Students’ learning style and its effect on blended learning: Engineering Student Perspective

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**Abstract.** Blended Learning (BL) refers to instructional programs that combine multiple delivery modes to optimize both learning outcomes and cost efficiency. A comprehensive evaluation of BL must consider various factors, including students’ learning styles, as these preferences shape the effectiveness of BL environments and influence academic achievement. This study investigated the relationship between first‑year engineering students’ learning styles and their perceptions of BL, as well as the impact of key BL components on implementation effectiveness. A total of 150 students at a public university completed Kolb’s Learning Style Inventory and a BL questionnaire assessing three domains: process, content, and ease of use. Most respondents were classified as Divergent learners, followed by Assimilator, Convergent, and Accommodator. ANOVA results revealed significant differences in BL perceptions across learning‑style groups. Multiple linear regression analysis further demonstrated that each BL domain-process, content, and ease of use significantly predicts overall implementation effectiveness.

# Introduction

In the face of rapid technological advancement and the growing demand for flexible education, blended learning (BL) has emerged as a transformative instructional approach in higher education. BL combines traditional face-to-face instruction with online learning components to create a more dynamic, accessible, and learner-centered environment [1-2]. This approach aligns with global educational reform initiatives, such as the Malaysia Education Blueprint 2013–2025, which emphasizes the development of holistic and globally competitive graduates through innovative teaching and learning methods [3].

The strength of blended learning lies in its ability to enhance engagement, autonomy, and knowledge retention by accommodating various learning pathways [4]. Research suggests that the success of BL is closely tied to how well it supports students’ individual learning needs and preferences [5]. When designed effectively, BL promotes deeper learning by encouraging active participation, self-regulation, and reflective thinking [6].

Despite increased access to digital tools in higher education, many institutions still face challenges in optimizing student engagement and satisfaction in blended settings. This is particularly true when pedagogical approaches fail to align with students’ learning preferences [7]. Understanding how students learn best particularly through the lens of learning styles can play a critical role in improving the design and effectiveness of blended learning environments.

Learning styles refer to the consistent ways individuals prefer to perceive and process information [8]. Various studies have highlighted that learning styles differ from one person to another, hence, being aware of learning styles allows educators to detect and tackle students’ learning issues [9-11]. Recent studies reaffirm that aligning instructional strategies with students’ learning styles enhances engagement, academic performance, and satisfaction in blended learning contexts [12-13].

Kolb’s Experiential Learning Theory remains one of the most widely adopted frameworks for categorizing learning styles, distinguishing learners into four categories: Convergent, Assimilator, Divergent and Accommodator. Each type reflects a unique combination of experiential and cognitive learning preferences [14]. Divergent learners excel at viewing situations from multiple perspectives and thrives on brainstorming, group discussions, and reflection. They prefer rich, varied content formats and benefit from open-ended tasks and collaborative learning environments [14]. In blended learning, Divergent learners are best supported through interactive content such as multimedia case studies, peer discussion forums and reflective journaling [15].

Assimilators prefer concepts and logical reasoning which make they excel in structured, theory-rich content and benefit from well-organized online modules and in-depth readings. In BL settings, they favor self-paced content and clearly sequenced instructional materials that allow them to absorb and analyze information independently [16].

Convergent learners are problem-solvers who apply ideas in practical ways. They perform well in tasks requiring technical skills or decision –making and prefer con-tent that is actionable and concise. In a blended environment, they benefit from real-world simulations, quizzes with immediate feedback, and hands-on assignments [17].

Accommodators, by contrast, are active, intuitive learners who rely on trial-and-error and personal experiences. They thrive in learning process that are flexible and exploratory. These student benefits most from experiential content such as project-based learning, mobile learning apps, and fieldwork integrated into BL formats [9].

As learning styles are significant in the preparation and implementation of BL, this study investigates the relationship between first-year engineering students’ learning styles, as measured by Kolb’s Learning Style Inventory, and their perceptions of blended learning. Focusing on three core dimensions-learning process, content, and ease of use, the study aims to provide evidence for how personalized instructional design can improve the implementation and effectiveness of blended learning in higher education settings.

