journal homepage: www.pktm.my

International Journal of Technical Vocational and Engineering Technology

e-SSN2710-7094, Vol. 5, No. 1 (2024)

Implementation of Blended Learning Method in Chemical Engineering Course

Chong Yang Chuah[1]*, Khairiraihana Johari[1]

[1]Universiti Teknologi PETRONAS, Persiaran UTP, 32610 Seri Iskandar, Perak, Malaysia

*Corresponding Author email: chongyang.chuah@utp.edu.my

ARTICLE INFO

Article History:
Received 31 January 2024
Revised 28 April 2024
Accepted 2 June 2024

Keywords:
Online learning,
Asynchronous session,
Blended learning

ABSTRACT

The presence of online learning platforms, namely LinkedIn Learning, edX, Udemy, and Coursera has served as an appropriate tool for learners to equip themselves with new skills or knowledge. Such a situation is driven sharply by the presence of the ongoing pandemic that makes it feasible to obtain knowledge through online means. However, online learning platform often demonstrates undesirable challenges that limit the effectiveness of the learners in grasping the knowledge. For instance, the motivation of the learners to grasp the knowledge is challenged by the difficulty level of the course that in most circumstances does not much well with the learners. Besides, the learning materials provided under such platforms often do not align well with the intended learning outcomes that are presented. Thus, to ensure that the university curriculum is well-mapped with the current trend of the learning environment, the blueprint that was set by the Ministry of Higher Education (MOHE) Malaysia has set the requirement that at least 70% of the university courses are offered as blended learning. Hence, in this approach, we have attempted the blended learning approach into two chemical engineering subjects (Process Heat Transfer and Separation Process II) throughout the twelve-week lecture and tutorial sessions. Subsequently, additional improvement plans will also be proposed to enhance this approach in future semesters.

1.0 Introduction

The presence of the novel coronavirus (COVID-19) which was discovered in late 2019 has affected the teaching and learning (T&L) landscape among students (Daniel, 2020). In the context of Malaysia, since the movement control order (MCO) that began on 18th March 2020, about five million students have suffered from disrupted learning due to the closure of schools and academic institutions across the entire world to ensure minimized physical contact with other individuals. Hence, before the physical T&L officially resumes, the Ministry of Education (MOE) Malaysia has developed an online platform for T&L worldwide to ensure minimal impact on the student's learning experience (UNICEF, 2020). Furthermore, undeniably, the booming of various online learning platforms such as LinkedIn learning, edX, Udemy, and Coursera are partially driven by the pandemic (Virani et al., 2023). This platform has served as an important platform for learners

in general to acquire new skills and knowledge, which may be difficult to obtain based on the conventional formal academic setting. However, such an approach, which is categorized as informal learning possesses various limitations that are difficult to ignore (Sclater, 2016). First, this platform expects the learners to be self-motivated and self-persistent as the progress will not be monitored as thoroughly as compared to the formal learning as elaborated earlier. Second, in most circumstances, the content or learning materials provided in the online platform are prepared on a level that is not on par with the intended course learning outcome and program outcome that was expected from the learners. In comparison, all bachelor's degrees in engineering programs that are offered by academic institutions are required to abide by the regulations set by the Engineering Accreditation Council (EAC) under the Board of Engineers Malaysia (BEM) to ensure that the courses are accredited. This is because Malaysia, which is one of the signatories of the Washington Accord (WA) is required to ensure that all graduates are well-equipped with the twelve graduate attributes at the time of graduation (Engineering Accreditation Council, 2020). Lastly, in comparison to the formal learning approach where the instructors can perform the required intervention if the students are unable to catch up with the lesson, the online platform may not be able to assist effectively as the students are expected to learn independently. This can be highly evident if the content provided does not match the level of the learners, leading to an increased difficulty for them to catch up with the content provided.

2.0 Literature review

The role of MOE Malaysia is critical to ensure that the students are equipped with the required skills for students to adapt to the new learning environment (Janal et al., 2020; Sanmugam et al., 2022). Therefore, a comprehensive review of the education system was performed in October 2011. Under the National Education Blueprint, which was conducted from 2013 to 2015, the exploration of new learning models has been proposed to enhance the students' T&L experience, and blended learning was considered as one of the options available (Ministry of Education Malaysia, 2013). Subsequently, the National E-learning Policy (*Dasar e-Pembelajaran Negara, DePAN*), which was under the purview of the Ministry of Higher Education (MOHE) Malaysia has been revised to reflect the expectation of the latest blueprint. Under this revised policy, at least 70% of the total courses offered by the Institute of Higher Learning (IHL) are required to be offered under the blended learning format (Wut et al., 2024). Thus, Universiti Teknologi PETRONAS (UTP), which is classified as the IHL has set a target by 2025 to ensure that the university abides by the recent guideline that is imposed by the MOHE Malaysia. Under this plan, UTP has instructed the lecturers to start with the implementation of blended learning in the May 2022 semester.

