



Exploring Students' Online Learning Interaction Behaviors and Experiences: A Case Study

ABSTRACT

This study chose an undergraduate course offered at a public university in Malaysia as the case to discover students' unseen online interaction behaviors and experiences in order to obtain insights into ways to devise relevant online pedagogical approaches. The study employed the learning management system's (LMS) analytics and the analysis of interactions within the social messaging app and virtual live classes to discover students' online interaction behaviors, focusing mainly on student-content, student-instructor interactions, and student-student interactions. It also employed interviews and a survey to gain insights into students' online learning experiences. The analysis and reflection of the derived online interaction behaviors and experiences reveal that students require conducive learning environments, regular check-ins on their progress and social-emotional well-being, and favor the learning flexibility afforded by asynchronous learning. It also provides insights into commendable pedagogical practices and reveals some considerations in virtual communication and virtual collaboration to improve students' online interaction behaviors and experiences.

KEYWORDS

online learning, interaction behavior, online learning experience, learning analytics

INTRODUCTION

The Covid-19 pandemic has made online learning the new normal for educators in Malaysia and worldwide. Online and physical learning environments are different in several aspects. In online learning environments, student-student and student-instructor interactions are primarily text-based and occur via discussion forums, emails, and text-based chat/messaging tools (Al Tawil 2019; Marden and Herrington 2022). With technological advancements, audio- and video-based online interactions are made feasible and occur via social messaging apps and virtual conferencing platforms (Lowenthal et al. 2021; Milovic and Dingus 2021; Rassaei 2022). In addition, student-content interaction also occurs when students interact with course contents (Murray et al. 2012).

As opposed to the physical learning environment, the visual cues are lacking in an online learning environment (Smith, Ferguson, and Caris 2001). Hence, students' online interaction behaviors are often not physically observable. Studies such as Kuo et al. (2013), Phirangee (2016), Shackelford and Maxwell (2012), and many others collected students' self-reported data on their online interactions. However, as Wang (2017) pointed out, students' engagement can also be observed via their interaction with some tools, and their online behaviors as captured in their online activity logs. For example, Zimmerman (2012) used the statistical reports from the learning management system (LMS) to examine how students' time spent completing quizzes and reviewing course content were related to their

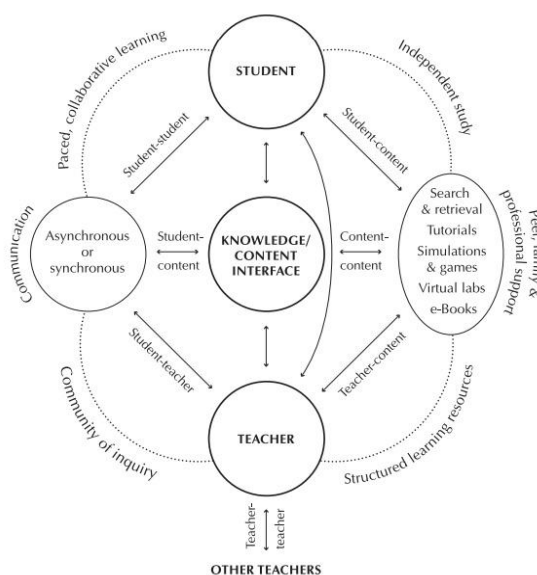
course achievements. More recent studies such as Ginda et al. (2019) produced learning analytics and visualizations based on students' activity logs from the LMS to examine and communicate students' engagement, performance, and trajectories in online courses and Wu et al. (2022) employed deep learning technique, social network analysis, and lag sequence analysis to examine the interaction patterns of students with different co-reflection levels based on students' postings in discussion forums set in an LMS. Such studies provide insight into employing LMS learning analytics to examine students' interaction behaviors in this study.

A systematic review of online learning research studies by Martin, Sun, and Westine (2020) reveals that most studies from 2009 to 2018 examined online learning experiences. This indicates the significance of understanding students' experiences in online courses. Hence, this SoTL study aims to obtain insights into the online pedagogical practices of a fully online undergraduate course offered at a public university in Malaysia by exploring students' online learning interaction behaviors and experiences. The study employed the learning management system (LMS) analytics and the analysis of interactions within both the social messaging app and virtual live classes as techniques to discover students' online interaction behaviors. It also employed interviews and a survey to gain insights into students' online learning experiences.

THEORETICAL FRAMEWORK

Anderson's model of online learning, as depicted in Figure 1, provides the theoretical foundation of this study (Anderson 2004; 2008), as it is a comprehensive model constructed based on several theories and models. The model integrates the four lenses of effective learning posited in National Research Council (2000): learner-centered, knowledge-centered, assessment-centered, and community-centered. It emphasizes the affordances of the web concerning the four lenses, including its hyperlinking feature associated with constructivism (Jonassen 1992). The model also highlights the importance of interactions among students, instructors, and content, as proposed in Moore (1989).

