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The impact of active learning and learning style on blended learning: Insights from higher education students

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ABSTRACT

Blended learning is a progressive teaching technique combining online and face-to-face instruction to encourage active learning and improve academic achievement. However, various problems, such as different attitudes and learning styles between educators and students, influenced the implementation of blended learning effectively. Therefore, there is a need to identify the factors that impact blended learning to improve students' performances and enhance blended learning. In this study, the proposed framework examines the mediation effect of active learning on the relationship between learning styles and accessibility of learning through blended learning. The study sample consisted of undergraduate students from Universiti Putra Malaysia. In addition, this study also utilized a random sampling method. In total, 224 responses were collected and analyzed using a partial least square structural equation modeling (PLS-SEM). The findings revealed that active learning fully mediated the relationship between learning style and blended learning. Active learning also mediated the relationship between accessibility and blended learning with complementary mediation. Moreover, this study offers several practical suggestions for essential parties, including the government and the education sector, to optimize blended learning approaches in Malaysia.

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1. INTRODUCTION

Education experts are becoming increasingly worried about the effects of this pandemic on the day-to-day operations of the education sector and students worldwide. Accordingly, the COVID-19 pandemic has posed significant challenges in education [1], [2]. Based on the statistics from the United Nations, by March 18th, 2020, 107 countries had closed their universities, secondary, and primary institutions for an unspecified period due to the increased risks of contagion dangers in heavily populated regions, impacting 862 million students or probably half of the worldwide student population [3]. Therefore, face-to-face (F2F) lectures became a thing of the past as a virtual learning environment utilizing multiple platforms and social media technologies have taken over [1], [4]. Consequently, academicians and institutions of higher learning implemented new teaching and learning methods to improve student performance through various educational techniques, notably technology-enhanced learning [5], [6].

As a result, blended learning (BL) appears to be a viable answer to the health concerns posed by the COVID-19 pandemic. As one of the most common approaches for incorporating digital technology into

education [6], BL mixes various delivery mechanisms, learning styles, and types of lesson plans. In other words, BL attempts to integrate F2F and online contexts, resulting in increased student participation and more flexible active learning, with rich configurations by use of a simple internet context library to support the F2F session [6], [7]. Accordingly, blended learning appears to be the most suitable e-learning method in transitioning from conventional to online learning [8], [9].

2. CONCEPTUAL FRAMEWORK AND HYPOTHESIS DEVELOPMENT

2.1. Blended learning

The adoption of blended learning appears to be one of the potential answers to the serious health concerns posed by the COVID-19 pandemic [10]. Effective blended learning involves different delivery modes, teaching models, and learning styles [11], [12] and is based on the concept that achieving learning targets turned on learning and teaching quality that has a positive influence on the curriculum progress [13], [14]. Moreover, student engagement was also crucial in blended learning.

Blended learning improved student satisfaction and productivity, resulting in more conceptual changes, new abilities, and enhanced performance [15]. Even though blended learning had viable advantages, its adoption required consideration of several factors, and this caused some issues and challenges. The most challenging aspect of blended learning is incorporating the concept into the teaching and learning system [6].

Similarly, cultural adaptability and technology knowledge were two main issues in blended learning design [16]. Hence, students must be adaptable to embrace the new educational method, since Huang [14] indicated a low interest in learning due to implementing blended learning. A study on effective blended learning during the pandemic revealed that educators encountered several challenges in creating lecture videos and selecting the best design suited for lectures [17].

2.2. Learning style (LS)

Some researchers stated that learning style is one of the top factors affecting BL [18]. Individuals' learning styles are various strategies for processing and organizing knowledge and reacting to external cues [19]. Learning styles are prominent ideas in psychology and education used to determine how people acquire knowledge. There are four types of learning styles commonly used in previous research such as visual [18], [19], audio [20], interpersonal [21], [22], and intrapersonal [23]. Learning style was significant in describing and comprehending user interactions with systems [24].