Blended learning in general involves the integration of both conventional face-to-face and technology-mediated approaches for the instructors to deliver the content to the students (Ministry of Education Malaysia, 2013; Muhria et al., 2023; Wu et al., 2024). This method integrates both approaches to improve the learning experiences among students by mitigating the drawbacks of pure online instruction (Azizan, 2010; Tayebinik & Puteh, 2013). Furthermore, the online learning platform will also provide an interactive setting to improve the communication between lecturers and students in the classroom, while facilitating cooperative learning that can be present within or beyond the classroom settings (Yuen, 2010). Hence, it is expected that this learning method will allow the students to learn at their own pace and time considering that different learning styles are present across each student. Thus, based on the typical 12-week session that is offered in UTP, this method will be prepared through a combination of both asynchronous and synchronous (i.e., live) sessions under the percentage of 30% and 70%, respectively. Therefore, a minimum of three weeks will be offered asynchronously. Thus, in this study, the discussion will be mainly focused on the preparation and implementation of the blended learning method on the core chemical engineering subjects offered at UTP, which are Process Heat Transfer and Separation Process II. The discussion in this paper will focus on the preparation, implementation, and challenges that have been encountered during the process. Lastly, the improvement plans that will be

implemented in these subjects will be proposed to ensure that this learning approach can be effectively implemented in the subsequent semesters across different subjects.

3.0 Methodology

The course planning and design for the effective implementation of blended learning will be elaborated below based on the two chemical engineering courses offered by UTP, namely Process Heat Transfer (May 2022) and Separation Process II (January 2023 and 2024).

3.1 Planning and Design for Process Heat Transfer (May 2022)

Process Heat Transfer is a required component of the Body of Knowledge in the Chemical Engineering profession as it is developed to ensure the students are equipped with the fundamentals of process heat transfer. It is expected that at the end of this course, the students can analyze and estimate the rate of heat transfer through conduction, convection, and radiation. Thus, as the blended learning method was first implemented, the course was initially prepared by utilizing two of the twelve-week sessions for the preparation of blended learning (**Figure 1**), since there are public holidays (Vesak Day replacement holiday and Agong's birthday) that falls on Week 2 and Week 5 of the May 2022 semester.

Week 1	Week 2	Week 3	Week 4		Week 5	Week 6	Week 7	Week 8	Week 9	Week 10	Week 11		Week 12	
Lecture (Chap 1)	Lecture (Chap 2)	Lecture (Chap 3)	Leture (Chap 6)	Test 1	Leture (Chap 7)	Leture (Chap 8)	Leture (Chap 9)	Lecture (Chap 10)	Lecture (Chap 10)	Lecture (Chap 11)	Lecture (Chap 12)	Test 2	Lecture (Chap 13)	Sub IDP
Lecture (Chap 1)	Lecture (Chap 3)	Leture (Chap 6)	Leture (Chap 7)		Leture (Chap 7)	Leture (Chap 8)	Leture (Chap 9)	Lecture (Chap 10)	Lecture (Chap 10)	Lecture (Chap 11)	Lecture (Chap 12)		Lecture (Chap 13)	

Figure 1: Class planning for Process Heat Transfer. The orange shading indicated in the figure depicts the session where the blended learning session will be conducted.

Once the course planning has been performed, the blended learning content has been uploaded on Week 2 and 5, respectively on the learning platform (i.e., Ulearn from Moodle platform), as indicated in **Figure 2**. The contents are arranged in proper order to ease the students' accessibility to the provided learning materials.

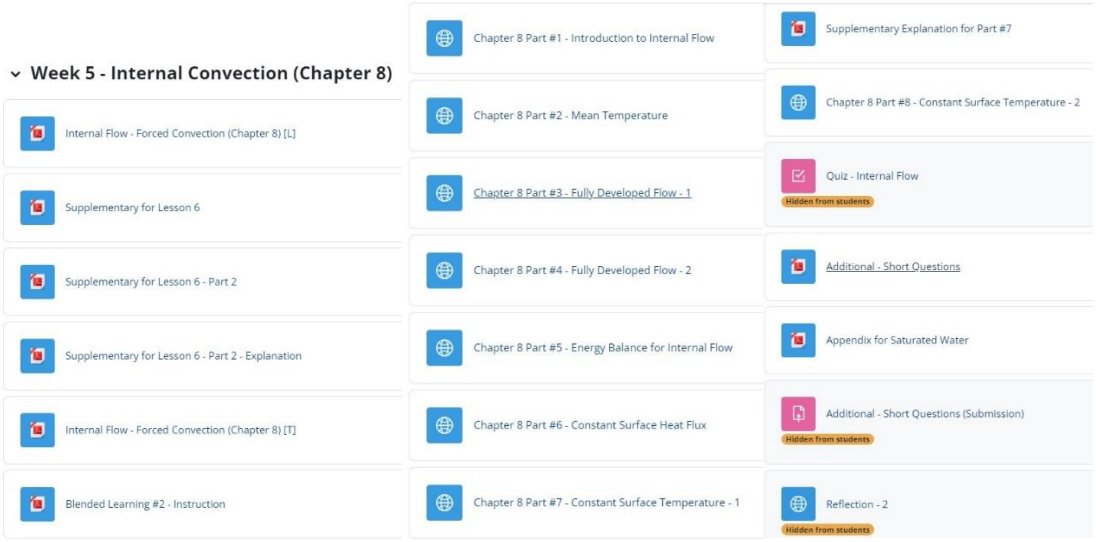

Figure 2: Implementation of blended learning content on Week 2 and Week 5 for Process Heat Transfer

3.2 Planning and Design for Separation Process II (January 2023 and 2024)

Separation Process II is a required component in Chemical Engineering subject to equip students with the fundamentals of the separation process principle. The scope of the subject will involve the design of processes such as adsorption, evaporation, drying, crystallization, ion exchange, and membranes. It is expected that at the end of the course, the students can solve the separation process that involves gas-gas, liquid-liquid, and solid- solid systems with the use of mass and energy balance. With the preparation and improvement that has been performed in the Process Heat Transfer as elaboration in **Section 3.1**, based on the course planning in **Figure 3**, Week 3, 5, and 11 have been selected for the blended learning session. The same schedule was adopted in January 2023 and 2024.