Figure 1: Anderson's model of online learning (Anderson 2008, reprinted with permission)



The model comprises three important entities: students, teachers, and content, as well as educational interactions between them. The model also depicts the relationships of these three entities with other elements of online learning (Anderson 2008). These elements form two modes of online learning: (i) collaborative, community-of-inquiry, and (ii) community-of-learning. In the first learning mode, students can interact directly with any content in multiple formats or follow the sequence as determined by teachers. The interaction can occur within a community of inquiry and is afforded by either synchronous or asynchronous communication channels. This mode of learning also allows collaborative learning and social skills development. The second learning mode involves structured learning tools associated with independent learning. Although students learn independently, they may gain support from communities such as peers, family members, and professionals in their respective fields.

Anderson (2008) stressed that an online course instructor plays the role of identifying and enhancing web-based educational activities that produce effective learning via learning-, knowledge-, assessment-, and community-centered educational experiences. Hence, this study examined students' online learning interaction behaviors and experiences to obtain insights into how the examined course supported the elements of this model and how this support can be further improved. Although Anderson's model depicts six different types of interactions, this study sought to discover students' online interaction behaviors that were derived through student-content interaction, student-instructor interaction, and student-student interaction, as only these three types of interactions involve students.

MATERIALS AND METHODS

This section describes the course that was chosen to be examined in order to obtain insights into its online pedagogical practices. It also describes methods employed to uncover students' online interaction behaviors and experiences that help to infer the appropriateness of existing pedagogical practices.

Full online course design

The study focused on a Malaysian fully online undergraduate course on "research methodology" with 76 students. This course was implemented for the whole semester, the duration of which is 14 weeks. The online course was delivered and facilitated via three different platforms: a Moodle-based LMS, a social messaging app, and a live class platform. Learning resources, such as pre-recorded teaching videos, lecture notes, and various online activities, were made available asynchronously in the LMS. The course delivery via the LMS aligns with the community-of-learning mode of Anderson's model since it allowed independent study, and family could be the source of support for students as most students were at home during the offering of the course due to the pandemic. The social messaging app was used mainly to facilitate communication between the instructor and students and among students. The weekly virtual live class meetings were meant to provide revision and reinforcement of what students had learned asynchronously via the LMS. The use of the social messaging app, live class meetings, and some LMS collaborative activities aligns with the collaborative, community-of-inquiry mode of Anderson's model.

Research activities

The study undertook the following research activities.

Activity 1: Identify means to uncover students' online interaction behaviors and experiences

Table 1 shows the means and techniques to identify students' online interaction behaviors and experiences on the three platforms.

Table 1: Means to identify online interaction behaviors and experiences

	Interaction types	Platform	Means	Techniques	Sample
Online interaction behaviors	Student-content	LMS	Learning analytics report	Report analysis	Five types of learning analytics reports
	Student-instructor	Virtual live class	Virtual live class attendance report	Report analysis	14 attendance reports
			Virtual live class interaction	Observation	14 live classes
			Virtual live chat	Chat analysis	14 live chats
	Student-instructor and student-student	Social messaging app	Chat	Chat analysis	One group chat
Online learning experiences			Virtual interview	Thematic analysis	12 students
			Online survey	Thematic analysis	76 students

Each of the five types of learning analytics reports available in the LMS provides insights into students' online interaction behaviors. These learning analytics provide quantitative descriptive information such as course access, content access, course activity statistics, and activity logs.

Activity 2: Uncover students' online interaction behaviors

As indicated in Table 1, LMS analytics reports, observations of virtual live classes, chat during live classes, and chat via the social messaging app were analyzed qualitatively to uncover students' online interaction behaviors. This activity was done weekly throughout the course, enabling ongoing interventions during the course offering.

Activity 3: Uncover students' online learning experiences

Interview sessions with chosen students were conducted in week 7 (interview 1) and week 12 (interview 2) of the semester. In each interview session, six students were purposively sampled, which involved students of different levels of online learning participation. Participants of interview 1 were labeled as S1, S2, S3, S4, S5, and S6. Participants of interview 2 were labeled as S7, S8, S9, S10, S11, and

S12. Two active students, two moderately active students, and two passive students were involved in each interview. They were requested to provide input on their learning experiences using the three different platforms. A brief online survey was also administered at the end of the course to compile all 76 students' best and worst learning experiences. Both the interview and survey data were analyzed qualitatively.

Activity 4: Reflect and act on findings from activity 2 and activity 3

Findings from learning analytics reports, observations, chat analyses, interviews, and/or surveys were further analyzed and used to reflect on possible ongoing interventions, good and not-so-good online pedagogical practices, and future improvement.

Activity 5: Produce a validating list of pedagogical practices

Right after the course offering ended, a validating list of good and not-so-good pedagogical practices, relevant interventions made in response to students' interaction behaviors and experiences, and insights gained for continuous and/or future improvement were produced.

RESULTS

This section describes the online interaction behaviors and experiences based on the collected data.

Results from activity 2 (learning analytics reports, observations, and chat analyses) and activity 4

Activity 2 uncovers students' online interaction behaviors based on the identified means (see Table 1); meanwhile, activity 4 focuses on reflecting findings derived via activity 2 and initiating necessary ongoing actions to improve students' interaction behaviors. This section reports the online interaction behaviors identified via the LMS, live classes, and the social messaging app. It also reports the instructor's interventions and insights from the identified behaviors.

