VIETNAM JOURNAL OF EDUCATION, 2025
Volume 9, Issue 1, 85-98
https://doi.org/10.52296/vje.2025.434

ORIGINAL ARTICLE

The Impact of Teaching Strategies in Blended Learning on Students' Self-Directed Learning Capability at Hanoi University of Science and Technology

Viet Anh Mai,
Chi Quynh Nguyen,
Thang Ngoc Duong,
Mai Quynh Thi Tran,
Hoc Hieu Le[+]

Faculty of Education, Hanoi University of Science and Technology, Vietnam
[+]*Corresponding author* ● *Email: hoc.lehieu@hust.edu.vn*

Article history
Received: 31 August, 2024
Accepted: 15 March, 2025
Published: 31 March, 2025

Keywords
Blended-learning, teaching strategies, self-directed learning, learning strategies

ABSTRACT
Blended learning (BL) is considered a highly effective educational approach in the 21st century. It not only fosters creative thinking but also promotes problem-solving, critical thinking, effective communication, and technology application among learners. This study investigates the impact of teaching strategies within a BL environment on the self-directed learning (SDL) competence of students at Hanoi University of Science and Technology (HUST). Using quantitative methods, the study analyzes data from 485 students engaging in a combination of face-to-face and online learning. Seven commonly used and valued teaching strategies in BL were examined. The study evaluates students' SDL levels using the Self-Rating Scale of Self-Directed Learning (SRSSDL), which comprises five factors. The research participants were divided into seven specialized groups based on their characteristics and academic majors. The results indicate that students' SDL competence is generally high. The students in the Electrical and Electronics Engineering group exhibited the highest SDL capability, while those in the Mechanical Engineering group require further improvement. The teaching strategies that have the most positive impact on SDL are Active Learning, Problem-Based Learning, and Personalized Learning. The findings of this study provide valuable insights into the effectiveness of various teaching strategies utilised in BL, which can serve as a foundation for optimizing teaching strategies to further promote learner self-direction competence.

1. INTRODUCTION

The rapid advancement of science and technology has transformed higher education, fostering the integration of digital tools and learning models such as Hybrid Learning, Technology-Mediated Instruction, Web-Enhanced Instruction, and Mixed-Mode Instruction. Among these, BL has gained prominence as an effective instructional approach, merging face-to-face interactions with online components to enhance student learning experiences (Catlin & Tucker, 2016). Research suggests that BL fosters critical thinking, problem-solving skills, collaboration, and digital literacy, making it a crucial strategy for 21st-century education (Catlin & Tucker, 2016). In particular, its impact on self-directed learning (SDL) - where students take responsibility for their own learning - has become a significant area of research.

At Hanoi University of Science and Technology (HUST), BL has been formally implemented since 2017, aligning with the university's commitment to digital transformation in education. As part of its Education

Development Strategy, HUST has integrated BL into more than 100 course modules, offering approximately 230 BL classes per semester, serving 15,000 - 20,000 students. The university's policy framework emphasizes flexible learning, student-centered instruction, and the leveraging of technology to improve academic performance. Despite these efforts, there remains a critical need to assess the actual impact of these BL strategies on students' SDL competence.

While several international studies have explored the relationship between BL and SDL, research within the Vietnamese higher education context remains limited. Previous studies on BL in Vietnam have predominantly focused on technical infrastructure, student satisfaction, and online engagement, rather than examining how specific teaching strategies in BL influence SDL abilities. Furthermore, existing research has not provided empirical evidence on the effectiveness of BL in STEM-oriented universities like HUST, where students often require high levels of independent learning skills.

This study aims to fill this research gap by evaluating the impact of BL teaching strategies on students' SDL ability at HUST. The research addresses the following key questions: (1) How do different BL teaching strategies affect the SDL ability of HUST students?; (2) Which teaching strategies have the most significant impact on fostering SDL?; (3) What is the current level of SDL among HUST students?

By answering these questions, this study provides empirical insights that can inform curriculum design, faculty development, and policy enhancements for BL at HUST and other Vietnamese universities.

2. LITERATURE REVIEW

2.1. Definition of Blended learning

Blended learning is widely recognized as an effective pedagogical approach that integrates face-to-face instruction with online learning components to optimize learning outcomes. While there is no universal definition, Graham (2004) describes it as the strategic combination of in-person and digital learning experiences. Cronje (2020) further refines this understanding, defining BL as the appropriate use of a combination of learning theories, teaching methods, and technologies to optimize learning in a given context. More recent studies (Carroll et al., 2024; Ismaya, 2022) emphasize that BL should not be merely a mix of modalities but rather a well-structured integration of learning theories, technologies, and pedagogical strategies to maximize student engagement and autonomy.

Globally, different models of BL have been implemented, ranging from rotation models (where students alternate between online and in-person instruction) to flipped classrooms (where students engage with digital content before class and participate in discussions during face-to-face sessions) (Catlin & Tucker, 2016). In European and North American universities, student-centered approaches, including active learning and collaborative learning, dominate the landscape of BL (Istenic, 2024). Asian institutions, particularly in China and Singapore, have emphasized adaptive and AI-driven BL environments, allowing for personalized learning pathways based on student performance analytics (Vashishth et al., 2024).

This paper approaches BL as a teaching method that organizes flexible learning activities through a combination of face-to-face and online formats, with a particular emphasis on teaching strategies in the context of higher education.

2.2. Teaching Strategies

The effectiveness of BL is largely influenced by teaching strategies that actively engage students and promote SDL. Recent studies (Cummings et al., 2017; Vander Ark, 2024) suggest that student-centered and interactive teaching strategies are crucial in developing students' ability to plan, monitor, and evaluate their learning autonomously. The most impactful teaching strategies in BL environments include:

Active Learning - Encourages student participation through problem-solving tasks, case studies, and in-class discussions. Research (Karataş & Arpaci, 2021) suggests that active learning enhances metacognitive skills, leading to improved SDL abilities.