Week 1	Week 2	Week 3	Week 4		Week 5		Week 7	Week 8	Week 9	Week 10		Week 11		Week 12
Lecture (Intro)	Lecture (Ads)	Lecture (IE)	Lecture (IE)	Lecture (Cryst)	Lecture (Cryst)	Lecture (Cryst)	Lecture (Memb)	Lecture (Memb)	Lecture (Dry)	Lecture (Dry)	Lecture (Evap)	Lecture (Evap)	Sub IDP	Lecture (Evap)
Lecture (Ads)	Lecture (Ads)	Lecture (IE)	**Test 1**		Lecture (Cryst)		Lecture (Memb)	Lecture (Memb)	Lecture (Dry)	**Test 2**		Lecture (Evap)		Lecture (Evap)

Figure 3: Class planning for Separation Process II. The orange shading indicated in the figure depicts the session where the blended learning session will be conducted.

In the next step, to ensure that the student load is not overloaded with the learning materials, planning of the student learning time (SLT) for the blended learning activities will be conducted. This is in consideration of the feedback received during the implementation of blended learning in Process Heat Transfer (**Section 3.1** and **Section 4.1**). Hence, because the required number of hours for SLT for a three-week duration is 36 hours (the sample calculation is elaborated in **Appendix I**), the detailed lesson plan for the selected weeks will be summarized in **Table 1**. The total SLT that is allocated for this session is 38 hours.

Table 1: Lesson plan for the blended learning session for Separation Process II in Week 3, 5, and 11

Timeline	Topic/Chapter	Lesson Details	SLT (hours)[a]
Week 3	Chapter 2: Ion Exchange	Learning materials: Interactive video Reading materials	5
		Learning activities: Mind-map (revision) Self-check H5P	4
		Assessment: Online Quiz 1	3
Week 5	Chapter 3: Crystallization	Learning materials: Interactive video Reading materials	5

		Learning activities: Mind-map (revision) Self-check H5P Assessment: Online Quiz 1	4 3
Week 11	Chapter 6: Evaporation	Learning materials: Interactive video Reading materials Learning activities: Mind-map (revision) Self-check H5P Assessment: Online Quiz 1	5 4 3
		Total SLT	38

[a] SLT is defined as the effective learning time for students to achieve the specified learning outcome.

Once the class planning and learning activities have been arranged, the blended learning content has been provided in Week 3, 5, and 11, respectively in the learning platform (i.e., Ulearn from Moodle platform), as indicated in **Figure 4**. Similarly, the content is arranged in proper order to ease the students' accessibility to the provided learning materials.

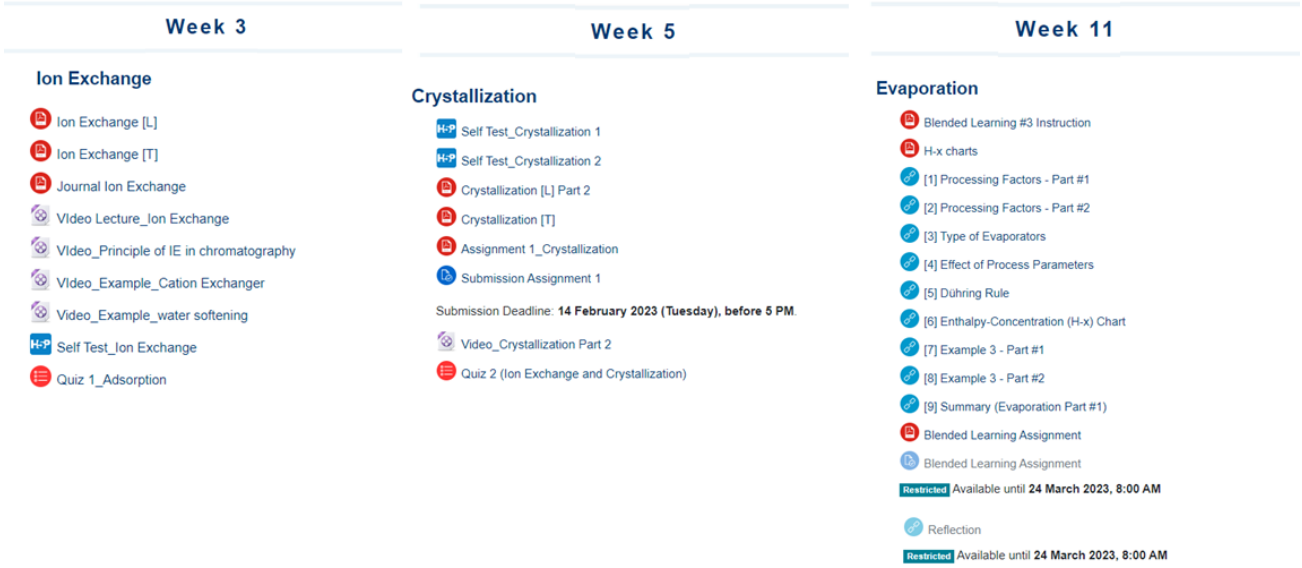

Figure 4: Implementation of blended learning content on Week 3, 5, and 11 for Separation Process II.