# METHod

The objective of this research is to examine how students’ learning styles relate to their views on blended learning, also to determine the influence of 3 domains of blended learning towards the blended learning implementation.

The following research questions were addressed.

a) What are the learning styles among engineering first year students in UTM Skudai?

b) Are there any significant different in learning style when using BL?

c) Are there any effects of the 3 BL domains-learning process, content and ease of use towards the effectiveness

of blended learning implementation?

## Research Population

This research was carried out at Universiti Teknologi Malaysia (UTM), Skudai Campus. UTM offer undergraduate engineering course and the blended learning method is being used for the teaching and learning process. The sampling was included of 150 engineering students year one.

## Research Instrument

In order to find the answer for the research questions, Kolb’s Learning Style Inventory (LSI) and Five-point Likert scale Blended Learning (BL) questionnaire were used to collect data and evidence.

• Kolb’s Learning Style Inventory (LSI): A 12‐item measure of Concrete Experience (CE), Reflective Observation (RO), Abstract Conceptualization (AC), and Active Experimentation (AE). Reliability coefficients ranged from .78 to .84 (.81 for CE, .78 for RO, .83 for AC, .84 for AE) [18].

• Blended Learning Questionnaire: Adapted from Ref. [19], this instrument assesses three domains—BL process (10 items), BL content (9 items), and ease of use (5 items)-using a 5‑point Likert scale. The overall scale reliability was α = .87.

Additional demographic data also collected included gender, date of birth, and enrolled course. Students were also

asked an open-ended questions to allow the students to share any problems or benefits related to the blended

learning method.

## Data Analysis

Data in Excel Spreadsheet was analyzed using SPSS. Descriptive statistics, one-way ANOVA and multiple linear regression test were executed. Multicollinearity arises when two or more predictors are highly intercorrelated, introducing redundant information that can destabilize regression coefficient estimates [20].

Multicollinearity is defined as a situation in which independent variables exhibit high correlation [21]. To detect and quantify multicollinearity, the following diagnostics were applied:

Variance Inflation Factor (VIF): A VIF > 10 indicates potential multicollinearity.

Tolerance: A tolerance < 0.1 suggests problematic multicollinearity.

Condition Index: Values > 15 signal suspected multicollinearity, while values > 30 denote serious multicollinearity [21].

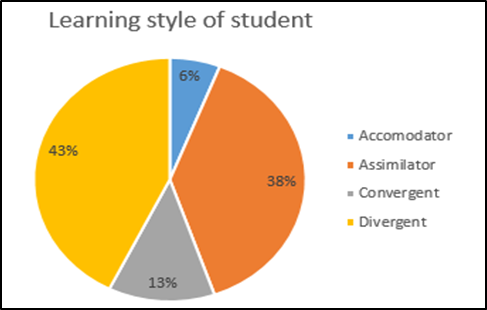
According to Ref. [20], unaddressed multicollinearity can inflate standard errors and compromise the interpretability of regression coefficients. All independent variables in our model met the above criteria before proceeding to the regression analysis. Besides this, feedback from open-ended questions were analyzed and reported as part of the findings.

# RESULT

The descriptive statistic showed that 17.33% (26/150) of the students were females, and 82.66% (124/150) were males. The student’s age ranged from 22-26 years.

## What Are The Learning Styles Found Among Student?

The study assessed the learning styles of students, and the results show that 43% (64/150) of the students categorized into the group of divergent, 38% (58/150) were assimilator, 13% (19/150) were convergent, and 6% (9/150) were accommodator (Figure 1).



**Figure 1.** Percentage of students’ learning style

## Are There Any Significant Differences in Learning Style When Using Blended Learning?

To begin, the discussion will focus on the average values related to students’ perceptions of blended learning across three domains, as shown in Table 1. The mean score of the students’ perceptions regarding blended learning process is 3.67, while the mean score for the blended learning content is 3.71 and the mean score for ease of use of blended learning is 3.70. From the results, it shows that the students have a high positive perception on blended learning based on the three domains where the overall mean score is 3.69.