Flipped Classroom - A model where students review course materials online before attending face-to-face discussions. This approach has been found to increase student motivation and engagement, particularly in technical and engineering courses (Nedeva et al., 2019).

Personalized Learning - Incorporating adaptive learning technologies that allow students to progress at their own pace. Studies (Castro, 2019) highlight that personalized learning enhances intrinsic motivation, a key driver of SDL.

Problem-Based Learning (PBL) - Involves real-world problem-solving tasks that require students to take responsibility for their learning. A study by Waqqar et al. (2024) found that PBL significantly improves critical thinking and self-regulation skills in BL environments.

Collaborative Learning - Encourages peer-to-peer interactions and teamwork, fostering interpersonal skills that support SDL. Research (Istenic, 2024) suggests that students who engage in collaborative learning demonstrate higher levels of self-efficacy and motivation.

Despite these findings, there is limited comparative research on how these strategies perform in Vietnam's BL contexts compared to international models. This study aims to fill this gap by analyzing which teaching strategies have the most significant impact on SDL among HUST students.

2.3. Definition of Self-Directed Learning

According to Zimmerman, SDL is a proactive, conscious, and purposeful process in which learners take responsibility for their own learning (Zimmerman, 1990). Similarly, Knowles (1975) argues that SDL is the process in which individuals take the initiative, with or without the help of others, in identifying their learning needs, setting learning goals, selecting and implementing appropriate learning strategies, and evaluating learning outcomes (Knowles, 1975). Knowles' definition remains more widely accepted and recognized in the field of education.

Unlike traditional educational methods, SDL opens new avenues for knowledge acquisition, where learners play an active role in collaboration with teachers to take responsibility for their learning journey. This approach does not imply that learners are completely self-sufficient without support. Instead, teachers guide, inspire, and create opportunities for learners to develop their potential. As a result, learners not only acquire knowledge proactively but also effectively practice critical thinking, problem-solving, and self-study skills. Moreover, SDL is considered the "key" to unlocking essential 21st-century competencies, particularly lifelong learning. This approach enables individuals to learn and grow in line with their own needs, interests, and goals, free from the constraints of rigid educational structures (Anshu, 2022).

The development of science and technology in the digital age further enhances the application of SDL. With the support of the Internet, online education platforms, and a vast array of resources, learners can access knowledge anytime, anywhere, freely exploring and honing their skills through diverse learning activities (Biggs, 2024). A modern learning environment that integrates technology not only provides abundant resources but also stimulates interest, excitement, and motivation among learners. As a result, they become more confident, believe in their ability to make decisions, and take a proactive approach to learning, transforming knowledge acquisition into an engaging and rewarding journey of discovery (Karataş & Arpaci, 2021). SDL contributes to the development of dynamic, creative individuals who can adapt to change and pursue lifelong learning autonomously (Loeng, 2020).

2.4. Comparative Analysis: Blended Learning Models Worldwide and Vietnam

Blended learning models have evolved differently across regions, influenced by technological infrastructure, pedagogical approaches, and institutional policies. In Western countries, BL is often student-centered, incorporating active learning, flipped classrooms, and AI-driven adaptive learning (Vashishth et al., 2024). These models prioritize personalized learning pathways and data-driven instructional strategies to enhance engagement and SDL (Istenic, 2024). Universities in North America and Europe extensively use learning management systems (LMS), AI-powered tutoring, and real-time learning analytics to support individualized learning experiences.

In contrast, Vietnamese universities, including HUST, are still in the early stages of integrating student-centered BL. While there is government support for digital transformation in education (Decision 131/QD-TTg, 2023), BL remains lecture-heavy, with a slower transition to interactive and technology-enhanced models (Tran et al., 2023). LMS platforms are widely adopted, but AI-driven learning tools and personalized education technologies are not yet prevalent. Faculty training, infrastructure limitations, and student adaptability remain key challenges for widespread adoption of international best practices.

The comparison between BL implementation in advanced countries and Vietnam is summarized in Table 1.

Table 1. Comparative Analysis: BL Models Worldwide vs. Vietnam

Feature	BL in advanced countries	BL in Vietnam
Pedagogical Approach	Student-centered, Active Learning	Lecture-heavy, transitioning to active learning
Technology integration	AI-based adaptive learning, LMS systems	LMS integration, limited AI use
Common Strategies	Flipped classroom, problem-based learning	Instructor-led learning
Institutional support	Strong policy and funding for BL adoption	Government support, but resource constraints
Challenges	Digital literacy gaps, resistance to change	Digital literacy gaps, resistance to change, infrastructure limitation, faculty training needs

2.5. Summary of Key Studies on Blended Learning and Self-Directed Learning

Blended learning has been widely recognized as an effective instructional model that enhances student engagement, self-regulation, and learning autonomy. Numerous studies have explored the role of teaching strategies in blended environments and their impact on SDL, highlighting key factors such as active learning, flipped classrooms, and personalized instruction. While global research provides extensive insights into how BL fosters SDL, studies in the Vietnamese higher education context remain limited, with most focusing on student satisfaction and technological integration rather than SDL outcomes. To establish a strong theoretical foundation for this research, Table 2 summarizes key studies on BL and SDL, highlighting their findings, methodologies, and relevance to the current study.