4.0 Discussion of analysis and findings

4.1 Process Heat Transfer (May 2022)

First, this course was the first time where blended learning content was being offered to this course. As an initial trial, the blended learning content was performed for two weeks (i.e., Week 2 and 5) as indicated. The number of participants that have accessed the recording and the assessments in **Figure 5**, based on the sample size of 138 students. In general, 23% and 63% have managed to access the lecture recording and assessment provided by the course lecturers. However, it is agreeable that several potential rooms for improvement could be made to enhance the students' T&L experience (Adeyele, 2024). First, one of the most prominent comments that was raised by the students was to trim the video into shorter segments instead of the whole video. Second, to extend the deadline for the assignment submission due to the tight deadline provided. Thus, we have acknowledged the comment raised, and have performed some improvements to the content delivered.

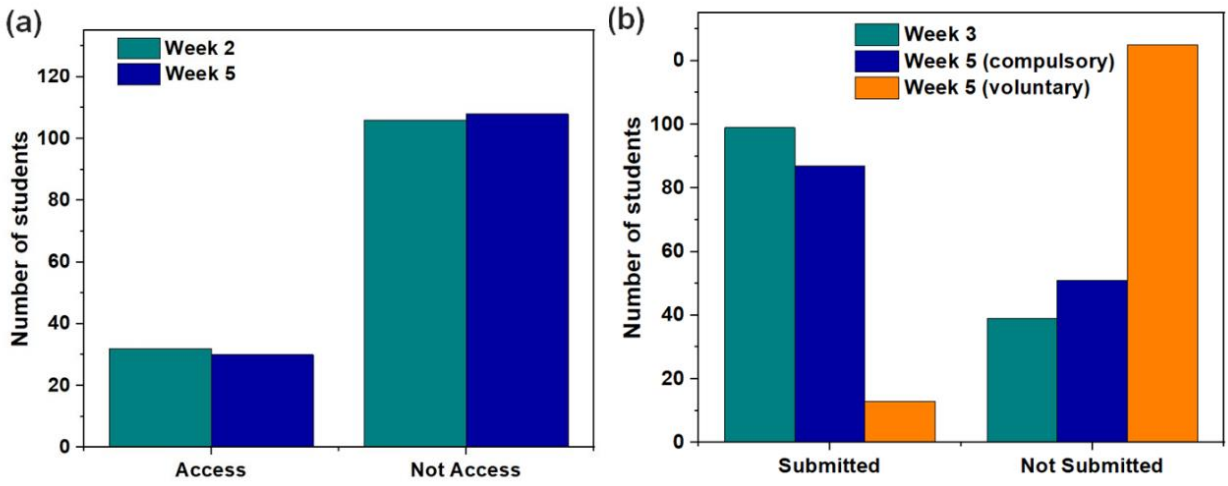

Figure 5: (a) Number of students who have accessed[a] the lecture recording; (b) Number of students who have submitted the assessments provided by the lecturers.

[a] The data is captured as "access" if the students have "clicked" on the lecture recording throughout that specific week.

4.2 Separation Process II (January 2023 and 2024)

4.2.1 Pre-questionnaire

First, to receive some expectations so that the students (sample size of 133 students) are aware and prepared for the courses where the blended learning format will be introduced to this subject, pre-questionnaires have been prepared to gather the responses. Hence, as indicated in **Figure 6**, a summary of the responses is provided. From **Figure 6 (a)**, c.a. 96% of the students have come across the term "blended learning" throughout their studies at UTP. Similarly, around 81% of the students are fully aware of the expected assessments that will be performed during the blended learning (**Figure 6 (b)**). Subsequently, based on the preferred learning method, c.a. 73% of the students in this cohort (**Figure 6 (c)**) preferred blended learning as the learning format for this subject, although a substantial percentage (c.a. 22%) of the students preferred the lecturers to deliver the lesson under a fully physical setting. This result is expected to show its promise as it is consistent with the target set by MOHE and UTP as elaborated in **Section 2**. The summary data in **Figure 6 (d)** also indicates that the lecture recording is critical for the students to recap the content learned. Thus, the availability of lecture recordings will assist students to perform the recap at their own pace throughout the semester.