**TABLE 1.** Students’ Perceptions of Blended Learning Based on Three Domains

|  |  |  |  |
| --- | --- | --- | --- |
| **Domains** | **N** | **Mean** | **SD** |
| Blended learning process | 150 | 3.67 | 0.57 |
| Blended learning content |  | 3.71 | 0.52 |
| Ease of use of web environment |  | 3.70 | 0.59 |
| Overall |  | 3.69 | 0.49 |

As this research purpose is to examine whether there are any differences in learning style when using BL, the descriptive statistical result for student’s BL score on the three BL domains according to their learning style are shown in Table 2.

**TABLE 2.** Descriptive summary of student’s perception of blended learning with learning style (n=150)

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| **Blended Learning Perception** | **Learning Style** | **N** | **Mean** | **SD** |
| BL process | Accommodator | 9 | 3.79 | 0.56 |
| Assimilator | 58 | 3.52 | 0.54 |
| Convergent | 19 | 3.57 | 0.45 |
| Divergent | 64 | 3.83 | 0.59 |
| Total | 150 | 3.67 | 0.57 |
| BL content | Accommodator | 9 | 3.86 | 0.23 |
| Assimilator | 58 | 3.56 | 0.47 |
| Convergent | 19 | 3.62 | 0.36 |
| Divergent | 64 | 3.85 | 0.59 |
| Total | 150 | 3.71 | 0.52 |
| Ease of use of the web environment | Accommodator | 9 | 3.69 | 0.44 |
| Assimilator | 58 | 3.62 | 0.59 |
| Convergent | 19 | 3.52 | 0.44 |
| Divergent | 64 | 3.84 | 0.64 |
| Total | 150 | 3.70 | 0.59 |
| Overall students' perception of BL | Accommodator | 9 | 3.78 | 0.29 |
| Assimilator | 58 | 3.56 | 0.47 |
| Convergent | 19 | 3.57 | 0.37 |
| Divergent | 64 | 3.84 | 0.54 |
| Total | 150 | 3.69 | 0.49 |

The results indicate that the Divergent group had the most positive perception of the blended learning process, while the Assimilator group showed the least. In terms of BL content, the Accommodator and Divergent learners led in scores, followed by the Convergent and Assimilator groups. As for the third domain, Divergent learners continued to score the highest, with Accommodator in second place, Assimilator in third, and Convergent learners ranking lowest.

However, the average rates as shown in Table 2, illustrates that students in all four groups of learning styles are quite similar. Thus, to decide whether the scores given by students vary according to their learning styles, variance analysis (ANOVA) was executed and outcomes are produced in Table 3. ANOVA results shows that students’ perceptions of BL presents significant difference among the four learning styles, F(3,146) = 3.858 and p = 0.011.

Some students from the Assimilator and Convergent learning style groups found the implementation of blended learning to be challenging due to unstable internet connectivity and they suggested for the university to provide more internet hotspot. A few students from Convergent group did mentioned that the blended learning is quite confusing and do not have idea about it.

In contrast, most Divergent learners reported positive experiences with blended learning, describing it as a fun, and the flexibility it provides for self-directed study.

**TABLE 3.** ANOVA on student’s perception of blended learning with learning style

|  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- |
| **Blended Learning Perception** |  | **Sum of Squares** | **df** | **Mean Square** | **F** | **Sig.** |
|  | Between Groups | 3.307 | 3 | 1.102 | 1.102 | 0.015 |
| BL Process | Within Groups | 44.686 | 146 | 0.306 |  |  |
|  | Total | 47.993 | 149 |  |  |  |
|  | Between Groups | 3.018 | 3 | 1.006 | 3.941 | 0.010 |
| BL Content | Within Groups | 37.267 | 146 | 0.255 |  |  |
|  | Total | 40.285 | 149 |  |  |  |
| Ease of Use | Between Groups | 2.272 | 3 | 0.757 | 2.169 | 0.094 |
|  | Within Groups | 50.984 | 146 | 0.349 |  |  |
|  | Total | 53.256 | 149 |  |  |  |
| Overall | Between Groups | 2.712 | 3 | 0.904 | 3.858 | 0.011 |
|  | Within Groups | 34.207 | 146 | 0.234 |  |  |
|  | Total | 36.919 | 149 |  |  |  |

## Are There Any Effects of The 3 BL Domains-Learning process, Content and Ease of Use Towards The Effectiveness Of Blended Learning Implementation?