Table 2. Key Studies on BL and SDL

Author(s)/Year	Study focus	Key findings
Graham (2004)	Definition and evolution of blended e-learning	Defined BL as an integration of face-to-face and online learning
Catlin & Tucker (2016)	Effectiveness of BL in fostering 21st-century skills	Found BL enhances problem-solving, communication, and digital literacy
Istenic (2024)	Role of collaboration in BL and its impact on SDL	Highlighted the positive influence of teamwork on SDL development
Cummings et al. (2017)	Impact of active learning strategies on SDL	Found that student-centered teaching significantly improves SDL abilities
Tran et al. (2023)	Implementation of BL in Vietnamese universities	Identified a need for structured faculty training and curriculum adaptation
Wang & Li (2024)	AI-driven adaptive learning in BL	Showed that AI-based learning pathways improve motivation and autonomy

2.6. Research model proposal

This study examines the impact of teaching strategies within a BL environment on students' SDL strategies. The independent variable is the teaching strategies while the dependent variable is the students' SDL competence.

The teaching strategies in BL include Student-Centered Approaches, Active Learning, the Flipped Classroom model, Personalized Learning, Peer Collaborative Learning, the Community of Inquiry (CoI), and Project-Based Learning. The Self-Rating Scale of SDL (SRSSDL) developed by Williamson measures students' SDL across five factors: Awareness, Learning Strategies, Learning Activities, Evaluation, and Interpersonal Skills, using a 5-point

Likert scale. In this study, this scale, the Self-Rating Scale of SDL (SRSSDL), is used to measure the dependent variable - students' level of SDL (Williamson, 2007) (See Figure 1).

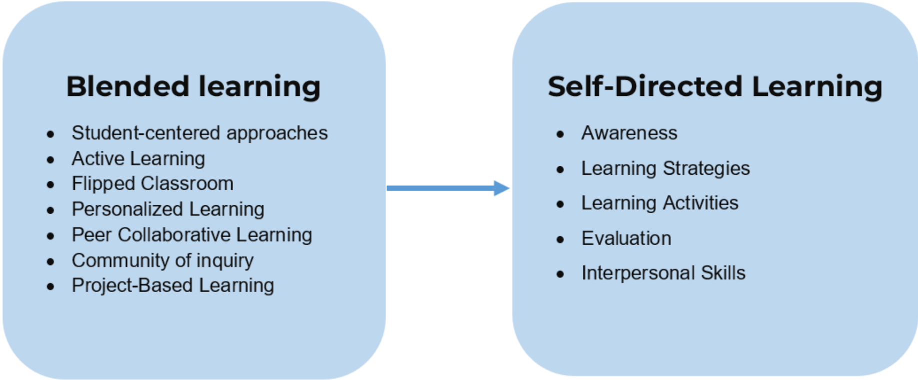

Figure 1. Research model

3. MATERIALS AND METHODS

3.1. Literature research methods

The literature research process involves three stages: First, a theoretical overview is conducted to analyze previous studies and identify research gaps. Second, literature on relevant topics is reviewed to build the research model. Lastly, measurement criteria are developed and validated through related studies to support the research model and hypotheses.

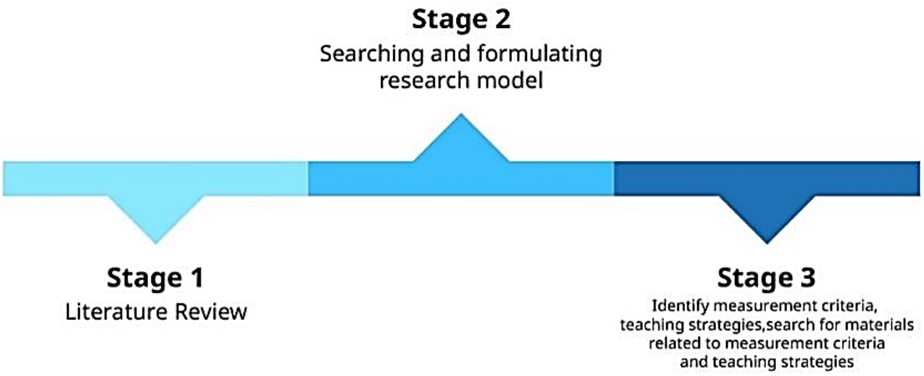

Figure 2. Stages of Literature Review

Stage 1: Literature reviews

Identify the research gaps, research topics, research objectives, research issues, and to develop a theoretical framework for the study.

Stage 2: Searching and formulating research model

Design the research model, formulate research questions, and identify measurement methods for the research variables. Select the most frequently used measurement methods.

Stage 3: Identify measurement criteria, teaching strategies, search for materials related to measurement criteria and teaching strategies.

Based on the criteria to select the most suitable measurement method for the study. Seven popular teaching strategies in recent BL studies were selected to be included in the survey questionnaire.

3.2. Quantitative research

This study employed a stratified sampling method to ensure a diverse and representative selection of students across multiple disciplines at HUST. Given that HUST offers a wide range of programs, they are grouped into seven major academic fields, including: Foreign Languages; Education Science, Business and Management; Physics, Chemistry, Material and Life Sciences; Mechanical Engineering; Electrical and Electronics Engineering; Mathematics and ICT.

These disciplines were selected based on their varying pedagogical approaches and levels of reliance on SDL strategies in a BL environment. STEM-related disciplines (Mechanical Engineering, Electrical and Electronics Engineering, and Mathematics & ICT) tend to incorporate problem-based learning, project-based learning, and flipped classrooms, all of which require a high degree of self-regulation and independent study. Meanwhile, Foreign Languages and Education Science often emphasize collaborative and active learning strategies, which also play a crucial role in SDL development.