Similarly, students' learning styles contributed to students' engagement in class [25]. Siew-Eng and Muuk [24] also revealed that there has been a lack of research on the learners' intention to utilize learning technology from the standpoint of learning styles. Accordingly, learning styles significantly influenced educators' interaction, group project settings, and customized learning experiences [25].

2.3. Accessibility of learning (AOL)

Accessibility of learning (AOL) is essential in the blended learning approach [26]. AOL is the flexibility of academic adjustment preparation for students that guarantees open access to education [27], [28]. Learning Management System is a blended learning approach that reflects the AOL criteria. Therefore, educators are encouraged to provide accessibility aspects in their teaching and learning platform, such as accessible course content, online courses, and internet-based student tasks [29]. Moreover, using technology in the teaching and learning process, such as online learning tools, will benefit students in accessing the learning information [26].

2.4. Active learning (AL)

Active learning (AL) is among the most significant factors in enhancing blended learning. It is an instructional approach that incorporates the student's active participation in learning via viable activities [30]. Examples of active learning approaches include real-life patient case studies, discussion questions, and buzz-group conversations. Students must engage with the lecturers' teaching approach to improve their blended learning [13]. Several researchers have studied the impact of active learning on the blended learning curriculum [5], [9], [13] had found that it is fundamental to determine the level of active learning coupled with learning style and accessibility of learning to design an effective blended learning design.

A passive approach to blended learning discouraged students from completing tasks, especially students ready to implement active learning and preferred a F2F learning setting [5]. Suharyati *et al.* [31] examined the indirect effect of active learning and found that active learning mediated the relationship between social factors and students' engagement. Similarly, active learning significantly enhanced blended learning [32], [33]. Since the active learning element is essential to the blended learning design and enhancement process [34], the hypotheses proposed in this study are: i) H_1: Active learning significantly

mediated the relationship between active learning and blended learning; and ii) H_2: Active learning significantly mediated the relationship between the accessibility of learning and blended learning.

3. RESEARCH METHOD

3.1. Participants and data collection procedure

This study utilized a survey questionnaire and simple random sampling methods to collect data. The questionnaires had a 10-point interval scale with answer scores that ranged between strongly disagree=1 and strongly agree=10. Subsequently, four experts were used in this study (three for content validity and another one for scale measurement) to evaluate the questionnaire to ensure content validity. According to Rausch–Koster *et al.* [33], content validity is important because it can determine the suitability of an instrument for the study. However, no numerical index indicates content validity [34].

The respondents consisted of students who actively utilized the e-learning platform and learning management system (LMS) during the closure of their institution due to the COVID-19. This learning mode was known as PutraBLAST, and it featured educator tools that ensure optimum teaching and learning in a blended learning environment. In total, 224 undergraduate students from Universiti Putra Malaysia were selected using a random sampling method. Based on this benchmark, the sample size was adequate to permit estimates. The partial least squares structural equation modeling (PLS-SEM) is significant when the sample size is small [35], but it also works exceptionally well on large sample sizes.

4. DATA ANALYSIS

4.1. Mediation analysis

This study anticipated that active learning is the significant mediator in learning styles and accessibility of learning towards blended learning among undergraduate students. A few decades ago, Hair *et al.* [35] proposed a mediation analysis approach called a causal approach. However, the mediation analysis approach has conceptual and methodological problems [35].

There are two stages in mediation analysis, such as testing of total indirect effect and direct effect. Although the test by Hair *et al.* [35] is famous for indirect effect testing, it is irrelevant to the present study. The best alternative to indirect impact testing is to use the bootstrap approach. The findings by Hair *et al.* [35] summed up the bias-corrected bootstrap confidence interval and the percentile bootstrap confidence interval as the best tests for the bootstrap approach.