The reliability analysis for this study is presented in Table 4. Cronbach’s alpha reliability test which also known as internal consistency reliability test, measures the internal consistency between items in a scale. Internal in this context means that how participants responding to each item. There are a total of 150 participants with no missing values. The questionnaire is said to be reliable if the value of Cronbach’s Alpha is more than 0.7. The Cronbach’s Alpha in this study is 0.931, indicating that the questionnaire is reliable or consistent.

**TABLE 4.** Reliability Analysis

|  |  |
| --- | --- |
| **Item** | **Value** |
| Number of Items | 4 |
| Cronbach’s Alpha | 0.931 |

Table 5 displayed the inter-item correlation matrix, where it presented the correlation of every item with each other. For an example, the correlation between mean blended learning content and mean blended learning process is 0.785, which indicates that there is a high correlation among these two items. All of these items are positively correlated since the questionnaire are worded in the same way or direction, either positively worded or negatively worded. However, we can see a very strong correlation (0.926) between mean blended learning content () and mean blended overall (). It may lead to a multicollinearity issues between independent variables.

**TABLE 5.** Correlation matrix between variables

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
|  | **Mean BL process** | **Mean BL content** | **Mean BL ease of use** | **Mean BL overall** |
| Mean BL process | 1.000 | 0.785 | 0.564 | 0.879 |
| Mean BL content | 0.785 | 1.000 | 0.698 | 0.926 |
| Mean BL ease of use | 0.564 | 0.698 | 1.000 | 0.858 |
| Mean BL overall | 0.879 | 0.926 | 0.858 | 1.000 |

Hence, multicollinearity was performed to determine whether there is an inter-correlation or a strong relationship between independent variables (). In this case, we are testing on whether there is a high correlation between mean BL process, mean BL content, and mean BL ease of use. There are many methods out there testing for multicollinearity, however, in this study, tolerance and variance inflation factor (VIF) method will be used for multicollinearity testing, which is shown in Table 6.

VIF is the reciprocal of tolerance. Tolerance value less than 0.1 or VIF value more than 10 would be the indicative of multicollinearity. From the Table 6, we can see that there’s no multicollinearity exist in the data sets since all values are more than 0.1 (tolerance), and less than 10 (VIF). The tolerance value of mean BL process is 0.512 indicating that 51% of the variance in mean BL process is not being predicted by the other independent variable, same goes with other variables.

**TABLE 6.** Collinearity Statistics.

|  |  |  |
| --- | --- | --- |
| **Variable** | **Tolerance** | **VIF** |
| Mean BL process | 0.512 | 1.952 |
| Mean BL content | 0.682 | 1.466 |
| Mean BL ease of use | 0.384 | 2.607 |

Multiple linear regression was performed after the multicollinearity has been checked, using the stepwise method. A regression model is said to be a good model when there is no multicollinearity reported in the independent variables. The multiple linear regression model is presented in Equation (1).

(1)

The regression coefficients for all three predictors are positive, indicating that improvements in each area are associated with more effective blended learning implementation. Blended learning process (X₁): β = 0.348, suggesting that enhancements in the design and delivery of the process lead to better implementation outcomes. Blended learning content (X₂): β = 0.400, indicating that richer, higher quality content contributes significantly to implementation effectiveness. Ease of use (X₃): β = 0.380, showing that increased usability of the blended learning environment is linked to improved implementation success.

