

The Implementation of Blended Learning in the Field of Electrical and Electronic Engineering in a Vocational School

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ABSTRACT

This study aims to investigate the effectiveness of using blended learning in the field of electrical and electronic technology in vocational schools. The primary focus of education is to increase the effectiveness of using a flexible learning environment for instruction and practice in the fields of electrical and electronic technology. Periodically, teachers provide guidance on problems as well as lessons that are classroom and teacher-student oriented, which remain relatively consistent during the teaching and learning process. The research design employs quantitative methods through selected topics. The respondents consisted of 68 students from Vocational Colleges in the Johor area. Findings revealed the effects of blended learning based on knowledge, skills, and attitudes. The study underscores the potential long-term consequences of using blended learning. Recommendations include encouraging students to incorporate blended learning into their learning process. The implications and recommendations are discussed to address the effect on knowledge, skills, and attitudes using blended learning.

Keywords: Blended learning, electric and electronic students, Vocational College

INTRODUCTION

Education in Malaysia places significant emphasis on the Technical and Vocational Education and Training (TVET) sector. The inclusion of technical and vocational fields within the “Global Level Online Learning” initiative, as stated in the Malaysia Education Development Plan 2015–2025, under the key shift of Student Talent Drive, reflects the country’s commitment to advancing digital learning. Students today are expected to master critical thinking and communication skills as essential competencies for learning in the modern era.

Zulkifli et al. (2020) highlighted that technological applications within the educational ecosystem enable the integration of teaching and learning processes through digital platforms, supporting creativity and innovation among students. Similarly, Ahmad, Syed Mohd, and Mohammad (2012) observed that vocational training programs have evolved over time, involving continuous improvements in both curriculum content and teaching strategies.

The shift towards blended learning is becoming more prominent among educators and students. Teaching and learning are no longer limited to blackboards and chalk; instead, computers, the internet, and digital resources are now integral parts of the process. Rusdiana et al. (2020) emphasized that the rapid development in education has allowed teaching and learning activities (PdPc) to continue through online and distance-based modes.

According to Mohd Fairuz Jafar (2021), e-learning has transformed the conventional education system into virtual modes in both methodology and content. The learning culture has progressed in tandem with global technological change—from textbook-based learning to computer-assisted instruction, followed by internet-based learning and the introduction of simulators that allow students to visualize real-world scenarios. In Malaysia, blended learning now represents a new phase of educational transformation.

Azizan (2010) described blended learning as a hybrid approach that combines face-to-face sessions with online instruction, creating an effective balance that utilizes various delivery methods, teaching strategies, and learning

styles within an interactive environment. Mohd Fairuz et al. (2020) further explained that even when educators and students are physically separated, they can still interact creatively through technology. Consequently, platforms such as Blendspace, Moodle, MOOCs, and Blackboard should be further promoted to strengthen the traditional learning system and align it with modern technological progress, ultimately developing students with higher competency and skill.

A research framework is a graphical representation that illustrates the overall structure and flow of a study. It serves as a key foundation in explaining the relationships between variables, contributing factors, and the effects that influence the research outcomes. Through the research framework, the researcher is able to systematically present the design and direction of the study being conducted.

This study aims to examine the effectiveness of blended learning implementation in the field of Electrical Engineering at a Vocational College. The conceptual framework is developed to clarify the progression of the research process, beginning with the identification of the research problem, followed by the formulation of objectives and research questions, the implementation of the methodology, and concluding with data analysis and the findings obtained.

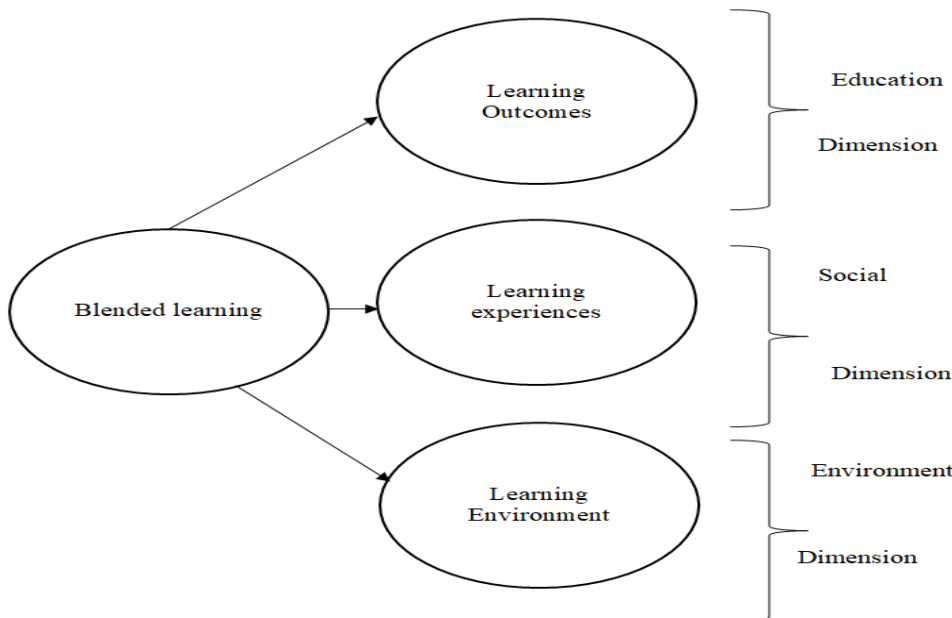


Figure 1: Adapted from *The Sociability of Computer-Supported Collaborative Learning Environments* by Karel et al., 2002