4.2. Research framework model

To answer hypothesis 1 and 2, the hierarchical latent variable model with a reflective-formative, type II model. Figure 1 shows that active learning and learning styles are higher-order constructs, while the accessibility of learning and blended learning are lower-order constructs. The evaluation of the hierarchical latent variable model involved three steps, namely i) The assessment of the measurement model for lower-order constructs; ii) The evaluation of the measurement model for higher-order constructs; and iii) The evaluation of the structural model. This study used a two-stage disjoint (DT-S) approach with Mod B and a path weighting scheme proposed by Hair *et al.* [35] in estimating the hierarchical latent variable model. There were two stages to the DT-S approach-stage one and stage two.

4.2.1. Stage one of the disjoint two-stage approach

The first stage of DT-S considers only the lower-order constructs of higher-order constructs associated with other constructs. They are theoretically related to higher-order constructs. The assessment of the reflective measurement model of the lower-order construct relied on the findings obtained from the first stage of the DT-S approach [35].

4.2.2. Assessment of the reflective measurement model

The evaluation of the lower-level constructive reflective measurement model was based on: i) the reliability of the indicator or item; ii) internal consistency reliability; iii) convergent validity; and iv) discriminant validity [34]. The internal consistency reliability was based on Cronbach's alpha (CA), reliability metric (ρA), and composite reliability (CR), while the convergent validity depended on the average value of extracted variance (AVE). The internal consistency reliability, such as CA, ρA, and CR for each construct, exceeded the standard value of 0.708 [35]. On the other hand, AVE estimations for all components were more than 0.5 and met the cut-off threshold specified by [34], except the learning style audio (LSA) construct (AVE=0.479). Since the occult construct had not achieved the AVE standard value, this study removed the LSA7 indicator from the measurement model as it had the lowest item loading value of 0.58.

Table 1 shows the reliability of indicators, internal consistency reliability, and convergent validity of the new reflective measurement model upon exclusion of the LSA7 indicator. Although there are still items with an item loading value of less than 0.7, all constructs' CR, ρA, CA, and AVE values have reached the default values. This means that the model meets the indicators' reliability, internal consistency, and convergent validity conditions.

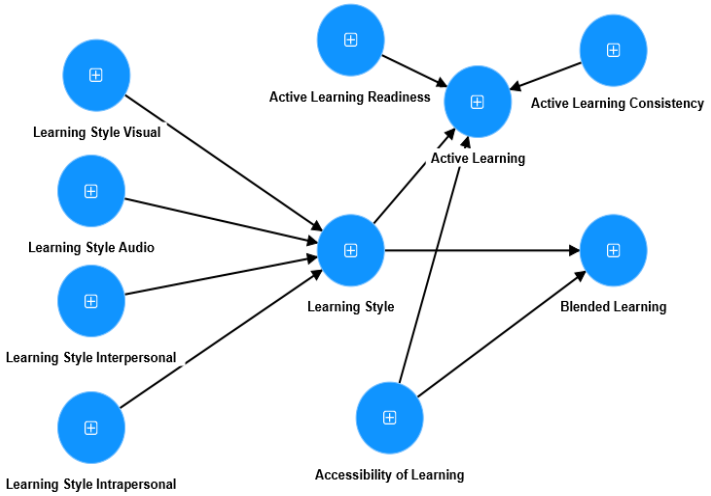

Figure 1. Research framework model

Table 1. Reflective measurement model results

Construct	CA	P_A	CR	AVE
Blended learning	0.958	0.963	0.964	0.69
Learning style visual	0.875	0.881	0.902	0.539
Learning style audio	0.844	0.855	0.88	0.479
Learning style interpersonal	0.908	0.913	0.926	0.613
Learning style intrapersonal	0.904	0.915	0.926	0.676
Accessibility of learning	0.953	0.955	0.959	0.703
Active learning readiness	0.917	0.931	0.933	0.61
Active learning consistency	0.915	0.917	0.929	0.568

Furthermore, the assessment of the validity of discrimination was based on the Fornell-Larcker criterion and the heterotrait-monotrait ratio (HTMT). Table 2 shows that the square root value of AVE (the thickened value) of each construct is greater than the correlation coefficient between constructs except for active learning consistency and blended learning. However, the Fornell-Larcker criterion lacks effectiveness, especially when there is only a slight difference in the value of the loading indicator for a construct [35]. As shown in Table 3, the value of the HTMT ratio for each construct was less than 1.0. Hence, there is no problem with the discriminant validity. Based on the Fornell-Larcker criterion and the HTMT ratio, it can be concluded that this measurement model has good reliability and achieved discriminant validity.