In this study, the convenience sampling method was used to collect data. A total of 656 survey responses were collected from 16 classes implementing BL. After filtering out incomplete or inconsistent responses, 485 valid samples were retained. The survey content included demographic information, teaching strategies used in BL courses, and questions from the SRSSDL, using a 1-5 Likert scale.

The 485 valid samples were divided into seven groups based on the students' majors: Foreign Languages (45), Education Science (27), Business and Management (38), Physics, Chemistry, Material and Life Sciences (44), Mechanical Engineering (185), Electrical and Electronics Engineering (61), and Mathematics and ICT (85). This classification was made according to criteria such as the training program, field of specialization, and level of required knowledge. This approach allows for a more in-depth understanding of the characteristics and learning behaviors of each student group.

4. RESULTS AND DISCUSSION

4.1. Research findings

4.1.1. Teaching strategies at HUST

At HUST, "Student-Centered Approaches" and "Active Learning" strategies are highly popular, with 282 and 283 students, respectively, demonstrating significant engagement and appeal (Figure 3).

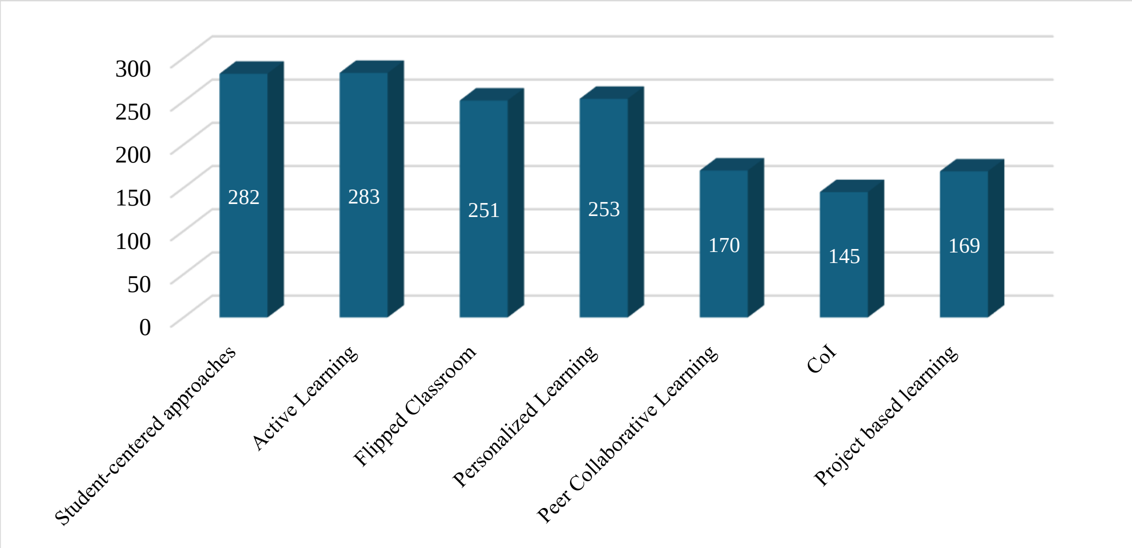

Figure 3. The Teaching Approaches applied at HUST in Blended-Learning courses

The study shows substantial student participation in "Flipped Classroom" and "Personalized Learning" strategies, while "Peer Collaborative Learning," "CoI" and "Project-Based Learning" had lower involvement due to the high interaction demands. "CoI" had the least participation, with 145 students, indicating a need for further research. The analysis of the SRSSDL scale reveals generally positive averages across all departments. The Electrical and Electronics Engineering group received the highest scores overall (M=3.8210), particularly excelling in the Awareness dimension (M=3.9235). In contrast, the Mechanical Engineering group scored the lowest overall (M=3.6456), though the differences between departments are not statistically significant.

Table 3. Mean values of the SRSSDL scale (Source: Authors' survey)

	Awareness	Learning Strategies	Learning Activities	Evaluation	Interpersonal skills	SRSSDL
Mathematics and ICT	3.8725	3.8373	3.6990	3.7863	3.7039	3.7798
Electrical and Electronics Engineering	3.9235	3.8880	3.7090	3.8415	3.7432	3.8210
Mechanical Engineering	3.7869	3.6842	3.5968	3.6149	3.5450	3.6456
Physics, Chemistry, Material and Life Sciences	3.8277	3.7822	3.7235	3.6705	3.6534	3.7314
Business and Management	3.7654	3.7105	3.5987	3.7851	3.6689	3.7057
Education Science	3.6605	3.7840	3.5216	3.7500	3.7037	3.6840
Foreign Languages	3.8593	3.7407	3.7019	3.7352	3.7389	3.7552

4.1.2. The effect of teaching strategies on self-directed learning competence

After analyzing the data on the seven teaching strategies to examine their impact on the dependent variable, which is the various aspects of SDL, the results show that only two main teaching strategies significantly affect SDL: Active Learning and Problem-Based Learning (Tables 4, 5, 6, 7). Additionally, for the element of Interpersonal Skills Learning, the strategy of Personalized Learning also has a notable impact.

Table 4. Coefficients of Dependent Variable: Awareness (Source: Author's survey)

Model	Unstandardized Coefficients		Standardized Coefficients	T	Sig.	Correlations			Collinearity Statistics	
	B	Std. Error	Beta			Zero-order	Partial	Part	Tolerance	VIF
(Constant)	3.609	.045		80.415	.000					
Active Learning	.244	.054	.200	4.542	.000	.205	.203	.200	.999	1.001
Problem-based Learning	.201	.055	.159	3.623	.000	.165	.163	.159	.999	1.001

Based on the regression model results for Awareness, it is evident that Active Learning has the strongest positive impact, with a standardized regression coefficient of 0.200. Project-Based Learning also has a positive impact, reflected by a standardized regression coefficient of 0.159.