METHODOLOGY

This quantitative research aimed to examine the application of blended learning among students in Electrical and Electronic Engineering programs at Vocational Colleges. The study focused on assessing students' knowledge, skills, and attitudes developed through blended learning during teaching and learning sessions.

A total of 68 students from Vocational Colleges in Johor were selected as participants using the simple random sampling technique, ensuring that every member of the population had an equal probability of being chosen (Creswell & Creswell, 2022).

Data were collected through a Google Form questionnaire designed by the researcher, consisting of six sections that explored the effects of blended learning experiences on students in Technical and Vocational Education. Respondents were required to provide demographic details and respond to items measuring the influence of blended learning on their knowledge, skills, and attitudes. The collected data were analyzed to determine how blended learning contributes to improving students' engagement and performance in vocational education settings. his study utilised a Likert scale to allow respondents to indicate their level of agreement with given

statements by selecting one of the response options provided. The Likert scale is a bipolar scaling method that measures both positive and negative responses toward a statement. A four-point response scale was used in this questionnaire, as presented in Table 1

In addition, the data collection method employed purposive random sampling. In this study, purposive random sampling was used to select students from a Vocational College who were engaged in blended learning. Therefore, this method was considered appropriate for the study. Through this sampling technique, the sample was determined within a smaller and more accessible group.

Table 1: Four-point response scale

Item	Scale	Score
Strongly Disagree	SD	1
Disagree	D	2
Agree	A	3
Strongly Agree	SA	4

There have six sections of questionnaire :

Section A: Demographics

This section includes respondents' demographic information such as gender, age, ethnicity, educational background, and level of technological knowledge. This information serves as supporting data for the researcher to better understand the respondents' background and its relationship to the study findings. According to Wiersma (1995), most questionnaires include a section on respondents' background, such as educational level, and it is typically placed after the cover page to ensure smooth reading and to avoid disrupting respondents' focus on the main items of the study.

Section B: Students' Experiences of Pedagogy in Integrated Learning

This section was developed to identify students' experiences regarding teachers' pedagogical practices in the implementation of integrated learning during teaching and learning sessions. The items aim to assess the extent to which the teaching approaches, strategies, and methods employed by teachers influence students' experiences and engagement in blended learning. The researcher examines how these pedagogical elements support and enhance students' learning effectiveness.

Section C: Identifying Students' Experiences of Technology in Integrated Learning During Teaching and Learning Sessions

This section was designed to examine the role of learning technology in integrated learning and its influence on students' experiences in the classroom teaching and learning process. The researcher aims to determine how the technological components within blended learning support and enhance the overall teaching and learning process.

Section D: Identifying Students' Experiences of Resource Support in Integrated Learning During Teaching and Learning Sessions

This section was developed to examine how learning resource support within blended learning influences students' experiences during classroom teaching and learning. The researcher seeks to identify how the availability and quality of learning resources in integrated learning contribute to the effectiveness of the teaching and learning process.

Section E: Identifying Students’ Experiences of Assessment in Integrated Learning During Teaching and Learning Sessions

This section was designed to examine how assessment practices within blended learning influence students’ experiences in the teaching and learning process. The researcher aims to determine how assessment methods in integrated learning support students’ academic development and engagement.

Section F: Identifying Students’ Experiences of Management in Integrated Learning During Teaching and Learning Sessions

This section was developed to examine how learning management in blended learning influences students’ experiences during classroom teaching and learning. The researcher seeks to identify how instructional organization and management practices within integrated learning contribute to the overall teaching and learning process.

Section G: Identifying the Effects of Students’ Experiences on Learning Outcomes, Learning Experiences, and the Learning Environment in Integrated Learning During Teaching and Learning Sessions

This section was designed to examine how learning outcomes, learning experiences, and the learning environment influence students’ experiences in blended learning. The researcher aims to determine the effects of these elements on students’ social development and engagement throughout the teaching and learning process.

RESULTS

This section demonstrates the distribution of the number of respondents based on gender, their age, and the education backgrounds in Vocational College. A total of 68 respondents, who are student were involved in this study. Table 2 presents respondents’ background based on gender. The result found that 75% (n=51) of respondents who are student were males, while 25% (n=17) were females.