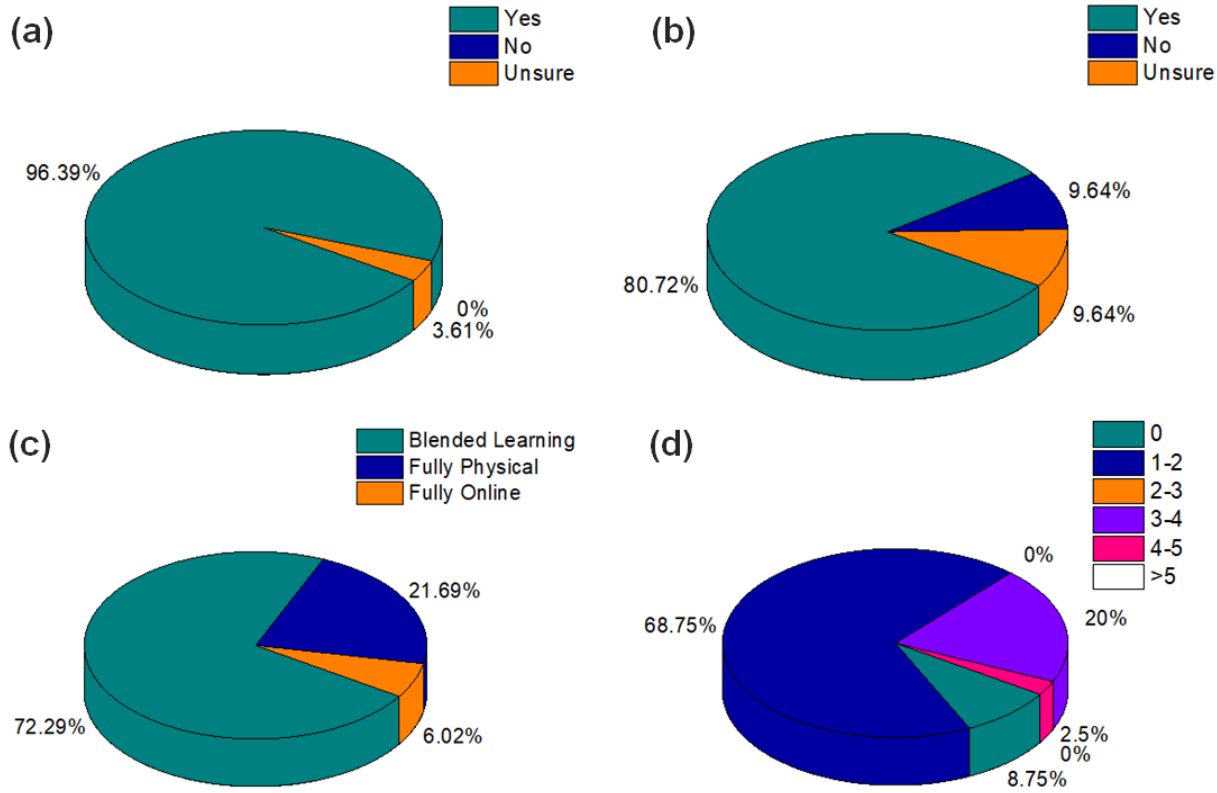

Figure 6: (a, b, c, d) Summary of the result based on the expectation of blended learning for students attending the Separation Process II in January 2023. The question for each section indicated in (a-d) can be summarized in Table 2.

Table 2: Pre-questionnaire for blended learning

No.	Questions
1	Have you heard about blended learning throughout your studies at UTP?
2	For your information, this course has been selected to be delivered under a blended learning format. Therefore, for three weeks, you are expected to perform your self-paced learning, with potential graded assignments/quizzes. Please advise if you are aware of this
3	What type of learning method do you prefer during your study at UTP?
4	How often (times per week) will you be referring to the recorded videos after each lecture/tutorial session?

4.2.2 Access to Learning Activities and Assessment

Figure 7 (a) shows the percentage of students that have accessed the lecture recording, where based on the summarized data, 56%, 45%, and 21% of the students have accessed to the recorded lectures. The results for Week 3 and 5 are relatively comparable, with the exception for Week 11. Based on the feedback that the lecturers received from the students, the poor participation rate on that specific week was attributed to the presence of other assessments and tests from other courses that the students have taken for this semester. Hence, with this consideration, an additional live discussion session was arranged on that specific week to recap the content that was covered on that specific week. This has resulted in an improvement to 41.4% of the total participation from students has been observed. That live discussion will also be utilized to discuss the solution for the assessments provided by the lecturers during the blended learning week.

Subsequently, based on the data in **Figure 7 (b)**, more than 80% of the students have submitted the assessment for the blended learning session. Based on the previous observation in Process Heat Transfer (**Section 4.1**), it is generally difficult for the students who submit the required assessment if the assessment is not graded. As expected, only c.a. 10% of the students have submitted the voluntary blended learning assessment, as compared to 63% of the students who have submitted the compulsory assessment for the same week (**Figure 5 (b)**). Thus, when blended learning was introduced in Separation Process II, all assessments prepared were graded

and included as part of the coursework completion. Based on the student performance, c.a. 30 to 40% of the total students in this specific cohort have managed to obtain at least 80% (i.e., "A-" grade) and above, indicating that the students can grasp the content covered in the blended learning assignment.