Table 5. Coefficients of Dependent Variable: Learning Strategies (Source: Author's survey)

Model	Unstandardized Coefficients		Standardized Coefficients	T	Sig.	Correlations			Collinearity Statistics	
	B	Std. Error	Beta			Zero-order	Partial	Part	Tolerance	VIF
(Constant)	3.547	.047		75.428	.000					
Active Learning	.272	.056	.214	4.836	.000	.217	.215	.213	.999	1.001

Model	Unstandardized Coefficients		Standardized Coefficients	T	Sig.	Correlations			Collinearity Statistics	
	B	Std. Error	Beta			Zero-order	Partial	Part	Tolerance	VIF
Problem-based Learning	.153	.058	.116	2.629	.009	.122	.119	.116	.999	1.001

Based on the regression model results for Learning Strategies, it is evident that Active Learning has the strongest positive impact, as indicated by the standardized regression coefficient of 0.214. Project-Based Learning also has a positive impact, with a standardized regression coefficient of 0.116.

Based on the regression model results for Learning Activities, it is evident that Active Learning has the strongest positive impact, with a standardized regression coefficient of 0.201. Project-Based Learning also has a positive impact, reflected by a standardized regression coefficient of 0.118 (Table 6).

Table 6. Coefficients of Dependent Variable: Learning Activities (Source: Author's survey)

Model	Unstandardized Coefficients		Standardized Coefficients	t	Sig.	Correlations			Collinearity Statistics	
	B	Std. Error	Beta			Zero-order	Partial	Part	Tolerance	VIF
(Constant)	3.437	.048		71.018	.000					
Active Learning	.263	.058	.201	4.543	.000	.205	.203	.201	.999	1.001
Problem-based Learning	.159	.060	.118	2.658	.008	.124	.120	.118	.999	1.001

The regression model findings for Evaluation clearly indicate that Active Learning has the strongest positive impact, with a standardized regression coefficient of 0.231. Project-Based Learning also exerts a positive influence, confirmed with a standardized regression coefficient of 0.123 (Table 7).

Table 7. Coefficients of Dependent Variable: Evaluation (Source: Author's survey)

Model	Unstandardized Coefficients		Standardized Coefficients	t	Sig.	Correlations			Collinearity Statistics	
	B	Std. Error	Beta			Zero-order	Partial	Part	Tolerance	VIF
(Constant)	3.474	.049		71.393	.000					
Active Learning	.305	.058	.231	5.247	.000	.234	.232	.230	.999	1.001
Problem-based Learning	.169	.060	.123	2.803	.005	.130	.127	.123	.999	1.001

The results from the regression model for Interpersonal Skills demonstrate that Problem-Based Learning exerts the most significant positive effect, with a standardized regression coefficient of 0.149. Active Learning also contributes positively, with a standardized regression coefficient of 0.111, and Personalized Learning further adds a positive influence (Table 8).

Table 8. Coefficients of Dependent Variable: Interpersonal Skills (Source: Author's survey)

Model	Unstandardized Coefficients		Standardized Coefficients	t	Sig.	Correlations			Collinearity Statistics	
	B	Std. Error	Beta			Zero-order	Partial	Part	Tolerance	VIF
(Constant)	3.401	.060		56.628	.000					
Active Learning	.157	.063	.111	2.496	.013	.117	.113	.111	.999	1.001
Personalize Learning	.145	.062	.104	2.328	.020	.124	.106	.103	.985	1.015
Problem-based Learning	.218	.065	.149	3.338	.001	.165	.150	.148	.985	1.015

Analysis of SDL by seven student groups

The application of a One-Way ANOVA to the complete set of 60 questions within the Self-Rating Scale of Self-Directed Learning (SRSSDL) identifies statistically significant mean differences in three specific questions: 1.1, 2.1, and 3.4. The other questions had Sig. coefficients greater than 0.05, indicating no significant statistical difference in mean values.

For Question 1.1, "I identify my own learning needs." the Sig. result of 0.019 ($p < 0.05$) (Table 7) indicates a statistically significant difference among the groups in their ability to self-identify learning needs. The Electrical and Electronics Engineering group had the highest mean score (3.9344), suggesting they are most capable of identifying their learning requirements, while the Education Science group had the lowest mean score (3.2963), indicating they may face challenges in this area compared to other groups.

For Question 2.1, "I participate in group discussions." the Sig. value of 0.000 ($p < 0.05$) (Table 8) shows a statistically significant difference among groups in the frequency of participation in group discussions. The Education Science group scored the highest mean (3.7407), reflecting their active engagement in group discussions, whereas the Mechanical Engineering group had the lowest mean score (2.9730), indicating they participate less in group discussions compared to their peers.

Table 9. ANOVA Analysis (Source: Author's survey)

		Sum of Squares	df	Mean Square	F	Sig.
1.1. I identify my own learning needs.	Between Groups	9.549	6	1.591	2.555	.019
	Within Groups	297.742	478	.623		
	Total	307.291	484			
1.2. I participate in group discussions.	Between Groups	50.623	6	8.437	9.102	.000
	Within Groups	443.080	478	.927		
	Total	493.703	484			
1.3. I am able to use information technology effectively.	Between Groups	10.435	6	1.739	2.636	.016
	Within Groups	315.372	478	.660		
	Total	325.806	484			

For Question 3.4, "I am able to use information technology effectively." the Sig. value of 0.016 ($p < 0.05$) (Table 9) indicates a statistically significant difference among groups in their effective use of information technology. The

Foreign Languages group had the highest mean score (3.9333), showing their proficiency in using information technology, while the Mechanical Engineering group had the lowest mean score (3.5946), suggesting their room for improvement in this area compared to other groups.