# DISCUSSION

From the result, it shown that majority of the study population is categorized into the Divergent group follow by Assimilator, Convergent and Accommodator. Many studies suggested that by knowing the students’ learning styles, educator can design the learning curricula accordingly so that it can enhances the students’ experience and result to better outcomes [22-24]. The result also indicates that students are generally positive about the blended learning usage as the highest mean belong to the domain of blended learning content. A study by Ref. [25] demonstrate that both the learning design features and the learning outcomes play a critical role in shaping the successful implementation of blended learning. The work in Ref. [26] suggesting discipline tailored BL can enhance engagement and outcomes such as the blended design’s mix of multimedia lectures, discussion forums, and in class work-shops was particularly effective for Convergent learners. The findings further indicate that there is a significant difference between the students’ learning styles and the blended learning and this is align with study conducted by Ref. [27]. This outcome can lead to the implementation of adaptive learning in blended environments as it can personalizing the learning experience of students where the adaptive learning technologies able to customize educational content in real time, providing students the flexibility to advance at their own speed and preferences [28]. In the context of blended learning, where face-to-face instruction is combined with online components, adaptive systems can bridge the gap between instructor-guided and self-directed learning. For example, learners identified as Accommodators may benefit from interactive, practice-based activities in the digital portion of the course, while Assimilators may perform better when provided with well-structured readings or lecture videos. Convergent, who prefer problem-solving and independent work, might be assigned real-world tasks or simulations, whereas Divergent may thrive with reflective journals and group discussions [29].

The high Cronbach’s α (0.931) confirms that the blended‐learning questionnaire is a consistently reliable measure of students’ perceptions. This finding aligns with prior studies reporting robust internal consistency in blended‐learning scales [19].

Although BL process, content, and ease of use were moderately to highly correlated particularly content and overall perception—the multicollinearity diagnostics (all VIFs < 2.7; tolerances > 0.38) demonstrated that each predictor contributes unique variance to the regression model [20-21]. This suggests that while students’ views of content and overall experience are closely linked, they nevertheless capture distinct facets of the blended‐learning environment.

With multicollinearity ruled out, the stepwise regression approach can reliably estimate the relative impact of each BL domain on students’ overall perception that enable us to identify which elements—process design, content quality, or ease of use are the strongest predictors of positive blended‐learning experiences. This has direct pedagogical implications: for example, investing exclusively in content development than emphasizing user‐friendly platforms may yield larger gains in over-all satisfaction. A study by Ref. [30] highlight that successful blended-learning implementation not only on technology, but also on pedagogical design, institutional support, stakeholder attitudes, and continuous quality assurance.

# CONCLUSION

The students in this study population were fell into all four groups of Kolb’s learning styles categories which are the majority is Divergent, follow by Assimilator, Convergent and the minority is Accommodator. By understanding the unique character of each learning style provides valuable information for creating more effective blended learning environments.

The students' perceptions of BL were generally positive across all learning styles, with Divergent and Accommodator learners consistently ranking highest, followed by the Convergent and Assimilator groups. However, the findings indicated a significant relationship between students’ learning styles and their views on blended learning. Responses to the open ended questions further support this finding: the majority of positive feedback originated from students with a Divergent learning style, whereas those with Convergent and Assimilator styles expressed more varied views.

Inter‑item correlations revealed strong positive relationships among the domains of process, content, and ease of use; however, multicollinearity diagnostics (all VIFs < 2.7, tolerances > .38) confirmed that each domain contributes unique explanatory power to the model. Consequently, our multiple regression analysis can validly partition the influence of each dimension on students’ overall blended‑learning experience.

These findings underscore that, in order to maximize students’ satisfaction and perceived effectiveness of blended learning, educators should adopt a balanced approach: investing not only in high‑quality content but also in thoughtfully designed learning processes and intuitive, easy‑to‑use digital environments.

# LIMITATIONS AND FUTURE WORK

There are several limitations to this study. The respondents were only focused on first year engineering students, which may restrict the generalizability of the results to students in other academic levels or disciplines. Furthermore, the study only looked at Kolb’s Learning Style model, which may have left out other cognitive or affective elements that affect learning preferences. Another limitation of this study is its reliance on self-reported surveys, which means that it is subject to the accuracy of the responses provided by participants. Even though the results area valid, they should not be generalized to other higher education institutions.

Future research could address these limitations by involving students from multiple courses and year levels in order to increase the diversity and representativeness of the data. Additionally, incorporating objective performance metrics or learning analytics could help validate or complement self-reported responses.

The incorporation of adaptive learning systems, which tailor information delivery according to students’ reported learning styles is another promising direction for future work. Researchers can investigate the effects of real-time personalization on student engagement, retention and academic achievement by integrating learning styles into adaptive platforms, such as learning management system or mobile learning applications.

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