Table 2: Respondent’s Background Based on Gender

Category	Frequency(n)	Percentage(%)
Male	51	75
Female	17	25

Table 3 presents respondents’ background based on age. The result found that 32.4% (n=22) of respondents who are student were 16-17 years, 48.5% (n=33) of respondents who are students were 18-19 years. 19.1% (n=13) of respondents who are students were 19 years and above.

Table 3: Respondent’s Background Based on Age

Age (years)	Frequency(n)	Percentage(%)
16-17	22	32.4
18-19	33	48.5
19 and above	13	19.1

Table 4 presents respondents’ background based on education background. The result found that 47.1% (n=32) of respondents who are student were Sijil Vokasional Malaysia and 52.9% (n=36) of respondents who are students were Diploma Vokasional Malaysia.

Table 4: Respondent’s Background Based on Education Background

Education Background	Frequency(n)	Percentage(%)
Sijil Vokasional Malaysia	32	47.1
Diploma Vokasional Malaysia	36	52.9

Table 5 provides information on the student's experience with pedagogy in blended learning during teaching and learning sessions

During blended learning sessions, I found:

Items	Strongly disagree	Disagree	Agree	Strongly agree
Various strategies used by lecturers in subject delivery: material-centric and activity-centric approaches	0	1	53	14
In teaching and learning sessions, lecturers apply various delivery techniques such as discussions and problem-solving to enhance the educational experience.	1	1	47	19
The student-centered learning approach through question-and-answer sessions in face-to-face meetings conducted in blended learning involves actively engaging students in the learning process.	0	2	52	14
Active teaching processes conducted during activities in blended learning sessions enhance the teaching and learning experience significantly.	0	1	50	17
The learning process that encourages critical thinking, known as High Order Thinking Skills (HOTS), is crucial for developing students' analytical and problem-solving abilities.	0	7	43	18
The kinesthetic learning style, also known as experiential learning or learning through physical experience, is practiced in blended learning to engage students who learn best through movement and hands-on activities.	0	3	42	23

Table 5 presents respondents’ perceptions of students’ experiences with pedagogy in blended learning during teaching and learning sessions. Overall, the findings indicate that most respondents reported positive experiences with pedagogical approaches implemented in blended learning.

The highest level of agreement was observed in the use of various strategies by lecturers in subject delivery, including material-centric and activity-centric approaches, where 77.9% of respondents agreed and 20.6% strongly agreed. Similarly, 76.5% of respondents agreed and 20.6% strongly agreed that the student-centered learning approach through question-and-answer sessions during face-to-face meetings actively engages students in the learning process. These findings suggest that diversified teaching strategies and interactive classroom practices play an important role in enhancing student engagement in blended learning environments.

In addition, 73.5% of respondents agreed that active teaching processes conducted during blended learning activities significantly enhance the teaching and learning experience, while 25% strongly agreed. Likewise, 69.1% agreed and 27.9% strongly agreed that lecturers apply various delivery techniques such as discussions and problem-solving during teaching and learning sessions to enhance the educational experience. This trend indicates that interactive instructional techniques contribute positively to students' learning experiences.

Although respondents generally reported positive perceptions, slightly lower agreement was observed in aspects related to higher-order thinking and kinesthetic learning. For example, 63.2% of respondents agreed and 26.5% strongly agreed that learning processes encouraging Higher Order Thinking Skills (HOTS) are important for developing analytical and problem-solving abilities. Meanwhile, 61.8% agreed and 33.8% strongly agreed that kinesthetic or experiential learning approaches are practiced in blended learning to engage students through hands-on activities. These results suggest that while higher-level cognitive and experiential learning strategies are present in blended learning, their implementation may vary compared to other pedagogical practices.

Overall, the synthesis of the findings indicates that the effectiveness of blended learning in vocational education is largely influenced by pedagogical practices that emphasise diverse instructional strategies, student-centered learning, active engagement, and the development of higher-order thinking skills. These findings therefore address the first research objective, which aims to identify students' experiences of pedagogy in blended learning during teaching and learning sessions.

Table 6 provides identifying students' experiences with technology in blended learning during teaching and learning sessions

During blended learning sessions, I found:

Items	Strongly disagree	Disagree	Agree	Strongly agree
The ease of using computers is readily available during blended learning sessions	2	8	39	19
The ease of using laptops is easily accessible during blended learning sessions.	2	7	37	22
Easy access to internet/WiFi connectivity is available during the blended learning process.	1	13	35	19
The use of applications that actively involve students in the classroom.	0	5	40	23
The use of audio systems such as TVs, microphones, or LCDs as teaching and learning materials	1	2	41	24
The convenience of using smartphones or tablets to access notes during teaching and learning.	0	2	37	29

Table 6 presents respondents' perceptions of students' experiences with technology in blended learning during teaching and learning sessions. Overall, the findings indicate that most respondents reported positive experiences with the use of technology to support blended learning.