Table 10. Descriptive Analysis (Source: Author's survey)

		N	Mean	Std. Deviation	Std. Error	95% Confidence Interval for Mean	
						Lower Bound	Upper Bound
1.1. I identify my own learning needs.	Mathematics and ICT	85	3.8706	.75259	.08163	3.7083	4.0329
	Electrical and Electronics Engineering	61	3.9344	.77177	.09881	3.7368	4.1321
	Mechanical Engineering	185	3.7243	.77649	.05709	3.6117	3.8370
	Physics, Chemistry, Material and Life Sciences	44	3.7273	.81736	.12322	3.4788	3.9758
	Business and Management	38	3.6579	.87846	.14251	3.3692	3.9466
	Education Science	27	3.2963	.86890	.16722	2.9526	3.6400
	Foreign Languages	45	3.8222	.77720	.11586	3.5887	4.0557
	Total	485	3.7567	.79680	.03618	3.6856	3.8278
2.1. I participate in group discussions.	Mathematics and ICT	85	3.6235	.85880	.09315	3.4383	3.8088
	Electrical and Electronics Engineering	61	3.7377	.83470	.10687	3.5239	3.9515
	Mechanical Engineering	185	2.9730	1.05001	.07720	2.8207	3.1253
	Physics, Chemistry, Material and Life Sciences	44	3.5000	.90219	.13601	3.2257	3.7743
	Business and Management	38	3.5263	1.03289	.16756	3.1868	3.8658
	Education Science	27	3.7407	1.02254	.19679	3.3362	4.1452
	Foreign Languages	45	3.6000	.88933	.13257	3.3328	3.8672
	Total	485	3.3753	1.00997	.04586	3.2851	3.4654
3.4. I am able to use information technology effectively.	Mathematics and ICT	85	3.9294	.70353	.07631	3.7777	4.0812
	Electrical and Electronics Engineering	61	3.8525	.81314	.10411	3.6442	4.0607
	Mechanical Engineering	185	3.5946	.87413	.06427	3.4678	3.7214
	Physics, Chemistry, Material and Life Sciences	44	3.8409	.83369	.12568	3.5874	4.0944
	Business and Management	38	3.6316	.67468	.10945	3.4098	3.8533
	Education Science	27	3.6667	1.00000	.19245	3.2711	4.0623
	Foreign Languages	45	3.9333	.68755	.10249	3.7268	4.1399
	Total	485	3.7464	.82046	.03726	3.6732	3.8196

SDL of HUST students

According to the SRSSDL scale, the total score for the questionnaire is categorized as follows: 60-140 (Low), 141-220 (Moderate), and 221-300 (High). Six out of the seven groups achieved scores in the high range (221-300), with only the Mechanical Engineering group falling into the moderate range (Figure 4).

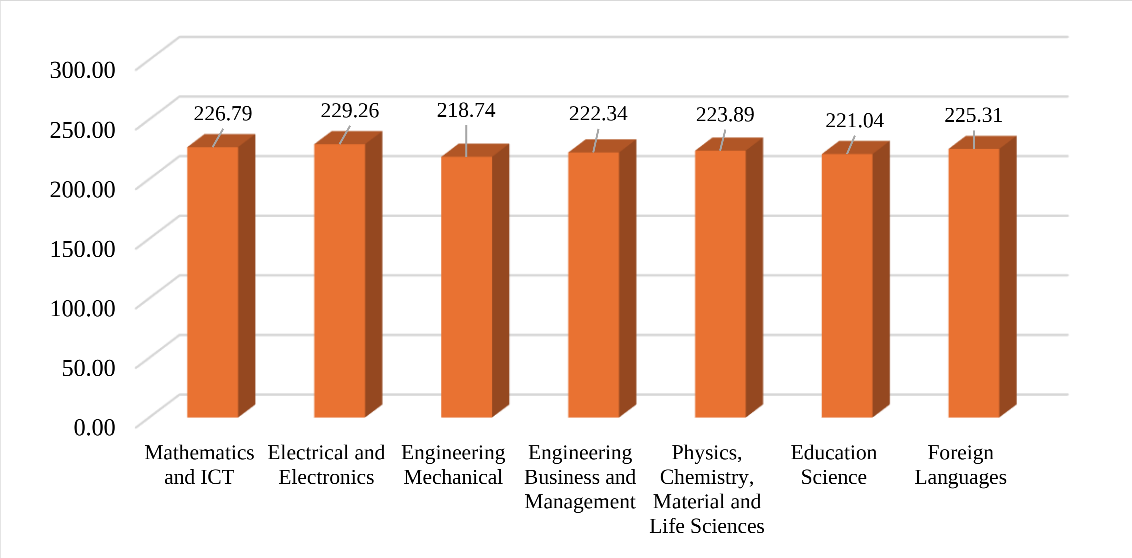

Figure 4. SDL levels Total score of seven group students

4.2. Discussion

The analysis results demonstrate that BL positively enhances the SDL ability of HUST students. All seven groups exhibited high or near-high levels of SDL, although the most effective teaching strategies varied among the groups. The highest SDL levels were observed in the Electrical and Electronics Engineering group, while the Mechanical Engineering group showed the lowest levels. Within the BL framework, the two teaching strategies - Active Learning and Problem-Based Learning - have the most significant impact on students' SDL abilities. These strategies positively influence all aspects of SDL, with Personalized Learning additionally impacting communication skills. BL provides an optimal environment for implementing these teaching strategies, allowing students to engage in a mix of online and in-person activities, discussions, and group work, rather than relying solely on traditional lectures.