Derivation of online interaction behaviors via LMS

The learning analytics reports were analyzed weekly to obtain students' online participation and interaction information from the LMS. The following behaviors were observed and reflected.

Students' online presence in LMS. The LMS participants' report, the first type of learning analytics report employed in this study, recorded every student's last access to the online course. A weekly compilation of these records enabled easy identification of students who did not access the online course for a specific duration, thus getting the instructor's attention to further probe students' absence. The instructor contacted those who did not access the course for two weeks or more to inquire about their social and emotional well-being. Most students reported that their internet connectivity was poor. Thus, to avoid leaving them behind, the instructor added all learning resources to a shared folder. These students were expected to find a spot with a good internet connection to download all resources to their own devices for offline studying. A couple of these students reported experiencing stress, which further hindered their learning. Most students appreciated such personal check-ins, which served as a good way to break the ice between the instructor and students.

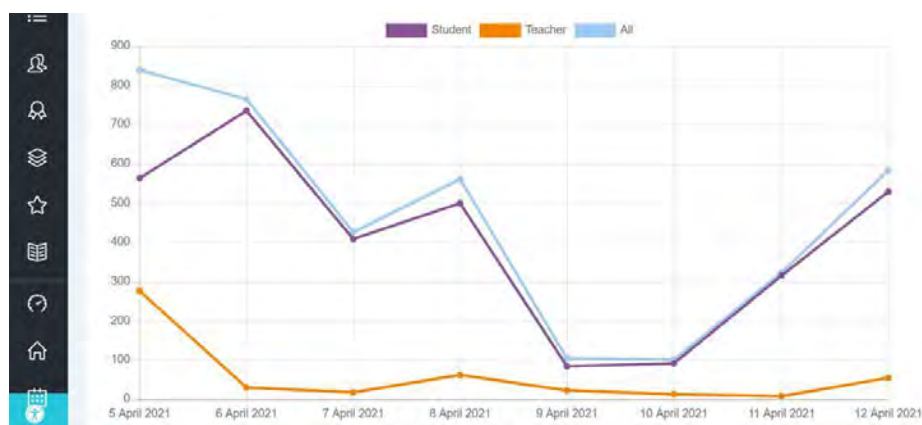
Students' favored learning items. The activity report, the second type of learning analytics report, provided a good overview of students' general participation in all learning items. High numbers of views indicate the popularity of a specific learning item. For example, an analysis of this report reveals that lecture slides and a progressive task named "Outline for Chapter 1" were more popular than other learning items. Students tended to prefer lecture slides to teaching videos of similar slides and provided more effort to a progressive task that needed to be reported in live classes. Such a report also informed on less acted-on learning items that prompted the instructor to implement relevant interventions. For example, only 89 views were recorded in the activity report for all items in "Learning Unit 3: Preparing a Research Proposal." However, the number of views was noted to increase to 249 views three days after the instructor reminded all students to study the uploaded items.

Students' participation in learning items. The weekly analysis of the course participation analytics report, the third type of learning analytics report, alerted the instructor on students' participation levels in learning items they were expected to partake in. The report shows each student's actions for a chosen learning item, enabling inactive students to be easily identified. For example, the report shows each student's participation in a quiz to prepare students for their mid-semester examination. The analytics initially revealed that 45 students completed the quiz by the due date. The instructor then lifted the due date and advised those who had yet to attempt the quiz to work on it before their mid-semester examination. Thereafter, 75 out of 76 did the quiz.

Individual student's accomplishment of activities. Another insightful analytic is the activity completion report. The report shows the completion of every students' activities and provides a good overview of students' individual accomplishments. The instructor reached out to students who showed poor overall accomplishment via a text messaging app. All students responded positively to the instructor's intervention.

Students' participation trend. The statistics analytic provided a good insight into students' course participation trends throughout the weeks and months of the semester. The trend reveals that participation often spiked on days when live classes were held. Figure 2 shows an example of this trend. This trend signals the potential benefit of adopting a hybrid instructional model where synchronous virtual classes can trigger students' participation in the asynchronous LMS content.

Figure 2: Participation trend over a week



The line chart, as shown in Figure 3, shows the number of students' online activities over the chosen duration, with the details on the total numbers shown in Figure 4. The high number of online activities for a particular week indicates active online participation, inferred as a consequence of sound pedagogical practices. A cross-check was made with weekly activity reports to identify those practices. The reflection on this information reveals some practices that explain the resulting statistics for the first eight weeks of the semester (see Table 2), in which a high number of students' online activities infers high online engagement.

