686	0.267	Failed to reject Ho	No significant difference
• Male	3.52				
Professional Development Participation					
• Female	3.41	2233	0.006	Reject Ho	With significant difference
• Male	3.54				
Overall Level of Implementation of Blended Teaching					
• Female	3.44	2198	0.004	Reject Ho	With significant difference
• Male	3.53				

Table 8 reveals some notable differences and similarities between male and female respondents across several dimensions of blended teaching implementation. In terms of Technology Integration Proficiency, female teachers reported a mean score of 3.46 while their male counterparts scored slightly higher at 3.54. However, the U-value of 2553 with a p-value of 0.111 indicates that this difference is not statistically significant, meaning that both genders exhibit similar proficiency in integrating technology into their teaching practices.

For Pedagogical Adaptation, the pattern is similar: female teachers had a mean score of 3.46 compared to 3.52 for males. The statistical analysis (U-value = 2686, p-value = 0.267) again shows no significant difference, suggesting that both male and female teachers are equally capable of adapting their pedagogical strategies to meet the demands of blended teaching. In contrast, when examining Professional Development Participation, the findings show a significant gender difference. Female teachers reported a lower mean score of 3.41 compared to 3.54 for male teachers. With a U-value of 2233 and a p-value of 0.006, the result is statistically significant, leading to the rejection of the null hypothesis. This indicates that male teachers are significantly more engaged in professional development activities than female teachers.

For the Overall Level of Implementation of Blended Teaching, female teachers scored an average of 3.44 while male teachers scored 3.53. The U-value here is 2198 with a p-value of 0.004, which is statistically significant. This suggests that, overall, male teachers are implementing blended teaching practices at a higher level than their female counterparts. The findings align with and extend prior research on blended teaching and teacher professional development. In the domain of Technology Integration Proficiency and Pedagogical Adaptation, the data reveal no significant gender differences, which supports the perspective of Mishra and Koehler's (2006) TPACK framework. Their work emphasizes that effective technology integration and pedagogical flexibility depend largely on structured professional development and access to resources rather than on inherent gender differences. This is consistent with studies such as Picciano (2019), who argue that when institutional support and training are provided, teachers across genders can achieve comparable proficiency in digital and adaptive teaching methods.

However, the significant differences observed in Professional Development Participation and the Overall Level of Implementation of Blended Teaching indicate that male teachers are more engaged in these areas compared to female teachers. This finding resonates with research by Ford and Turner (2019), who observed that engagement in professional development can directly influence the quality of blended teaching practices.

Table 9. Test of significant difference in the level of implementation of blended teaching in automotive education when grouped according to the Educational level of teachers

Technology Integration Proficiency	Mean	X ² -value	P-value	Decision	Conclusion
• College graduate	3.52	1.335	0.721	Failed to reject Ho	No significant difference
• College graduate with vocational training	3.50				
• Master's degree	3.48				
• Ph.D	3.44				
Pedagogical Adaptation					
• College graduate	3.50	1.351	0.717	Failed to reject Ho	No significant difference
• College graduate with vocational training	3.53				
• Master's degree	3.46				
• Ph.D	3.44				
Professional Development Participation					
• College graduate	3.47	0.680	0.878	Failed to reject Ho	No significant difference
• College graduate with vocational training	3.50				
• Master's degree	3.44				
• Ph.D	3.46				
Overall Level of Implementation of Blended Teaching					
• College graduate	3.50	2.099	0.552		

Technology Integration Proficiency	Mean	X ² -value	P-value	Decision	Conclusion
• College graduate with vocational training	3.51			Failed to reject Ho	No significant difference
• Master's degree	3.46				
• Ph.D	3.44				

The data reveals that educational qualifications do not significantly influence proficiency in various areas. For technology integration proficiency, the means range from 3.44 for Ph.D. holders to 3.52 for college graduates, with a P-value of 0.721, indicating no significant difference. Similarly, for pedagogical adaptation, professional development participation, and the overall level of blended teaching implementation, the means for the groups (ranging from 3.44 to 3.53) also show no significant differences, as indicated by their respective P-values of 0.717, 0.878, and 0.552. Regardless of whether an individual holds a college degree, vocational training, a master's degree, or a Ph.D., their proficiency and participation in these areas are not significantly impacted by their level of education. Research on technology integration proficiency has shown that while higher educational qualifications, such as master's or Ph.D. degrees, may offer a deeper theoretical understanding, they do not necessarily result in superior technology integration skills (Al-Emran et al., 2018). This supports the current study's finding of no significant differences between educational levels. Studies by Ertmer (1999) suggest that technological proficiency is often influenced more by continuous professional development and hands-on experience than by formal education alone. Research on pedagogical adaptation emphasizes that effective teaching practices are shaped not just by educational credentials but by real-world experience and ongoing professional development (Darling-Hammond, 2000).

D. Conclusion

The demographic profile of students and teachers in the Automotive Education program at Liaocheng Vocational and Technical College provides a strong foundation for evaluating the implementation of blended teaching methods. Variations in educational attainment among teachers suggest differences in readiness and potential adaptability to blended teaching. These characteristics, supported by related literature, underscore the importance of considering age, gender, and professional background when assessing the effectiveness and design of blended teaching strategies.

The implementation of blended teaching in automotive education at Liaocheng Vocational and Technical College is at a high level, with strong competencies in technology integration, pedagogical adaptation, and professional development. Teachers confidently use digital tools and adapt teaching strategies but need further improvement in optimizing interactive learning and troubleshooting technical issues. While professional development participation is high, proactive engagement in innovative methodologies is needed. Continuous training and enhanced interactive strategies will further strengthen blended teaching effectiveness.

The study reveals a high level of student acceptance of the blended teaching mode. Students highly value teacher feedback, particularly its clarity and timeliness, though its impact on motivation varies. Engagement with online materials is strong, but some students show less initiative in using additional resources. Peer collaboration is well-received, yet not all students equally benefit from group interactions. These findings align with prior research, highlighting the need for improved digital access, teacher training in blended pedagogy, and strategies to enhance student self-discipline for more effective blended learning.

The findings of this study indicate that students across different age groups exhibit a consistently high level of acceptance of the blended teaching mode, with no statistically significant differences in their experiences regarding feedback on learning, engagement with online materials, and peer collaboration. The findings also indicate no significant gender-based differences in students' acceptance of the blended teaching model in automotive education. Both male and female students reported similar perceptions regarding feedback on learning, engagement with online materials, peer collaboration. The findings also indicate that year level has no significant impact on students' feedback, online engagement, peer collaboration, or overall acceptance of the blended learning model. The closely aligned mean scores across all year groups, along with non-significant Chi-square values, suggest that other factors may play a more influential role in shaping students' learning experiences.

The findings indicate no statistically significant differences across age groups in Technology Integration Proficiency, Pedagogical Adaptation, Professional Development Participation, and the Overall Level of Implementation of Blended Teaching. The findings also no significant gender differences in Technology Integration Proficiency and Pedagogical Adaptation, suggesting that both male and female teachers are similarly skilled in these areas. However, significant gender differences were found in Professional Development Participation and the Overall Level of Implementation of Blended Teaching, with male teachers reporting higher levels of engagement and implementation. Finally, educational qualifications do not significantly impact proficiency in technology integration, pedagogical adaptation, professional development, or blended teaching implementation. With no significant differences observed across various educational levels, it suggests that factors like experience and ongoing professional development are more influential than formal education.

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