Among the 60 questions on the SRSSDL scale, three questions revealed statistically significant differences in average scores. The findings show that the ability to identify learning needs was highest in the Electrical and Electronics Engineering group, significantly surpassing that of the Education Science group. The students in the Mechanical Engineering group participated in group activities less frequently than those in other groups. Additionally, the ability to use information technology effectively in BL was the most pronounced among the students in the Foreign Languages group, while it was lowest among the students in the Mechanical Engineering group. Therefore, students in the Education Science group may require additional support in identifying learning needs, while Mechanical Engineering students should focus on improving their group discussion skills and information technology usage.

The SRSSDL scores for HUST students indicate that six groups achieved high levels, while one group achieved a near-high level. Consequently, instructors need to apply appropriate teaching strategies to support these varying levels of SDL. Concerning classes where most students have moderate SDL abilities, instructors should identify and address areas needing improvement and offer guidance when necessary. As for classes where most students have high SDL abilities, instructors should maintain and strengthen students' existing strengths and continue to apply effective teaching strategies.

The study underscores that the BL approach positively impacts the SDL of students at HUST. The most effective teaching strategies in this context are Active Learning, Problem-Based Learning, and Personalized Learning. Additionally, BL showcases its strengths in enhancing student awareness and promoting interactive learning within the classroom.

5. CONCLUSION

Contributions and constraints

First, this study makes a significant contribution to the growing body of research on BL and SDL by focusing on engineering students at HUST - a group that has received limited attention in previous studies. Unlike traditional theoretical disciplines, engineering education at HUST is characterized by a strong emphasis on problem-solving, applied learning, and hands-on experimentation, requiring students to engage in self-regulated and autonomous learning practices. The technical nature of engineering courses, combined with the hybrid structure of BL, presents unique challenges and opportunities in fostering SDL among students.

Second, this research paper proffers important contributions to various aspects of education. For learners (students, trainees, etc.), this study provides a clear understanding of the teaching strategies currently applied in the BL model. With this knowledge, learners can adjust their learning strategies accordingly to enhance their efficiency in the learning process. Furthermore, learners are also encouraged to explore other strategies to figure out the most appropriate and optimal learning strategy. Regarding lecturers, this study supports capacity building and professional development by helping them effectively apply teaching strategies that have been proved to positively impact a BL environment.

With regard to administrators and educational institutions (such as HUST), the study provides valuable data for managing, organizing, and improving essential conditions, such as facilities, information technology systems, and learning resource repositories to maximize the effectiveness of the BL model. Additionally, this study serves as a valuable reference for individuals and research groups interested in topics related to BL and SDL. As for society, the research reflects the current state and effectiveness of the BL model's implementation at universities in general, and at HUST in particular. It thereby contributes to the development of high-quality human resources.

Due to time constraints, the research team was able to collect data only at a single point in time. As a result, the findings may not fully capture the variability or accurately reflect the reality. To improve the quality of future research, the team plans to implement a multi-time survey approach (including early and late-semester surveys) to gain deeper insights into the correlation and reliability of the data.

Recommendations to enhance the effectiveness of BL courses

Based on the findings and analysis, to maximize the benefits of BL in fostering SDL at HUST and other universities, tailored recommendations are provided for key stakeholders: students, lecturers, and the university administration.

Recommendations for Students

Students play a critical role in active engagement with blended learning environments. To enhance their SDL capabilities, students should:

- Adopt active learning strategies: Engage in pre-class preparation for flipped classroom sessions, take initiative in discussions, and apply problem-based learning approaches.

- Develop digital literacy skills: Utilize online learning platforms (LMS, MOOCs, and research databases) to access diverse educational materials.

- Practise time management and goal setting: Use learning plans, study schedules, and progress-tracking tools to manage self-paced learning in BL.

- Leverage peer collaboration: Participate in study groups, discussion forums, and collaborative projects to enhance peer-supported learning.

- Seek feedback and utilize university resources: Actively seek guidance from instructors, use self-assessment tools, and attend academic support workshops.

Recommendations for Lecturers

Lecturers play a pivotal role in designing and facilitating effective blended learning experiences. To support SDL in BL environments, they should:

- Implement student-centered pedagogies by integrating active learning, flipped classrooms, and project-based learning to encourage student autonomy and/or using gamification and adaptive learning technologies to personalize instruction.

- Enhance digital teaching competencies by engaging in continuous professional development on LMS tools, AI-driven learning analytics, and virtual labs and using interactive multimedia content (e.g., videos, simulations, online quizzes) to enhance engagement.

- Encourage Self-Assessment and Reflection through guiding students in using self-evaluation rubrics and learning journals to monitor their SDL progress and providing constructive, timely feedback on assignments and projects.

- Facilitate online and offline support by offering virtual office hours, creating discussion boards for ongoing academic support and designing hybrid consultation sessions that combine face-to-face mentorship with online Q&A forums.

Recommendations for University Administration

To create a sustainable and supportive BL environment, the university are advised to:

- Enhance infrastructure and digital resources: expanding access to high-quality LMS platforms, AI-driven assessment tools, and virtual labs and investing in smart classrooms, high-speed internet, and mobile learning solutions for flexible learning access.

- Develop faculty training programs by organizing workshops on SDL-friendly teaching strategies and integrating blended learning pedagogies and encouraging faculty participation in global blended learning conferences and certifications.

- Promote a blended learning culture through the establishment of a university-wide policy supporting flexible learning formats and hybrid course structures and the recognition and reward for innovative BL teaching practices through grants and incentives.

- Ensure equitable access to BL by providing digital learning resources for students from diverse backgrounds and developing student mentoring programs to guide first-year students in adapting to BL environments.