Figure 3: A sample line chart of students' activities

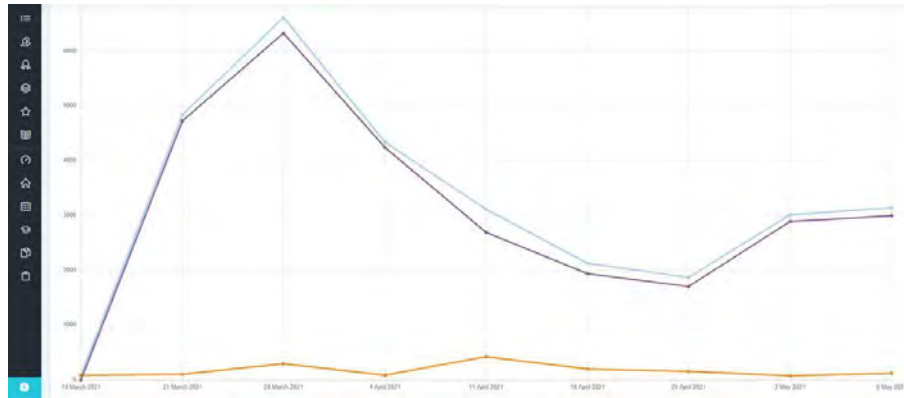


Figure 4: A sample tabulation of students' number of activities

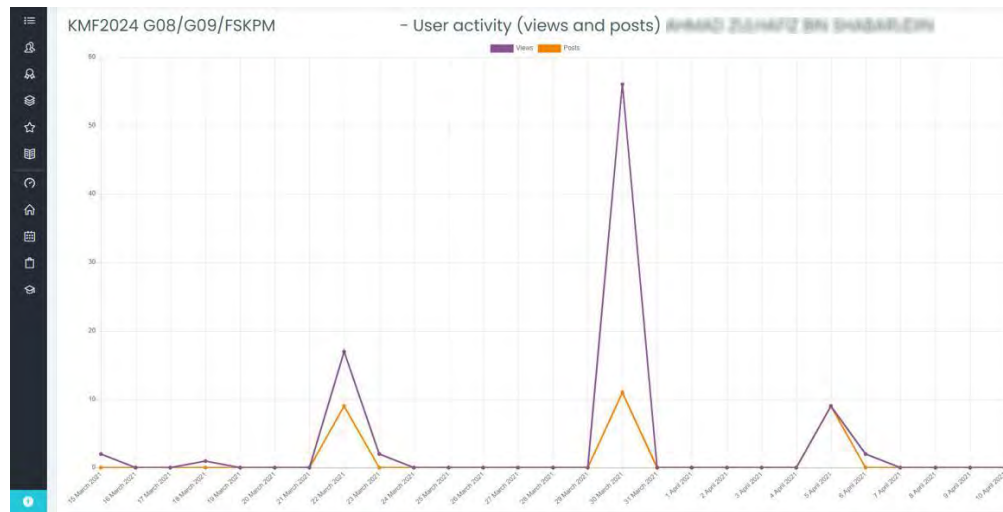
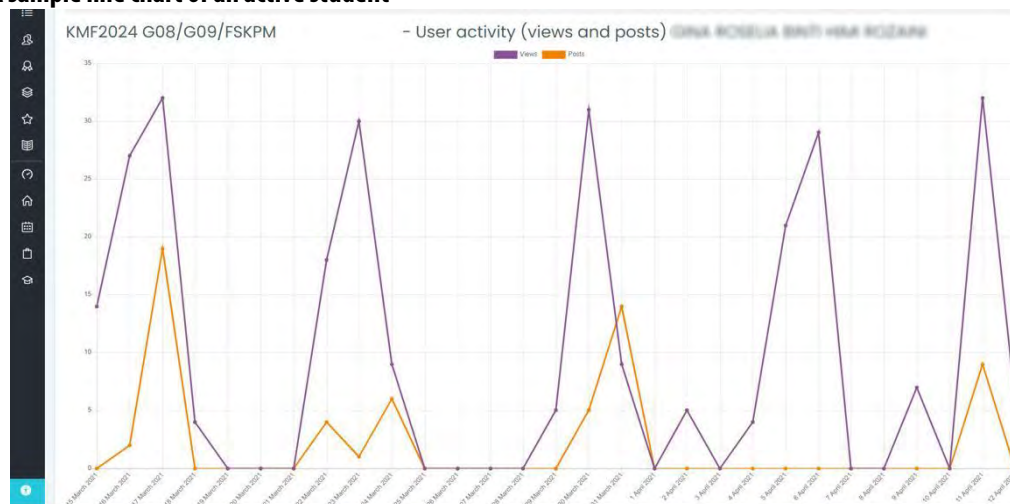
Period ending (Week)	Student Views	Student Posts	Logs
16 May 2021	306	58	Course Logs
9 May 2021	2319	578	Course Logs
2 May 2021	2337	550	Course Logs
25 April 2021	1418	290	Course Logs
18 April 2021	1498	446	Course Logs
11 April 2021	2361	330	Course Logs
4 April 2021	3456	787	Course Logs
28 March 2021	5128	1194	Course Logs
21 March 2021	4083	644	Course Logs