The highest level of agreement was observed in the use of audio-visual systems such as televisions, microphones, and LCD projectors as teaching and learning materials, where 60.3% of respondents agreed and 35.3% strongly agreed. Similarly, the use of applications that actively engage students in the classroom also recorded high agreement, with 58.8% of respondents agreeing and 33.8% strongly agreeing. These findings suggest that digital tools and multimedia technologies play an important role in enhancing the effectiveness of blended learning sessions.

In terms of accessibility to technological devices, the majority of respondents indicated that computers and laptops were readily available during blended learning sessions. Specifically, 57.4% of respondents agreed and 27.9% strongly agreed that computers were easily accessible, while 54.4% agreed and 32.4% strongly agreed regarding the accessibility of laptops. In addition, the use of smartphones or tablets to access learning materials was widely supported, with 54.4% of respondents agreeing and 42.6% strongly agreeing that these devices were convenient for accessing notes during teaching and learning activities.

However, slightly lower levels of agreement were observed regarding internet or WiFi accessibility. Although 51.5% of respondents agreed and 27.9% strongly agreed that internet connectivity was easily accessible during the blended learning process, a relatively higher proportion of respondents expressed disagreement (19.1%). This finding indicates that while technological devices and digital tools are generally available, internet connectivity may still present challenges in supporting the full implementation of blended learning.

Overall, the findings demonstrate that technological facilities such as digital devices, multimedia tools, and learning applications support the implementation of blended learning. Nevertheless, improvements in internet connectivity may further enhance the effectiveness of technology integration in teaching and learning sessions.

Table 7 provides identifying students' experiences with resource support in blended learning during teaching and learning sessions

During blended learning sessions, I found:

Items	Strongly disagree	Disagree	Agree	Strongly agree
Easily accessing notes from the subjects studied through internet links in blended learning.	0	5	37	26
Easily accessing exercises via internet links in blended learning.	0	6	40	22
Easily obtaining assignments through internet links in blended learning	0	5	36	27
Easily obtaining quizzes or past questions through blended learning	0	1	45	22
Can link instructional and practical teaching videos related to subjects through blended learning	0	3	40	25
Easily accessing additional references related to the subject	0	3	45	20

Table 7 presents respondents' perceptions of students' experiences with resource support in blended learning during teaching and learning sessions. Overall, the findings indicate that most respondents reported positive experiences in accessing learning resources through blended learning platforms.

The highest level of agreement was observed in the accessibility of quizzes or past questions and additional references related to the subject. Specifically, 66.2% of respondents agreed and 32.4% strongly agreed that quizzes or past questions could be easily obtained through blended learning, while 66.2% agreed and 29.4% strongly agreed that additional references related to the subject were easily accessible. These findings suggest that blended learning platforms effectively support students in accessing supplementary learning materials that can enhance their understanding and preparation for assessments.

In addition, respondents also indicated positive perceptions regarding access to learning materials such as notes, exercises, and assignments through internet links. For example, 54.4% of respondents agreed and 38.2% strongly

agreed that they could easily access subject notes, while 58.8% agreed and 32.4% strongly agreed that exercises were easily accessible online. Similarly, 52.9% agreed and 39.7% strongly agreed that assignments could be easily obtained through blended learning platforms. This pattern highlights the role of digital platforms in facilitating the distribution and accessibility of instructional materials.

Furthermore, the use of instructional and practical teaching videos was also positively perceived, with 58.8% of respondents agreeing and 36.8% strongly agreeing that such videos could be linked to the subject content through blended learning. This indicates that multimedia learning resources support students in gaining a better understanding of theoretical and practical concepts.

Overall, the findings demonstrate that blended learning provides strong resource support by enabling students to access a wide range of learning materials, including notes, exercises, assignments, quizzes, references, and instructional videos. This accessibility contributes to a more flexible and resource-rich learning environment that supports students' learning experiences.

Table 8 provides identifying students' experiences with assessment in blended learning during teaching and learning sessions

During blended learning sessions, I found:

Items	Strongly disagree	Disagree	Agree	Strongly agree
Assessment can be conducted through online forum discussions	1	6	42	19
Assessment can be conducted effectively through well-designed exercises within the teaching and learning of this subject	0	2	44	22
Assessment can be conducted through online assignments given to students	0	7	42	19
Can respond well to quizzes uploaded online by the lecturer	1	3	45	19
Discussions on exercises, assignments, or quizzes conducted online by the lecturer facilitate my understanding of my knowledge level	0	7	44	17
Hands-on learning in teaching and learning enhances my experience in this subject	0	2	44	22

Table 8 presents respondents' perceptions of students' experiences with assessment in blended learning during teaching and learning sessions. Overall, the findings indicate that respondents generally perceived the assessment approaches implemented in blended learning as effective in supporting the learning process.