By implementing these tailored recommendations, HUST can enhance the effectiveness of blended learning, foster self-directed learning, and prepare students for lifelong learning in a digitally evolving world.

Broadening the Perspective on the Long-Term Impact of Blended Learning

BL is not merely a short-term instructional strategy but a transformative educational approach that aligns with Vietnam's long-term digital transformation goals. As HEIs in Vietnam increasingly integrate technology into teaching and learning, the development of SDL skills becomes instrumental to equip students with the ability to adapt to emerging technologies, lifelong learning demands, and global workforce requirements.

Vietnam is undergoing rapid digital transformation, with government policies such as Decision 131/QD-TTg (2023) prioritizing digital education and online learning models. In this context, BL plays a critical role in fostering self-directed learners who can:

- Independently acquire and update knowledge in response to evolving industry demands.
- Utilize digital tools and online resources effectively for continuous learning.
- Develop problem-solving and critical thinking skills necessary for innovation-driven careers.

By embedding SDL within BL courses, universities can prepare students for lifelong learning, ensuring they remain competitive in dynamic technological fields such as engineering, information technology, and artificial intelligence. By emphasizing SDL as a core outcome of BL, HUST and other universities can equip future engineers with the adaptability and self-learning skills needed for lifelong career success.

Conflict of Interest: No potential conflict of interest relevant to this article was reported.

REFERENCES

Anshu, N., Gupta, P., & Singh, T. (2022). The Concept of Self-Directed Learning: Implications for practice in the Undergraduate curriculum. *Indian Pediatrics*, *59*(4), 331-338. https://doi.org/10.1007/s13312-022-2501-x

Biggs, J. (2024). Aligning teaching for constructing learning. *The Higher Education Academy*. https://www.researchgate.net/publication/Aligning_Teaching_for_Constructing_Learning.

Carroll, A., Maguire, M., & Ginty, C. (2024). Blended Learning in Higher Education: N-TUTORR Overview of Blended Learning and Its Impact on the Student Experience.

Castro, R. (2019). Blended learning in higher education: Trends and capabilities. *Education and Information Technologies*, *24*(4), 2523-2546. https://doi.org/10.1007/s10639-019-09886-3

Catlin, R. T., & Tucker, T. W. (2016). *Blended learning in action: A practical guide toward sustainable change*. Corwin Press.

Cronje, J. (2020). Towards a new definition of blended learning. *The Electronic Journal of e-Learning*, *18*(2). https://doi.org/10.34190/ejel.20.18.2.001

Cummings, C., Mason, D., Shelton, K., & Baur, K. (2017). Active learning strategies for online and blended learning environments. In *IGI Global eBooks* (pp. 88-114). https://doi.org/10.4018/978-1-5225-1803-7.ch006

Graham, C. R (2004). Blended learning Systems: Definition, Current Trends, and Future Directions. In Bonk, C. J. & Graham, C. R. (Eds) (in press). *Handbook of Blended Learning: Global Perspectives, Local Designs*. San Francisco, CA: Pfeiffer Publishing.

Ismaya, B., Arifin, A., Pattiasina, P. J., Destari, D., & Kusumawati, E. A. (2022). Concept and implemented blended learning for higher education. *KnE Social Sciences*, 350-358. https://doi.org/10.18502/kss.v7i10.11373

Istenič, A. (2024). Blended learning in higher education: the integrated and distributed model and a thematic analysis. *Discover Education*, *3*(1). https://doi.org/10.1007/s44217-024-00239-y

Karatas, K., & Arpaci, I. (2021). The role of self-directed learning, metacognition, and 21st century skills predicting the readiness for online learning. *Contemporary Educational Technology*, *13*(3), ep300. https://doi.org/10.30935/cedtech/10786

Knowles, M. (1975). *Self-Directed Learning: A Guide for Learners and Teachers*. Chicago, IL: Follett Publishing Company.

Loeng, S. (2020). Self-Directed learning: a core concept in adult education. *Education Research International*, 1-12. https://doi.org/10.1155/2020/3816132

Nedeva, V., Dineva, S., & Ducheva, Z. (2019). Students in Blended Learning by Flipped Classroom Approach. *Information Technologies and Learning Tools*, *72*(4), 204-213. https://doi.org/10.33407/itlt.v72i4.3046

Tran, L. T. T., Cao, T. T., & Vo, V. L. H. (2023). Pedagogical challenges in online teaching: A qualitative study on Vietnamese university teachers of social sciences. *Vietnam Journal of Education*, *7*(Special Issue), 227-239. https://doi.org/10.52296/vje.2023.300

Vander Ark, T. (2024). *Four mega trends reshaping global learning.* Forbes Education Review.

Vashishth, T. K., Sharma, V., Sharma, K. K., Kumar, B., Panwar, R., & Chaudhary, S. (2024). AI-Driven Learning Analytics for personalized feedback and assessment in higher education. In *Advances in media, entertainment and the arts (AMEA) book series* (pp. 206-230). https://doi.org/10.4018/979-8-3693-0639-0.ch009

Waqqar, S., Qaiser, A., & Ahmed Noor, A. (2024). Impact of Blended Learning Environment on Self-Directed Learning Skill Development Among PostGraduates of Health Professions Education. (2024). *Medical Forum Monthly*, *31*(10), 189-193.

Williamson, S. N. (2007). Development of a self-rating scale of self-directed learning. *Nurse Researcher*, *14*(2), 66-83. https://doi.org/10.7748/nr2007.01.14.2.66.c6022

Zimmerman, B. J. (1990). Self-Regulated Learning and Academic Achievement: An Overview. *Educational Psychologist*, *25*(1), 3-17. https://doi.org/10.1207/s15326985ep2501_2