Table 2: Weekly pedagogical reflection

Week	Number of students' online activities	Main activities	Reflection on pedagogical practices
1	4727	Participating in the self-introduction board Forming groups for group work Viewing course outline, course schedule Viewing course assignments Accessing learning resources	Populating an online course with relevant resources increases online engagement

2	6322	Posting of individual research interest Contributing to a glossary Accessing learning resources	Individual tasks increase online engagement
3	4243	Forming of group research project idea Accessing learning resources	The group research project idea is to be presented during live classes. Aligning online tasks with live class activities increase online engagement
4	2691	Forming of group research project idea Accessing learning resources	
5	1934	Accessing learning resources	Providing learning resources weekly ensures consistent online engagement
6	1708	Participation in a quiz Accessing learning resources	The quiz is meant to prepare students for their mid-semester examination. 99% of students participated. Activities that directly benefit students' course performance increase online engagement
7	2887	Participation in the quiz (after reminder) Accessing learning resources	
8	2997	Preparing for the mid-semester examination	A compilation of learning items increases online engagement

This statistics analytic also enabled the individual student's activities to be visualized and active or passive students for an examined duration could be detected. Figure 5 shows a sample line chart of a passive student. Figure 6 shows a sample line chart of an active student.

Figure 5: A sample line chart of a passive student**Figure 6: A sample line chart of an active student**

Derivation of online interaction behaviors via live classes

Students' attendance to live classes. Students were required to log their attendance during every live class session. The attendance report was referred after every live class to identify absentees. Such information prompted the instructor to establish personal communication with every absentee. All absentees reported poor internet connectivity interfered with their participation in live class sessions. Hence, the instructor recorded all live class sessions and uploaded them to the LMS to enable these students to watch the recording at their convenience.

Students' preference toward synchronous text chat. Most students seemed to prefer interacting with the instructor via the live chat box as compared to verbal interaction. The first interview session, which involved six students, confirmed this observation. S5 mentioned, "I feel shy to voice out." Meanwhile, S12 shared "I am not confident to speak up in a live meeting because there are a lot of people in the class." The instructor confirmed such a preference in which many students used private messaging to interact with her. Asynchronous communication channels such as email and messaging via the LMS

were not employed by any of the students. This finding confirms the benefit of having the live chat platform and the need to use an alternative communication platform for student(s)-instructor interactions.

Students' preference toward questions with short responses. Active responses were observed when the instructor posed questions that required short answers. The highest response received was "Yes," which appeared 81 times in the chat box during a live class meeting versus five responses when the instructor asked a question that required lengthier answers. This inspires the use of more questions with short responses.

Students' moderate use of live chats for learning purposes. The content of all live chats were analyzed and five main categories of content were identified: "attendance" (12%); "greetings and appreciation" (30%); "questioning" (4%); "responses" (52%); and "other" (2%). The analysis indicates that students moderately used the live chat for learning purposes because only "questioning" and "responses," which account for 56% of the total chats, were directly related to student learning. Further probing via the two interview sessions and online survey revealed reluctance, shyness, poor internet connectivity, and language barriers as reasons for non-participation. Table 3 shows the frequency of students for each reason and sample students' comments.

Table 3: Frequency and sample comments on non-participation in the live chat

Students	Sample comment	Inference
S6, S10, S17, S33, S36, S44, S47, S51, S55, S63	[S6] I would not initiate to ask a question. I will only answer if the lecturer asks questions.	Reluctance
S4, S14, S46, S51	[S4] During class, I am not confident to ask a question because I am not fluent in English.	Language barrier
S4, S12, S23, S35, S38, S52, S56	[S4] I feel shy to voice out even when I do not understand.	Shyness
S9, S16, S18, S25, S27, S33, S35, S39, S42, S47, S49, S50, S54, S57, S64, S76	[S54] When the Internet connection is very poor, I barely hear anything during live classes.	Internet connectivity

Derivation of online learning behaviors via the social messaging app

S1 stated that "WhatsApp is better than LMS because I will be holding my mobile phone all day;" meanwhile, S4 also shared that "WhatsApp is an effective communication medium for the lecturer to make important announcements because I seldom check LMS." Generally, interviews with students revealed that students agreed that the social messaging app was an important medium for student-

instructor interaction compared to the LMS. The chat analysis revealed 60 different conversation topics, which are classified into three main categories, as summarized in Table 4.

Table 4: Findings of the chat analysis

Conversation categories	Purposes	Topics frequency	Interpretation
The instructor communicated with students	Used by the instructor to make announcements, provide reminders, get students' feedback on course-related matters, and respond to students' inquiries	40 (67%)	An effective and efficient means for the instructor to disseminate information and clarify issues encountered by students
Students interacted with the instructor	Used by students to ask questions and respond to the instructor's inquiries and postings	17 (28%)	An effective and efficient means for students to approach their instructor
Students interacted with peers	Used by students to share relevant information	3 (5%)	A positive learning atmosphere was formed when students interacted with their peers to obtain and share valuable information. More student-to-student interactions are expected to occur in other messaging groups created by students.