Among the assessment methods examined, the highest level of agreement was observed in students' ability to respond to quizzes uploaded online by lecturers, where 66.2% of respondents agreed and 27.9% strongly agreed. Similarly, assessments conducted through well-designed exercises within the teaching and learning process also received strong support, with 64.7% of respondents agreeing and 32.4% strongly agreeing that such exercises effectively support assessment. These findings suggest that structured and continuous assessment activities play an important role in evaluating students' understanding in a blended learning environment.

In addition, online-based assessments such as assignments and forum discussions were also positively perceived by respondents. Specifically, 61.8% of respondents agreed and 27.9% strongly agreed that assessment can be

conducted through online forum discussions. The same proportion of respondents (61.8%) agreed and 27.9% strongly agreed that assessments through online assignments are effective during blended learning sessions. These results highlight the importance of digital platforms in facilitating flexible and interactive assessment practices.

Furthermore, respondents also indicated that online discussions related to exercises, assignments, or quizzes help them better understand their level of knowledge, with 64.7% agreeing and 25% strongly agreeing. In addition, hands-on learning activities were perceived to enhance students’ learning experiences, with 64.7% of respondents agreeing and 32.4% strongly agreeing. This suggests that the integration of practical activities and interactive discussions can further strengthen the assessment process in blended learning.

Overall, the findings demonstrate that a variety of assessment methods, including online quizzes, assignments, exercises, forum discussions, and hands-on learning activities, contribute to a comprehensive and flexible assessment system within blended learning environments.

Table 9 provides identifying students' experiences with management in blended learning during teaching and learning sessions.

During blended learning sessions, I found:

Items	Strongly disagree	Disagree	Agree	Strongly agree
The institution provides digital tools facilities for conducting blended learning	0	9	39	20
The availability of broadband facilities within the institution	0	6	45	17
The technical support facilities provided by the institution for conducting blended learning	0	5	44	19
Systematic and organized facilities for blended learning are implemented during teaching and learning sessions	0	2	43	23
Good financial support from the institution for implementing blended learning.	0	6	46	16
The institution's e-Learning policies implemented for students in teaching and learning to facilitate blended learning.	0	5	46	16

Table 9 presents respondents’ perceptions of students’ experiences with management support in blended learning during teaching and learning sessions. Overall, the findings indicate that respondents generally perceived that institutional management provides adequate support for the implementation of blended learning.

Among the aspects examined, the highest level of agreement was observed in the institutional support related to financial assistance and e-learning policies. Specifically, 67.6% of respondents agreed and 23.5% strongly agreed that the institution provides good financial support for implementing blended learning. Similarly, the same proportion of respondents (67.6%) agreed and 23.5% strongly agreed that the institution’s e-learning policies facilitate the implementation of blended learning in teaching and learning sessions. These findings suggest that institutional commitment through financial resources and policy support plays an important role in sustaining blended learning practices.

In addition, respondents also reported positive perceptions regarding the availability of broadband facilities and technical support provided by the institution. A majority of respondents (66.1%) agreed and 25% strongly agreed that broadband facilities are available within the institution, while 64.7% agreed and 27.9% strongly agreed that technical support facilities are provided to support blended learning implementation. This indicates that institutional infrastructure and technical assistance are important factors that contribute to the effectiveness of blended learning environments.

Furthermore, respondents indicated that blended learning facilities within the institution are systematically organized, with 63.2% agreeing and 33.8% strongly agreeing that the facilities are implemented in an organized manner during teaching and learning sessions. Similarly, 57.4% of respondents agreed and 29.4% strongly agreed that the institution provides digital tools to support blended learning activities. Although the majority of responses were positive, a small proportion of respondents expressed disagreement, suggesting that some aspects of institutional support may still require improvement.

Overall, the findings demonstrate that institutional management plays a crucial role in supporting blended learning through financial resources, policy implementation, infrastructure, technical support, and digital facilities that facilitate effective teaching and learning sessions.

Table 10 provides the effects of blended learning on learning outcomes, learning experiences, and learning environment.

During blended learning sessions, I found:

Items	Strongly disagree	Disagree	Agree	Strongly agree
Blended learning implemented during teaching and learning sessions enhances my understanding of the subject taught	0	4	42	22
Blended learning facilitates my access to resources to enhance knowledge in the subject both inside and outside the classroom	0	4	46	18
The ability to conduct quizzes and exams online anywhere in blended learning enhances my skill in answering questions effectively.	0	5	45	18
Blended learning can enhance skills in using ICT (Information and Communications Technology) for learning	0	7	41	20
The institution encourages me to use blended learning to enhance self-directed learning attitudes.	0	7	39	22
Feel comfortable with the use of technology utilized in blended learning during teaching and learning sessions	0	10	38	20
Motivated by the lecturer's use of blended learning during teaching and learning sessions	0	6	41	21
The institution always encourages me to use blended learning in teaching and learning sessions	0	8	39	21
The assessment of subject achievement through blended learning that I studied is encouraging	0	7	43	18