Table 2. Fornell-Larcker criterion

	LSV	LSA	LSIe	LSIa	AOL	ALR	ALC	BL
LSV	0.735							
LSA	0.670	0.712						
LSIe	0.675	0.737	0.783					
LSIa	0.437	0.43	0.29	0.822				
AOL	0.682	0.589	0.651	0.442	0.839			
ALR	0.668	0.535	0.599	0.450	0.778	0.781		
ALC	0.670	0.656	0.693	0.441	0.766	0.848	0.754	
BL	0.649	0.584	0.689	0.394	0.905	0.758	0.776	0.831

LSV=Learning style visual; LSA=Learning style audio; LSIe=Learning style interpersonal; LSIa= Learning style intrapersonal; AOL=Accessibility of learning; ALR=Active learning readiness; ALC=Active learning consistency; BL= Blended learning

Table 3. HTMT ratio

	LSV	LSA	LSIe	LSIa	AOL	ALR	ALC	BL
LSV								
LSA	0.777							
LSIe	0.756	0.844						
LSIa	0.478	0.476	0.321					
AOL	0.743	0.658	0.702	0.467				
ALR	0.734	0.613	0.659	0.494	0.821			
ALC	0.734	0.736	0.752	0.482	0.814	0.927		
BL	0.700	0.646	0.733	0.414	0.945	0.801	0.827	

LSV=Learning style visual; LSA=Learning style audio; LSIe=Learning style interpersonal; LSIa=Learning style intrapersonal; AOL=Accessibility of learning; ALR=Active learning readiness; ALC=Active learning consistency; BL=Blended learning

4.2.3. Stage two of the disjoint two-stage approach

Figure 2 shows stage two of the DT-S approach model. The assessment of the stage two model involved two parts–the evaluation of the high-level constructive formative measurement model and the structural model. The PLS-SEM assessment of the higher-order constructive formative measurement model was based on the collinearity indicator, statistical significance, and relevance of the indicator weigh [35].

Based on Table 4, VIF for all constructs were lower than 5.0 (VIF<5) [34]. Hence, all items did not encounter any multi-collinearity issue. The results of this higher-order formative construct measurement model also showed that four constructs with significant ($p<0.05$) influenced the learning style. Meanwhile, the findings also showed that both constructs with significant ($p<0.05$) influenced active learning. Learning style interpersonal and active learning consistency was the paramount contributor to learning style and active learning constructs. Upon completion of the assessments, the measurement model proved to be suitable for the assessment of the structural model.

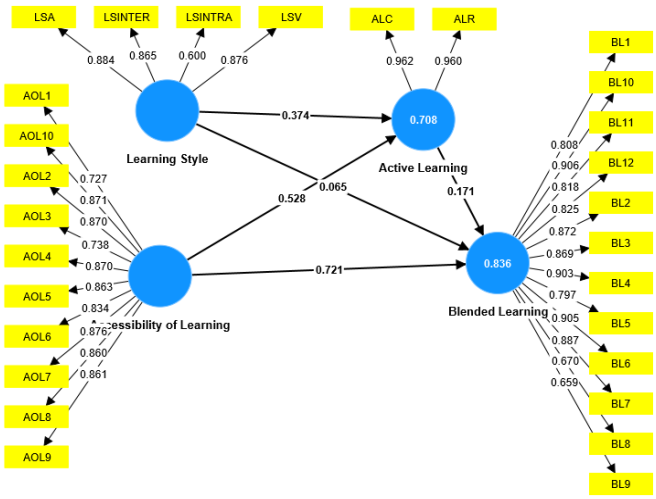

Figure 2. Stage two of the DT-S approach

Table 4. Collinearity between indicators and significance/relevance of outer weights