Results from activity 3 (interview, survey) and activity 4

The focus of activity 3 is to explore students' online learning experiences based on the identified means in Table 1, which are virtual interviews and an online survey. Activity 4 focuses on the reflection of the findings derived via activity 3 to inform the future pedagogical implementation of the course. This section reports the identified online learning experiences.

Students' positive learning experiences

Students shared their perceptions and views on elements that could enhance their course learning experiences through the two interview sessions and the brief online survey. The collected data were categorized into five themes that explain students' positive learning experiences. These themes include (i) providing flexibility, (ii) affording self-regulated learning, (iii) improving media literacy, (iv) benefits of quizzes, and (v) empathetic instructor (refer to Table 5).

These findings reveal that the flexibility for students to access learning at their convenience is a favorable online learning feature. The availability of asynchronous learning items also afforded the development of self-directed learning ability, as students were held responsible for planning their learning methods and possessed more control over their learning pace. The overall online learning

experience enhanced their confidence, motivation, independence, and sense of responsibility. Another positive learning experience relates to the opportunities provided by online learning to improve students' media literacy. Some students also pointed out the benefits of quizzes and their appreciation for the empathy shown by the instructor.

Activity 4 concluded that the aspects that contributed to these positive experiences are to be retained in the subsequent implementation of the course. The course was delivered via biweekly synchronous live meetings and an asynchronous online learning method, so it offered great flexibility for students. Hence, this aspect should be retained. The course should also maintain the use of web tools for creating e-portfolios and mind maps as this helps improve students' media literacy. Quizzes were also helpful in increasing students' learning engagement. Finally, the instructor also needs to be empathetic as students faced various personal online learning challenges during the pandemic.

Table 5: Themes related to students' positive learning experiences (with sample quoted comments)

Positive experiences	Students	Sample comments
Providing flexibility	S3, S5, S8, S9, S15, S18, S19, S21, S27, S30, S34, S37, S41, S42, S46, S50, S53, S56, S60, S61, S66, S68, S71, S73, S75	[S8] Flexible schedule and environment. [S15] In the comfort of our own home, easy to access class without being physically present.
Afford self-directed learning	S4, S14, S24, S26, S41, S45, S53, S59, S61, S68	[S4] I was initially a little tired of online learning, but it taught me to be patient. [S61] I have learned to become more independent and responsible.
Improve media literacy	S7, S14, S19, S26, S28, S37, S48, S59	[S7] I can know about new apps that were used during class and for assignments. [S37] Can use some technology for studying, improve the knowledge on how to use the technology as well.
Benefits of quizzes	S2, S12, S22, S29, S40, S48, S70	[S2] I feel good when I score well on the quiz. The weekly quizzes make me study. [S48] I favor the quiz after every learning unit. I will strive for high scores when I attempt all quizzes. Besides, it mentally prepares me for the final exam.
Empathetic instructor	S13, S20, S27, S30, S43, S47, S54, S55, S58, S70	[S30] An appreciation to my instructor for understanding our situation. Not all classes are live, and some are through recording. It helps us a lot, especially when we have a slow Internet connection. [S54] Friendly and approachable course instructor.

Students' negative learning experiences

The data collected via the two interview sessions and the brief online survey were categorized into five themes to explain students' negative learning experiences. These themes include (i) technical

difficulties, (ii) unconducive physical learning conditions, (iii) communication barriers, (iv) group work challenges, and (v) poor time management (refer to Table 6).

Poor connectivity, costly internet plans, and problematic devices are annoying technical difficulties that generate negative experiences for students. Students also identified unconducive physical environments as a negative contributing factor for their learning. Some students also faced barriers in their online communication with peers and the instructor. Others reported challenges in accomplishing their group work virtually. Some students also pointed out that poor time management created negative learning experiences.

Activity 4 concluded that certain aspects that contributed to these negative experiences could not be resolved by the instructor alone, such as the technical difficulties and unfavorable physical learning environments that students faced. However, some guidance and coaching on virtual communication, collaboration, and learning pathways are expected to alleviate some of these negative experiences.

Table 6: Themes related to students' negative learning experiences (with sample quoted comments)

Negative experiences	Students	Sample comments
Technical difficulties	S9, S16, S18, S25, S27, S33, S35, S39, S42, S47, S49, S50, S51, S54, S57, S64, S67, S76	[S9] Poor internet connection makes it difficult to attend live meetings and do assignments. [S51] My laptop always has problems.
Unconducive physical learning conditions	S16, S47, S49, S56, S62	[S48] My place is quite noisy because my family members were together during the pandemic. [S62] I am busier than before because I have responsibilities as a daughter.
Online communication barriers	S10, S18, S23, S27, S32, S41, S58	[S10] It is hard to communicate with our group members through text. If we try to have a live meeting, some members are unable to join due to poor connection. [S27] It is difficult to discuss group assignments with group mates online.
Group work challenges	S20, S21, S37, S40, S41, S45, S49, S60, S67, S71, S73	[S20] Group members hardly cooperate and use poor connectivity as their main excuse. [S21] I do have some unsupportive members in my group who never participate in online discussions.
Poor time management	S13, S18, S35, S42, S51, S57, S62, S63	[S13] I cannot manage my time well. [S63] Procrastination happened. I feel like I am not taking it seriously.