Always taking advantage of accessing resources such as notes, exercises, and assignments in blended learning	0	7	41	20
Learning is easier and faster using blended learning during teaching and learning sessions.	0	7	40	21
The conducive technology facilities for blended learning during teaching and learning sessions enhance my interest in the sessions	0	6	42	20
Time savings in accessing resource support in blended learning during teaching and learning sessions	0	8	39	21
Cost savings in institutional management through blended learning during teaching and learning sessions	1	6	41	20
Communication between students and lecturers in student-centered teaching techniques is prioritized	0	7	36	25

Table 10 presents respondents’ perceptions of the effects of blended learning on learning outcomes, learning experiences, and the learning environment during teaching and learning sessions. Overall, the findings indicate that most respondents reported positive perceptions regarding the impact of blended learning on their learning process.

In terms of learning outcomes, respondents generally agreed that blended learning enhances their understanding of the subject and improves their ability to answer questions effectively. For instance, 61.8% of respondents agreed and 32.4% strongly agreed that blended learning enhances their understanding of the subject taught. Similarly, 66.2% agreed and 26.5% strongly agreed that the ability to conduct quizzes and examinations online helps them improve their skills in answering questions effectively. In addition, 63.2% of respondents agreed that assessment through blended learning is encouraging in supporting subject achievement. These findings suggest that blended learning contributes positively to students’ academic performance and assessment engagement.

Regarding learning experiences, respondents also expressed positive perceptions towards the flexibility and accessibility provided by blended learning. A majority of respondents (67.6%) agreed and 26.5% strongly agreed that blended learning facilitates access to learning resources both inside and outside the classroom. Furthermore, 60.3% of respondents agreed that blended learning enhances their ICT skills for learning, while 58.8% agreed that learning becomes easier and faster through blended learning. The findings also show that 54.4% of respondents agreed and 42.6% strongly agreed that blended learning saves time in accessing learning resources. This indicates that blended learning promotes flexible learning opportunities and improves students’ digital competencies.

In terms of the learning environment, respondents generally perceived that blended learning creates a more engaging and supportive learning environment. For example, 60.3% of respondents agreed and 30.9% strongly agreed that they are motivated by lecturers’ use of blended learning during teaching and learning sessions. Additionally, 61.8% agreed that conducive technological facilities enhance their interest in learning sessions. Respondents also reported that communication between students and lecturers in student-centered teaching approaches is prioritized, with 52.9% agreeing and 36.8% strongly agreeing with this statement. These findings highlight the role of blended learning in fostering interaction, motivation, and engagement within the learning environment.

Overall, the results demonstrate that blended learning positively influences students’ learning outcomes, learning experiences, and the overall learning environment by improving access to learning resources, enhancing technological skills, promoting flexible learning, and supporting interactive teaching and learning practices.

The quantitative data collected from all respondents support the suitability of implementing blended learning in the Electrical Technology programme at Vocational Colleges. A semi-structured questionnaire was administered to students in order to obtain insights into their experiences with blended learning during the teaching and learning process. Overall, the respondents indicated that blended learning positively supports the teaching and learning process in terms of learning outcomes, learning experiences, and the learning environment.

One respondent described blended learning as *“learning that uses both face-to-face and online learning techniques at the same time”* (Respondent 1), highlighting the integration of traditional classroom instruction with digital learning platforms. Another respondent stated that blended learning *“can increase and deepen knowledge in various ways, whether inside or outside the classroom”* (Respondent 2), suggesting that the approach provides flexible learning opportunities beyond the physical classroom environment. Similarly, Respondent 3 emphasised that blended learning *“can enhance students’ understanding,”* while Respondent 4 noted that *“with the implementation of blended learning techniques, it can help individuals achieve clearer and better understanding.”* These responses indicate that the integration of multiple learning modes may contribute to improved comprehension and knowledge acquisition among students.

Furthermore, all respondents expressed the view that blended learning methods, particularly those involving online components, provide greater benefits compared to traditional face-to-face approaches alone. For instance, Respondent 1 stated that *“blended learning can incorporate more learning information from various external internet sources,”* indicating the expanded access to diverse learning materials. Respondent 2 further explained that *“blended learning can use concise notes containing extensive information in presentation formats, and the use of educational videos on social media can also have a significant impact on students.”* This highlights the role of multimedia resources in enhancing students’ engagement and understanding.

In addition, Respondent 3 noted that *“traditional methods are more difficult compared to online learning because online learning makes it easier to complete and submit assignments given by lecturers.”* Respondent 4 also emphasised that *“blended learning can save time, produce more organized work, increase students’ motivation, and make it easier for them to understand.”* These responses suggest that the flexibility and accessibility of online learning platforms may improve students’ efficiency and engagement in learning activities.