Higher-order constructs	Indicators	VIF	Outer weight	*p*-value
Learning style	Learning style visual	2.231	0.342	0.0000
	Learning style audio	2.647	0.306	0.0000
	Learning style interpersonal	2.561	0.346	0.0000
	Learning style intrapersonal	1.314	0.218	0.0000
Active learning	Active learning readiness	3.553	0.513	0.0000
	Active learning consistency	3.553	0.527	0.0000

Assessment of the determination coefficient (R^2) and predictive relevance (Q^2), was important in the structural model assessment. This hierarchical latent variable model described 70.8% and 83.6% of the variances in active learning (R^2=0.708) and blended learning (R^2=0.836). The R^2 value in this study implied that the hierarchical latent variable model had a strong predictor for the model. The result also showed the value of predictive relevance for active learning (Q^2=0.650) and blended learning (Q^2=0.571). Since Q^2 for both constructs was greater than 0.50, and implied that the model had a large predictive relevance [35].

The total indirect effect of learning style on blended learning among undergraduate students was 0.064, and the confidence interval (95%) corrected bias (CI) value was between 0.020 and 0.126. The CI value did not include a value of 0 and indicated that the indirect effect of learning style towards blended learning among undergraduate students was significant. This study also assessed the direct impact of learning style practice on blended learning among undergraduate students.

Table 5 shows the direct effect of learning style on blended learning among undergraduate students was 0.065 with CI (-0.056, 0.188). The value of CI included a value of 0, and this direct impact of learning style on blended learning among undergraduate students was insignificant. Based on Figure 2, it can be concluded that the relationship between learning style and blended learning among undergraduate students was fully mediated by active learning; therefore, H1 is affirmative.

Moreover, the total indirect effect of accessibility of learning through blended learning among undergraduate students was 0.090, and the confidence interval (95%) and CI values were between 0.024 and 0.171. This CI value did not include a value of 0 and indicated that the indirect effect of AOL towards blended learning among undergraduate students was significant. This study also assessed the direct impact of AOL on blended learning among undergraduate students.

Table 5 also shows that the direct effect of accessibility of learning on blended learning among undergraduate students was 0.721 with CI (0.602, 0.843). The value of CI did not include a value of 0, and the direct impact of learning style practice on blended learning among undergraduate students was significant. Moreover, the product value of the direct and indirect effects was positive. Based on Figure 2, it can be concluded that active learning complementarily mediates the relationship between the accessibility of learning and blended learning. Therefore, H_2 is in the affirmative.

Table 5. Structural model results

Construct	R^2	Q^2
Active learning	0.708	0.650
Blended learning	0.836	0.571
Indirect effect	Beta (β)	CI
Learning style → Active learning → Blended learning	0.064	0.020,0.126
Accessibility of learning → Active learning → Blended learning	0.090	0.024, 0.171
Direct effect	Beta (β)	CI
Learning style → Blended learning	0.065	-0.056,0.188
Accessibility of learning → Blended learning	0.721	0.602,0.843

5. RESULTS AND DISCUSSION

The first objective of this study was to examine the role of active learning as a mediator in the relationship between learning style and blended learning. The findings revealed a significant indirect effect of learning style on blended learning via active learning but an insignificant direct effect of learning style on blended learning. As a result of the study, it can be concluded that active learning fully mediates the association between learning style and blended learning. Hence, the learning style increases active learning and enhances blended learning. Even though learning style may influence the enhancement of the blended learning curriculum, blended learning would not be effective if the students are not ready and consistent in the active learning habit. Active learning increases academic performance and enhances students' interest in learning.