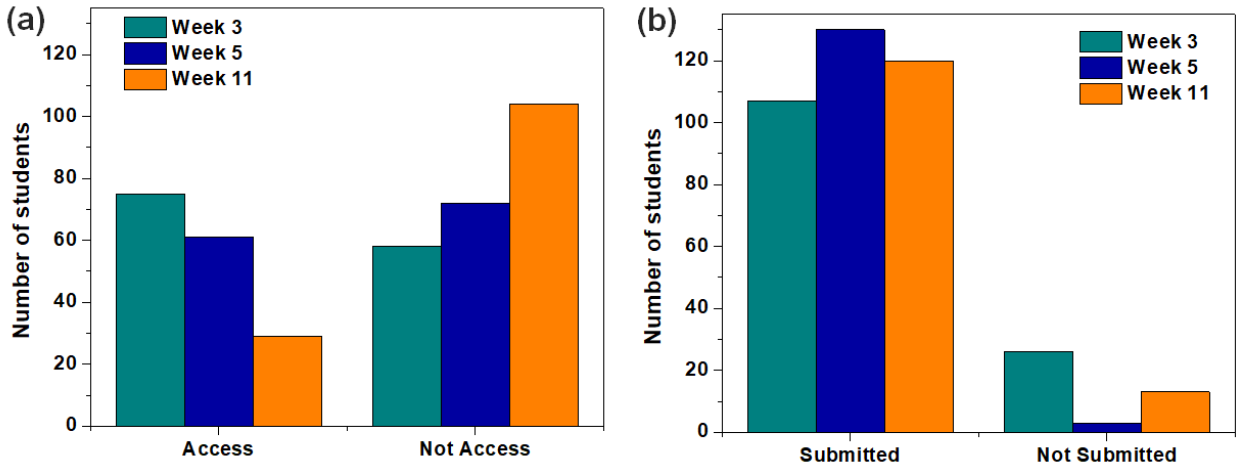

Figure 7: (a) Number of students who have accessed[a] the lecture recording; (b) Number of students who have submitted the assessments provided by the lecturers

[a] The data is captured as "access" if the students have "clicked" on the lecture recording throughout that specific week.

4.2.3 Challenges and Future Improvements for Implementation in the January 2024 Semester

Based on the data as summarized in **Figure 7 (a)**, there are still some challenges in effectively implementing blended learning for the specific subject. Some of the more notable reasons are: (1) lack of self-motivation to learn the content (Ameloot et al., 2024; Cheng et al., 2024); (2) difficulty in approaching the course lecturers in case they have any queries on the content given; and (3) high workload due to the assessments from other subjects. Hence, in the upcoming semester (January 2024), several improvement strategies will be implemented to enhance overall delivery. First, several stage gates will be implemented in the blended learning assessment as a checkpoint to ensure that the students can comprehend the content based on the recording provided (**Figure 8 (a, b**)). Second, a feedback/submission link will be provided to the students so that they can provide their queries on the link provided so that the course lecturer is aware of the problems that arise during the blended learning session. This will be followed by a recap lecture that will be conducted in the upcoming class to recap the content learned during that specific week. Lastly, a post-questionnaire will be provided to the students for continuous improvement on the subject.