The respondents also provided several suggestions for institutions to further encourage the implementation of blended learning in teaching and learning sessions. Respondent 1 suggested that institutions should focus on *“enhancing students’ self-skills and the use of equipment related to their competencies.”* Respondent 2 highlighted that blended learning *“can help students complete assignments more easily and allow them to ask questions even after class has ended, while reference materials can be obtained from websites.”* Meanwhile, Respondent 3 recommended expanding the use of digital tools, noting that *“students today are more attracted to blended learning.”* Respondent 4 added that blended learning is beneficial because it *“reduces the cost of printing notes and helps students better understand topics through internet resources if certain information is not included in the provided notes.”*

Overall, the findings suggest that blended learning provides significant advantages in supporting students’ learning experiences, enhancing accessibility to learning resources, and improving engagement in the teaching and learning process. These results indicate that the integration of face-to-face and online learning environments can create a more flexible and effective learning ecosystem for students in vocational education.

The Rasch Measurement Model analysis was conducted to evaluate the reliability, validity, and suitability of the questionnaire items used in this study. The analysis involved 68 respondents and 45 items developed to measure students’ perceptions of the implementation of blended learning.

Based on the analysis results, the person reliability value obtained was 0.93, indicating a very high level of response consistency among respondents. This value suggests that the research instrument is capable of consistently measuring differences in respondents’ perceptions. In addition, the person separation index was 3.61, indicating that the instrument is able to distinguish respondents into several different levels of ability or perception.

However, the item reliability value obtained was 0.30, with an item separation index of 0.66. This result indicates that the difficulty levels of the items in the instrument are relatively similar to one another. This condition may be influenced by several factors, such as the limited sample size and the relatively small variation in item difficulty. Furthermore, the instrument was developed to measure a specific construct related to students' perceptions of blended learning, which may have limited the variability in item difficulty.

In addition, the analysis of model fit statistics shows that the mean Infit Mean Square (MNSQ) value was 0.98, while the Outfit Mean Square (MNSQ) value was 0.97. Both values fall within the acceptable range of the Rasch Model, which is between 0.5 and 1.5. These findings indicate that the response patterns of the respondents are consistent with the expectations of the Rasch model, and that the items in the instrument function well in measuring the intended construct.

Overall, the results of the Rasch analysis indicate that the research instrument demonstrates high person reliability and good model fit. Although the item reliability value is relatively low, the instrument can still be used in this study as the items remain compatible with the Rasch model and are capable of measuring the intended construct consistently.

Based on the analysis in Table 11, the ability level of the students involved in this study ranges from -1.97 logit to 9.11 logit. The mean ability value of the students is 3.09 logit with a standard deviation (SD) of 2.32 logit. This distribution indicates the existence of diversity in students' ability levels, which include low, moderate, and high levels.

Several students have a maximum ability value of 9.11 logit, namely students from Vocational College A and Vocational College B. This shows that these students possess very high experience and mastery in blended learning. However, there are students with a minimum value of -1.97 logit, namely students from Vocational College C (SVM), which indicates a low ability level.

Table 10 shows the level of Vocational College students' experience regarding the Effectiveness of Blended Learning in Electrical and Electronic Technology based on the analysis using the Rasch Model. For the Infit and Outfit MNSQ fit statistics, most students have values between 0.5 and 1.5, indicating that their response patterns are consistent with the Rasch Model. However, there are students who show Infit or Outfit values higher than this range, which may be due to misunderstanding the requirements of certain items. In terms of student reliability, the obtained value is 0.93, which indicates a high level of reliability. This means that the instrument used can effectively differentiate the students' ability levels. The Separation Index value of 3.57 also supports that students can be classified into three ability levels is low, moderate, and high. Table 11 shows the students' levels of experience in blended learning at Vocational College. The students' levels of experience in blended learning at Vocational Colleges.

Table 10

ENTRY	TOTAL SCORE	MEASURE	S.E.	INFIT MNSQ	INFIT ZSTD	OUTFIT MNSQ	OUTFIT ZSTD	Respondent Information
11	180	9.11	1.83					DVM Vocational College A
43	180	9.11	1.83					DVM Vocational College B
45	180	9.11	1.83					DVM Vocational College B
60	180	9.11	1.83					DVM Vocational College B
7	174	5.97	0.44	0.95	-0.06	0.82	-0.43	SVM Vocational College A
31	174	5.97	0.44	1	0.09	0.98	0.06	DVM Vocational College C

46	170	5.34	0.36	1	0.05	0.98	-0.02	DVM Vocational College B
1	166	4.88	0.32	0.9	-0.69	0.86	-0.92	DVM Vocational College A
22	163	4.58	0.31	0.89	-0.99	0.87	-1.14	DVM Vocational College C
50	157	4.04	0.3	1.05	0.61	1.06	0.66	SVM Vocational College B
17	91	-1.97	0.25	0.51	-2.85	0.51	-2.85	SVM Vocational College C