Furthermore, the learning style increases active learning and enhances blended learning. Moreover, active learning improves academic performance and enhances students' interest in learning [34]. These findings are consistent with previous studies [33] and revealed that students' learning styles did not significantly affect their academic achievement. In terms of indirect effect, the findings were like the study by [33] in that active learning mediates the relationship between immersive virtual reality (VR) and learning outcomes.

In addition, the second hypothesis of this study was to evaluate the role of active learning as a mediator in the relationship between learning accessibility and blended learning. The findings showed a significant indirect influence of learning accessibility on blended learning and the function of active learning as a mediator between learning accessibility and blended learning. As a result, active learning is complementary in mediating learning accessibility and blended learning. Hence, expanding learning system accessibility, directly and indirectly, improves blended learning among undergraduate students by increasing active learning. Thus, the system accessibility of learning is high, perceptions of active learning are more positive, and significantly influences the enhancement of the blended learning curriculum. Furthermore, most previous research used active learning as a crucial factor in enhancing learning outcomes. Finally, the findings indicated that active learning fully and complementarily mediates the relationship between learning style and accessibility of learning in the context of blended learning. Therefore, active learning strongly indicates blended learning among undergraduate students.

6. CONCLUSION

This study examines the mediating role of active learning towards the relationship between learning style and accessibility of learning on blended learning among higher education students. The data findings have educational implications, particularly in improving blended learning among undergraduate students in different settings. Furthermore, the results offer a fresh viewpoint on comprehending and debating the difficulties affecting the current blended learning systems, particularly at the university level. Accordingly, the present study contributes to the existing body of research on blended learning.

REFERENCES

[1] R. Huang *et al.*, "Emergence of the online-merge-offline (OMO) learning wave in the post-COVID-19 era: a pilot study," *Sustainability*, vol. 13, no. 6, p. 3512, Mar. 2021, doi: 10.3390/su13063512.

[2] R. M. Viner *et al.*, "School closure and management practices during coronavirus outbreaks including COVID-19: a rapid systematic review," *The Lancet Child & Adolescent Health*, vol. 4, no. 5, pp. 397–404, May 2020, doi: 10.1016/S2352-4642(20)30095-X.

[3] N. Luburić, J. Slivka, G. Sladić, and G. Milosavljević, "The challenges of migrating an active learning classroom online in a crisis," *Computer Applications in Engineering Education*, vol. 29, no. 6, pp. 1617–1641, Nov. 2021, doi: 10.1002/cae.22413.

[4] S. Lomer and E. Palmer, "'I didn't know this was actually stuff that could help us, with actually learning': student perceptions of active blended learning," *Teaching in Higher Education*, vol. 28, no. 4, pp. 679–698, 2023, doi: 10.1080/13562517.2020.1852202.

[5] F. Saadati, R. A. Tarmizi, and A. F. M. Ayub, "Utilization of information and communication technologies in mathematics learning," *Journal on Mathematics Education*, vol. 5, no. 2, Jul. 2014, doi: 10.22342/jme.5.2.1498.138-147.

[6] H. Machumu, M. Almasi, and C. Zhu, "Context-based blended learning models and implementation in Sub- Saharan Africa: a literature review," *New Trends and Issues Proceedings on Humanities and Social Sciences*, vol. 5, no. 1, pp. 190–199, Jun. 2018, doi: 10.18844/prosoc.v5i1.3414.

[7] A. Bryan and K. N. Volchenkova, "Blended learning: definition, models, implications for higher education," *Bulletin of the South Ural State University series "Education. Education Sciences,"* vol. 8, no. 2, pp. 24–30, 2016, doi: 10.14529/ped160204.

[8] A. Al-Azawei, P. Parslow, and K. Lundqvist, "Investigating the effect of learning styles in a blended e-learning system: an extension of the technology acceptance model (TAM)," *Australasian Journal of Educational Technology*, Nov. 2016, doi: 10.14742/ajet.2741.