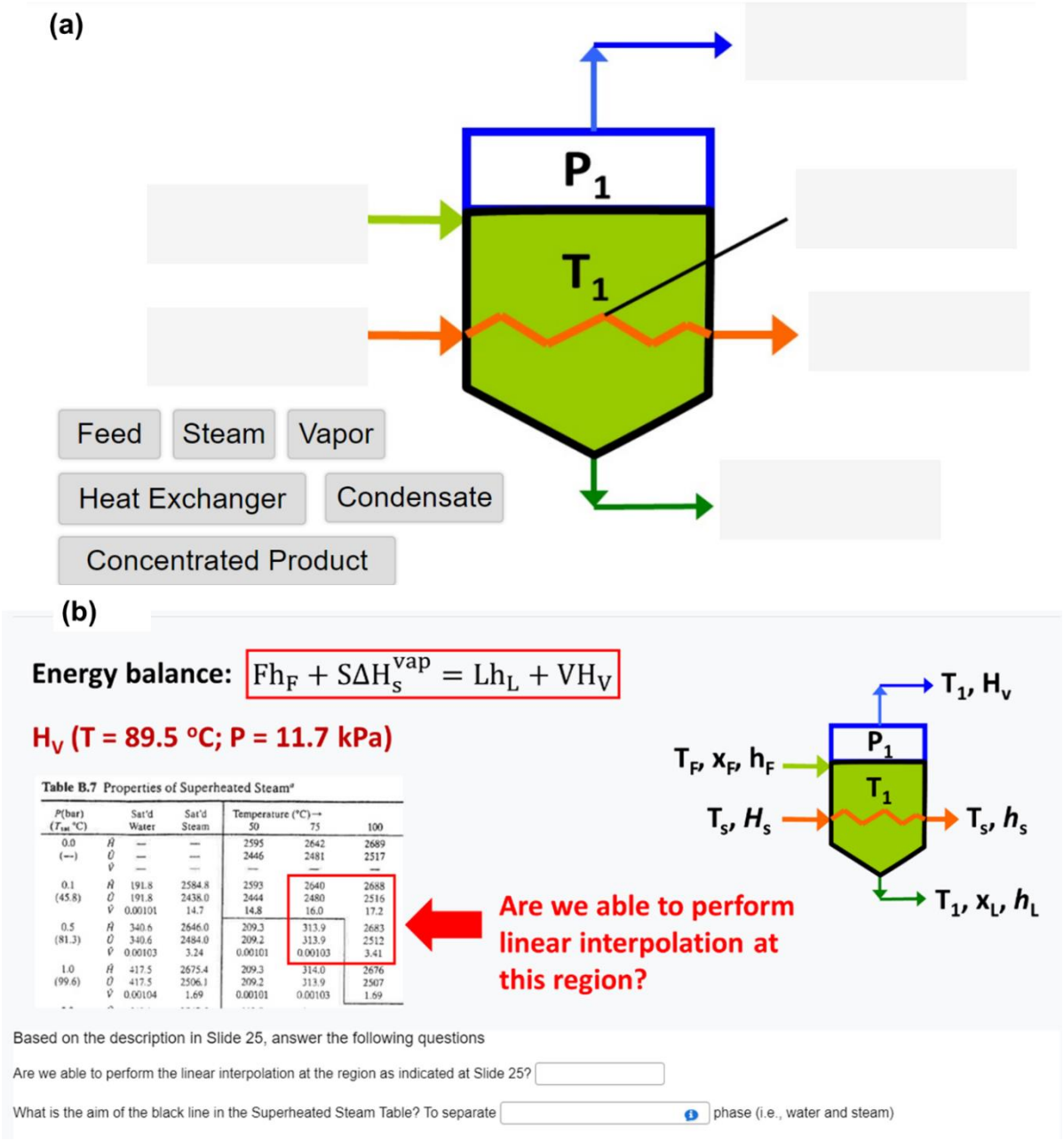

Figure 8: (a, b) Stage gates for blended learning on Week 11

5.0 Conclusion and future research

Moving forward, the blended learning approach is expected to be the future T&L method for IHL in Malaysia. As shown in **Figure 9 (a-d)**, the overall acceptance of blended learning has been positive, based on the sample size collected by the students in the January 2024 semester. Despite there being undesirable challenges that needs to be addressed so that the students can effectively comprehend the subjects, the lecturers are confident that with a concerted effort from both students and lecturers, the effectiveness of blended learning will benefit both parties in the long run.

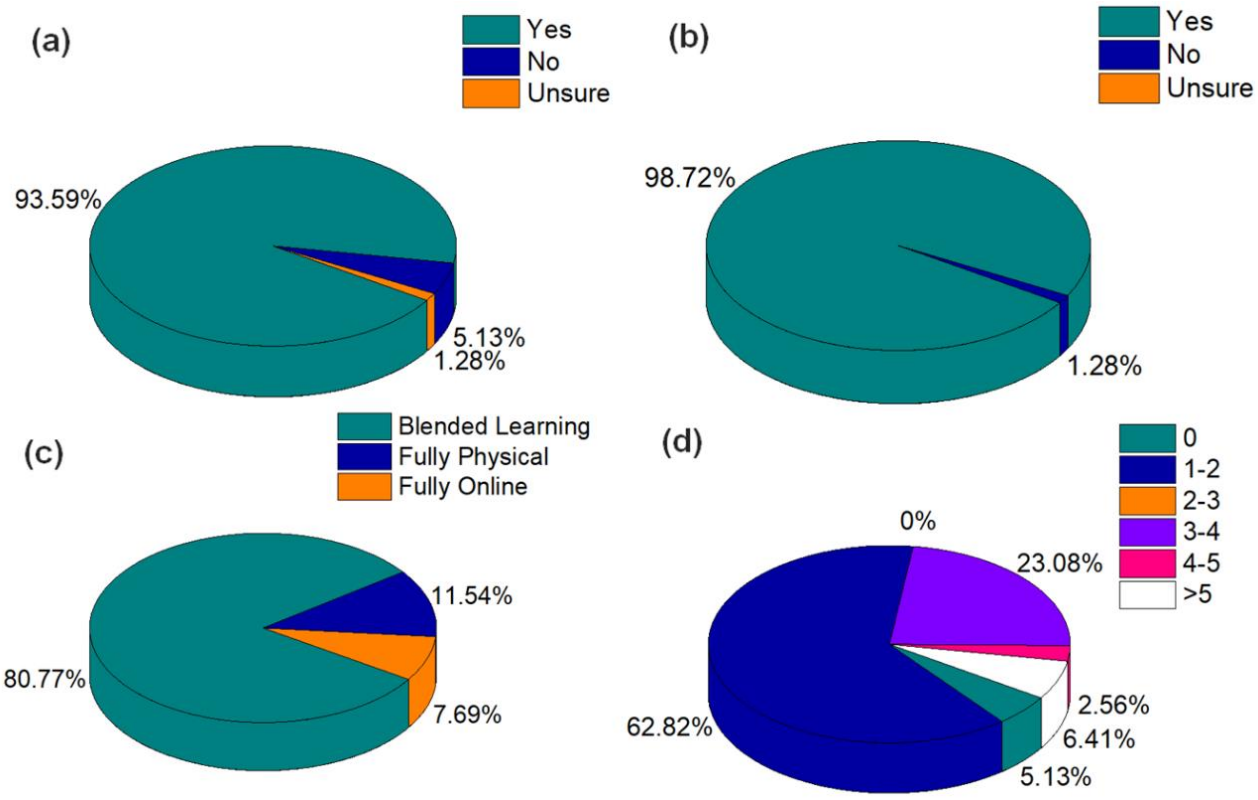

Figure 9: (a, b, c, d) Summary of the result based on the expectation of blended learning for students attending the Separation Process II in January 2024. The question for each section indicated in (a-d) can be summarized in Table 2