Table 11

ENTRY	RESPONDENT INFORMATION	LEVEL
11	DVM Vocational College A	High
43	DVM Vocational College B	High
45	DVM Vocational College B	High
60	DVM Vocational College B	High
7	SVM Vocational College A	High
31	DVM Vocational College C	High
46	DVM Vocational College B	Moderate
1	DVM Vocational College A	Moderate
22	DVM Vocational College C	Moderate
50	SVM Vocational College B	Moderate
17	SVM Vocational College C	Low

DISCUSSION

Overall, the findings presented in Table 5 to Table 10 indicate that the implementation of blended learning has a positive impact on the teaching and learning process. The majority of respondents expressed high levels of agreement regarding various aspects of blended learning implementation, including pedagogical approaches, the use of technology, resource support, assessment practices, and institutional management support.

From the perspective of pedagogy, the findings indicate that the use of diverse teaching strategies such as student-centered learning approaches, question-and-answer sessions, discussions, and active learning activities plays an important role in enhancing student engagement during teaching and learning sessions. These pedagogical practices within blended learning environments enable students to participate more actively in the learning process, which subsequently improves their overall learning experiences.

In terms of technology use, most respondents agreed that technological facilities such as computers, laptops, smartphones, and digital learning applications support the implementation of blended learning. In addition, the use of audio-visual equipment and interactive applications helps improve classroom interaction and learning effectiveness. However, the findings also suggest that internet or WiFi accessibility remains a challenge for a small proportion of respondents, which may affect the overall effectiveness of blended learning implementation.

Furthermore, with regard to resource support, the findings reveal that students are able to access various learning materials such as notes, exercises, assignments, quizzes, and additional references through blended learning platforms. The availability of these resources through online platforms allows students to review learning materials more flexibly and enhances their understanding of the subject matter.

From the perspective of assessment, the results indicate that online assessment methods such as quizzes, assignments, and forum discussions help students evaluate their level of understanding of the subject content. In addition, hands-on learning activities and discussions related to exercises and assignments also contribute to improving students' learning experiences. These findings suggest that assessment approaches within blended learning can effectively support continuous learning and knowledge evaluation.

The findings also demonstrate that institutional management support plays an important role in ensuring the successful implementation of blended learning. The provision of digital tools, technical support, broadband facilities, and well-structured e-learning policies facilitates the effective integration of blended learning into teaching and learning sessions.

Finally, the results indicate that blended learning positively influences learning outcomes, learning experiences, and the learning environment. The implementation of blended learning helps improve students' understanding of the subject, facilitates access to learning resources, and enhances students' ICT skills. In addition, blended learning increases students' motivation, encourages self-directed learning, and creates a more flexible and interactive learning environment.

Overall, the findings of this study suggest that blended learning is an effective instructional approach that can enhance the quality of teaching and learning, particularly within the context of technical and vocational education.

Limitations

This study has several limitations that should be considered when interpreting the findings. First, the relatively small sample size limits the transferability of the findings, as the sample was confined to a specific study zone and does not represent the broader student population. In addition, variations in participant characteristics, particularly in terms of technological skills and exposure to digital learning tools, may have influenced their perceptions of the implementation of blended learning.

Second, the data were collected from two programme courses across several institutions within the Johore zone only. As such, the findings may have limited applicability to other educational institutions, different courses, or learning environments located in other zones or regions.

Third, this study relied primarily on self-reported data obtained through a questionnaire. Although this approach provides useful insights into students' experiences and perceptions of blended learning, incorporating additional data sources such as classroom observations, analysis of online learning activities, or performance-based assessments could provide stronger data triangulation and offer a more comprehensive understanding of the effectiveness of blended learning implementation in teaching and learning contexts.

CONCLUSION

This study aims to identify the effects of blended learning in electrical and electronic engineering on learning outcomes, learning experiences, and the learning environment at a Vocational College in Johor. Overall, blended learning activities enhance the teaching and learning process, especially in the long term. This study suggests that students should participate in blended learning due to more efficient knowledge delivery, better utilization of skills conveyed by teachers, and higher student attitudes in the learning process.

The implications of the research findings and several recommendations are proposed for students and vocational institutions to improve this situation. Starting with small steps and gradually increasing blended learning as part

of the teaching and learning process in institutions is essential. Blended learning can have a positive impact in the long term, particularly in advancing the Malaysia National Education Philosophy.

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Conflict of Interest

Authors declare that there is no conflict of interests regarding the publication of the paper.

Author Contribution

This section is compulsory. This journal requires that all authors take public responsibility for the content of the work submitted for review. The contributions of all authors must be described in the following manner:

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