[9] K. M. Y. Law, S. Geng, and T. Li, "Student enrollment, motivation and learning performance in a blended learning environment: The mediating effects of social, teaching, and cognitive presence," *Computers & Education*, vol. 136, pp. 1–12, Jul. 2019, doi: 10.1016/j.compedu.2019.02.021.

[10] N. De Jong, M. Savin-Baden, A. M. Cunningham, and D. M. L. Verstegen, "Blended learning in health education: three case studies," *Perspectives on Medical Education*, vol. 3, no. 4, pp. 278–288, Jan. 2014, doi: 10.1007/S40037-014-0108-1.

[11] S. Lane, J. G. Hoang, J. P. Leighton, and A. Rissanen, "Engagement and satisfaction: mixed-method analysis of blended learning in the sciences," *Canadian Journal of Science, Mathematics and Technology Education*, vol. 21, no. 1, pp. 100–122, Mar. 2021, doi: 10.1007/s42330-021-00139-5.

[12] L. D. Lapitan, C. E. Tiangco, D. A. G. Sumalinog, N. S. Sabarillo, and J. M. Diaz, "An effective blended online teaching and learning strategy during the COVID-19 pandemic," *Education for Chemical Engineers*, vol. 35, p. 116, 2021, doi: 10.1016/j.ece.2021.01.012.

[13] F. Razali, T. Sulaiman, A. F. M. Ayub, and N. A. Majid, "Effects of learning accessibility as a mediator between learning styles and blended learning in higher education institutions during the COVID-19 pandemic," *Asian Journal of University Education*, vol. 18, no. 2, pp. 569–584, Apr. 2022, doi: 10.24191/ajue.v18i2.18189.

[14] Y.-M. Huang, "Exploring the factors that affect the intention to use collaborative technologies: the differing perspectives of sequential/global learners," *Australasian Journal of Educational Technology*, vol. 31, no. 3, May 2015, doi: 10.14742/ajet.1868.

[15] S. Ghavifekr and W. A. W. Rosdy, "Teaching and learning with technology: effectiveness of ICT integration in schools," *International Journal of Research in Education and Science*, vol. 1, no. 2, p. 175, Mar. 2015, doi: 10.21890/ijres.23596.

[16] E. M. Jiménez-Hernández, H. Oktaba, F. Díaz-Barriga, and M. Piattini, "Using web-based gamified software to learn boolean algebra simplification in a blended learning setting," *Computer Applications in Engineering Education*, vol. 28, no. 6, pp. 1591–1611, Nov. 2020, doi: 10.1002/cae.22335.

[17] Lestari *et al.*, "Hybrid learning on problem-solving abiities in physics learning: A literature review," *Journal of Physics: Conference Series*, vol. 1796, no. 1, p. 012021, Feb. 2021, doi: 10.1088/1742-6596/1796/1/012021.

[18] J. D. Snowball, "Using interactive content and online activities to accommodate diversity in a large first year class," *Higher Education*, vol. 67, no. 6, pp. 823–838, Jun. 2014, doi: 10.1007/s10734-013-9708-7.

[19] F. Alonso, D. Manrique, L. Martínez, and J. M. Viñes, "Study of the influence of social relationships among students on knowledge building using a moderately constructivist learning model," *Journal of Educational Computing Research*, vol. 51, no. 4, pp. 417–439, Jan. 2015, doi: 10.2190/EC.51.4.c.

[20] E. Ivanova, M. Polyakova, and M. Abakumova, "Implementing a blended learning approach to foreign language teaching at SPbPU," *IOP Conference Series: Materials Science and Engineering*, vol. 940, no. 1, 2020, doi: 10.1088/1757-899X/940/1/012138.

[21] P. Padayachee and A. L. Campbell, "Supporting a mathematics community of inquiry through online discussion forums: towards design principles," *International Journal of Mathematical Education in Science and Technology*, vol. 53, no. 1, pp. 35–63, Jan. 2022, doi: 10.1080/0020739X.2021.1985177.