Results from activity 5

Table 7 summarizes the types of online interaction behaviors and experiences that were derived and how they drove relevant interventions as well as provides insights into the existing practices of the examined course.

Table 7: A validating list of pedagogical practices, interventions, and gained insights

Interaction types	Online behaviors	Means	Intervention made	Insight gained
Learner-content	Students' online presence in LMS	LMS-participants' report analysis	Probed on LMS absentees	The need to be concerned about students' social-emotional well-being. Connectivity is the main barrier to online learning
	Students' favored learning items	LMS-activity report analysis	Provided reminders to students on less acted-on learning items	Students' preferred learning items and otherwise
	Students' participation in learning items	LMS-course participation report analysis	Provided feedback to individual students on their participation, such as complementing those who were active and reminding those who were inactive to participate in a specific learning item	Individual student or group's participation level for a chosen learning item
	Individual student's accomplishment of activities	LMS-activity completion report analysis	Reached out to students with poor accomplishment	Individual student's accomplishment of all learning items
	Students' participation trend	LMS-statistics report analysis	Identified practices that should be continued or discontinued in the next implementation of the course	An indication of good and not-so-good pedagogical practices, an indication of passive and active students Practices to be retained: <ul style="list-style-type: none"> - Populate an online course with relevant resources - Provide individual tasks - Align online tasks with live class activities - Provide learning resources weekly

				<ul style="list-style-type: none"> - Provide activities that directly benefit students' course performance (e.g. quizzes) - Provide a one-stop compilation of learning items
Learner-instructor	Students' attendance to live classes	Virtual live class-attendance report analysis	Probed on live class absentees Recorded all live class sessions and uploaded them to the LMS	Concern about students' social-emotional well-being
	Students' interaction in live classes	Virtual live class interaction-observation Virtual live chat-chat analysis	Employed more questions with short responses Probed on reasons for not fully utilizing the live chat for learning purposes	<p>Students' preference for synchronous text chat To provide private and low-bandwidth communication platforms Students' preference toward questions with short responses Students' moderate use of live chats for learning purposes Reluctance, shyness, internet connectivity, and language barrier are reasons for non-participation</p>
Learner-instructor and Learner-learner	Students' interaction in the social messaging app	Social messaging app-chat analysis		<p>The instructor communicated with students Students interacted with the instructor Students interacted with peer</p>
Students' learning experiences		Interviews and online survey		<p>Positive experiences</p> <ul style="list-style-type: none"> - Provide flexibility - Afford self-regulated learning - Improve media literacy - Benefits of quizzes - Empathetic instructor <p>Practices to be retained:</p> <ul style="list-style-type: none"> - Employ a hybrid synchronous and asynchronous method

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- Employ web tools for course activities
 - Employ quizzes
 - Be an empathetic instructor

Negative experiences

- Technical difficulties
- Unconducive physical learning conditions
- Communication barriers
- Group work challenges
- Poor time management

New practices (future implementation):