Appendix

The calculation of the required hours of student learning time (SLT) for blended learning sessions can be summarized as follows. For a typical three-credit hour course, the total number of SLT can be calculated based on the following expression:

(a) SLT calculation

$$\text{SLT} = 3 \text{ credit hours } \times \frac{40 \text{ notional hours}}{1 \text{ credit hour}} = 120 \text{ hours } \ldots (1)$$

(b) Minimum number of SLT allocated for blended learning:

$$\text{Minumum no. of SLT for blended learning} = 120 \text{ hours } \times 30\% = 36 \text{ hours } \ldots (2)$$

(c) For 12-week of T&L sessions, 36 hours of SLT is equivalent to:

$$\text{No. of weeks of blended learning} = \frac{36 \text{ hours}}{120 \text{ hours}} \times 12 \text{ weeks} = 3.6 \text{ weeks } \ldots (3)$$

Thus, based on the calculation, it is required to perform at least 3 to 4 weeks of T&L sessions as blended learning in order to be considered as blended learning.

Acknowledgements

C.Y. Chuah would like to thank Yayasan Universiti Teknologi PETRONAS-Fundamental Research Grant (YUTP-FRG, cost center: 015LC0-486) for the funding support.

Author Contributions

C. Y. Chuah: Conceptualization, Methodology, Writing- Original Draft Preparation; **K. Johari**: Data Curation, Validation, Writing-Reviewing and Editing.

Conflicts of Interest

The manuscript has not been published elsewhere and is not under consideration by other journals. All authors have approved the review, agree with its Submission and declare no conflict of interest in the manuscript.

6.0 References

Adeyele, V. O. (2024). Relative effectiveness of simulation games, blended learning, and interactive multimedia in basic science achievement of varying ability pupils. *Educ. Inf. Technol.*, 1-20.

Ameloot, E., Rotsaert, T., Ameloot, T., Rienties, B., & Schellens, T. (2024). Supporting students' basic psychological needs and satisfaction in a blended learning environment through learning analytics. *Comp. Educ.*, *209*, 104949.

Azizan, F. Z. (2010). Blended learning in higher education institution in Malaysia. Proceedings of regional conference on knowledge integration in ICT,

Cheng, X., Xu, Y., Tang, H., Chan, U., Li, Y. Q., & Yang, X. (2024). Chinese anatomy educators' perceptions of blended learning in anatomy education: A national survey in the post-COVID-19 era. *Anat. Sci. Educ.*, *17*(1), 77-87.

Daniel, S. J. (2020). Education and the COVID-19 pandemic. *Prospects*, *49*(1), 91-96.

Engineering Accreditation Council. (2020). Engineering Programme Accreditation Standard 2020. In B. o. E. Malaysia (Ed.).

Janal, M. A. B., Jalil, Z. B. A., & Ahmad, Z. B. (2020). The Effectiveness In Using Packet Tracer Simulation Software In Improving The Skills Among Computer System And Networks Programme Students. *International Journal of Technical Vocational And Engineering Technology*, *2*(1), 38-49.

Ministry of Education Malaysia. (2013). *Malaysia Education Blueprint 2013 - 2015 (Preschool to Post-Secondary Education)*. https://www.moe.gov.my/menumedia/media-cetak/penerbitan/dasar/1207-malaysia-education-blueprint-2013-2025/file

Muhria, L., Supriatna, N., & Nurfirdaus, N. (2023). Students' Challenges of Blended Learning Model in Higher Education. *J. Cor. Edu. Ling. Lit.*, *2*(3), 223-233.

Sanmugam, S. T., Rajanthran, N., & Periasamy, N. (2022). The Impact of Malaysian Polytechnic TVET Lecturers Research Engagement on their Professional Teaching and Learning Practices. *International Journal of Technical Vocational And Engineering Technology*, *3*(2), 28-33.

Sclater, N. (2016). MOOCs, Open educational resources and social networking: bridging the gap between informal and formal learning.

Tayebinik, M., & Puteh, M. (2013). Blended Learning or E-learning? *arXiv preprint arXiv:1306.4085*.

UNICEF. (2020). *Malaysia – Empowering teachers to deliver blended learning after school reopening*. https://www.unicef.org/evaluation/documents/unicef-education-covid-19-case-study-malaysia-empowering-teachers-deliver-blended

Virani, S. R., Saini, J. R., & Sharma, S. (2023). Adoption of massive open online courses (MOOCs) for blended learning: The Indian educators' perspective. *Interact. Learn. Environ.*, *31*(2), 1060-1076.

Wu, T.-T., Lee, H.-Y., Li, P.-H., Huang, C.-N., & Huang, Y.-M. (2024). Promoting self-regulation progress and knowledge construction in blended learning via ChatGPT-based learning aid. *J. Educ. Comp. Res.*, *61*(8), 3-31.

Wut, T.-m., Wong, S.-m., Sum, K.-m., & Chan, A.-h. (2024). Does institution support matter? Blended learning approach in the higher education sector. *Educ. Inf. Technol.*, 1-13.

Yuen, A. H. (2010). Blended learning in higher education: An exploration of teaching approaches. Proceedings of the 18th International Conference on Computers in Education: Enhancing and Sustaining New Knowledge Through the Use of Digital Technology in Education, ICCE 2010,