[22] G. Cheng and J. Chau, "Exploring the relationships between learning styles, online participation, learning achievement and course satisfaction: an empirical study of a blended learning course," *British Journal of Educational Technology*, vol. 47, no. 2, pp. 257–278, Mar. 2016, doi: 10.1111/bjet.12243.

[23] C. Malvik, "4 types of learning styles: how to accommodate a diverse group of students," Rasmussen University, 2020. [Online]. Available: https://www.rasmussen.edu/degrees/education/blog/types-of-learning-styles/ (accessed Jul. 04, 2020).

[24] L. Siew-Eng and M. A. Muuk, "Blended learning in teaching secondary schools' English: a preparation for tertiary science education in Malaysia," *Procedia - Social and Behavioral Sciences*, vol. 167, pp. 293–300, Jan. 2015, doi: 10.1016/j.sbspro.2014.12.677.

[25] N. Holiver, T. Kurbatova, and I. Bondar, "Blended learning for sustainable education: moodle-based English for specific purposes teaching at Kryvyi Rih National University," *E3S Web of Conferences*, vol. 166, 2020, doi: 10.1051/e3sconf/202016610006.

[26] F. Razali, "Exploring crucial factors of an interest in STEM career model among secondary school students," *International Journal of Instruction*, vol. 14, no. 2, pp. 385–404, Apr. 2021, doi: 10.29333/iji.2021.14222a.

[27] G. Gay, "Accessibility in e-learning: what you need to know," OCAD University, 2014. [Online]. Available: https://teaching.uwo.ca/pdf/teaching/accessibility-in-e-learning.pdf (accessed Nov. 02, 2020).

[28] B. M. Escribano, E. I. Agüera, and P. Tovar, "Television format or research project? Team work and the opportunity of choosing classroom-led activities reinforce active learning," *Advances in Physiology Education*, vol. 37, no. 2, pp. 207–209, Jun. 2013, doi: 10.1152/advan.00108.2012.
[29] E. Chew, L. J. N. Jones, and S. Wordley, "'Flipping or flapping?' investigating engineering students' experience in flipped classrooms," *On the Horizon*, vol. 26, no. 4, pp. 307–316, Nov. 2018, doi: 10.1108/OTH-04-2017-0014.
[30] J. Gong *et al.*, "Application of blended learning approach in clinical skills to stimulate active learning attitudes and improve clinical practice among medical students," *PeerJ*, vol. 9, p. e11690, Jun. 2021, doi: 10.7717/peerj.11690.
[31] H. Suharyati, L. H. Vonti, E. Suhardi, and O. Sunardi, "Promoting knowledge management approach and active learning model in blended learning activities of higher education," *International Journal of Innovation, Creativity and Change*, vol. 12, no. 9, pp. 123–142, 2020.
[32] N. Hernández-Nanclares and M. Pérez-Rodríguez, "Students' satisfaction with a blended instructional design: the potential of 'flipped classroom' in higher education," *Journal of Interactive Media in Education*, vol. 2016, no. 1, Jan. 2016, doi: 10.5334/jime.397.
[33] T. P. Rausch-Koster, A. J. van der Ham, C. B. Terwee, F. D. Verbraak, G. H. M. B. van Rens, and R. M. A. van Nispen, "Translation and content validity of the Dutch impact of vision impairment questionnaire assessed by three-step test-interviewing," *Journal of Patient-Reported Outcomes*, vol. 5, no. 1, p. 1, Dec. 2021, doi: 10.1186/s41687-020-00272-z.
[34] D. Ary, L. C. Jacobs, C. K. S. Irvine, and D. Walker, *Introduction to research in education*, 10th ed. Cengage Learning, 2018.
[35] J. F. Hair, J. J. Risher, M. Sarstedt, and C. M. Ringle, "When to use and how to report the results of PLS-SEM," *European Business Review*, vol. 31, no. 1, pp. 2–24, Jan. 2019, doi: 10.1108/EBR-11-2018-0203.

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