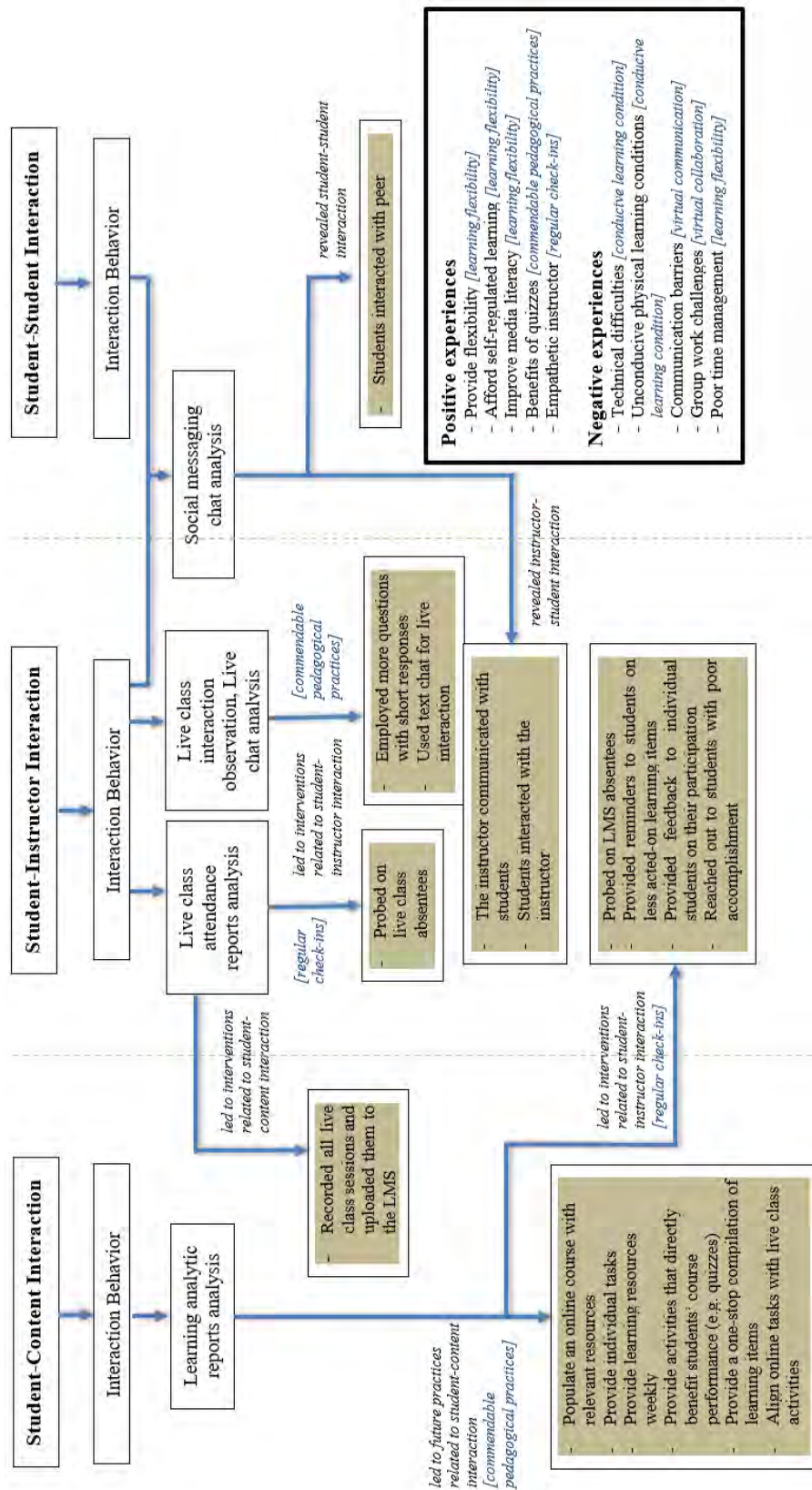
- Provide virtual communication, collaboration, learning pathway guidance and coaching
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The uncovering of interaction behaviors gave insights to the instructor for implementing other relevant interactions. Figure 7 depicts the dynamics of interaction types derived from these insights. For example, insights from student-content interaction led to interventions related to student-instructor interaction and informed future pedagogical practices related to student-content interaction. Insights from student-instructor interaction led to interventions related to a similar type of interaction and interventions related to student-content interaction.

DISCUSSION

This discussion is in accordance with interaction types and other elements of Anderson's online learning model. The analysis and reflection of online interaction behaviors and experiences related to student-content interaction reveal that students require conducive learning environments, regular check-ins on their progress and social-emotional well-being, as well as favor the learning flexibility afforded by asynchronous learning. It also provides insights into commendable pedagogical practices. In addition, the analysis and reflection of online interaction behaviors and experiences related to student-instructor interaction and student-student interaction reveal some considerations in virtual communication and virtual collaboration, respectively.

Figure 7: The dynamic of interaction types derived from insights gained via uncovered interaction behaviors and experiences



Student-content interaction

The student-content interaction behaviors discovered through the analysis of learning analytics reports and the follow-up virtual interviews on their learning experience reveal the following.

Conducive learning condition

Learning analytics revealed passive students, and further examination of their learning experiences related to this interaction type revealed that unconducive learning conditions such as poor connectivity and poor physical learning conditions, are barriers to such interaction. A similar phenomenon is reported in Chung, Subramaniam, and Dass (2020), Maqableh and Alia (2021), and many other studies. Therefore, the requisite technology for smooth online learning is good connectivity and a well-functioned digital device. While improvement in terms of technological infrastructure can be implemented by the government, telecommunication companies, and universities (Chung, Subramaniam, and Daas 2020), instructors may opt for asynchronous delivery methods as a handy solution to minimize inequalities in student-content interaction.

Regular check-ins

Students' social-emotional skills can affect their learning capacity and their risk for mental health problems (Durango and von der Embse 2020). The uncertainty, fear, isolation, and rapid change caused by the pandemic pose more challenges to students' social-emotional coping abilities. Observing students' interaction behavior with the content led to the instructor's regular check-in with students on their progress and social-emotional well-being. These include probing LMS absentees, providing reminders to students on less acted-on learning items, providing feedback to individual students on their participation, and reaching out to students with poor accomplishments. This demands an empathetic instructor and increased student-instructor interaction so that the instructor can provide relevant, personalized assistance to the affected students. Katzman and Stanton (2020) proposed the integration of social-emotional learning into online learning designs so that students can thrive better in online learning environments.

Learning flexibility

This study also reveals that students favored flexibility in accessing online learning. Students could learn at their convenient time, place, and pace. Many studies conducted during this pandemic, such as Dhawan (2020), Hasan and Khan (2020), and Simamora (2020), reported the benefits of such flexibility. The provision of asynchronous learning items enables flexible student-content interaction. This flexibility aligns with the independent study element of Anderson's model. Students reported such asynchronous learning as a positive learning experience, because it develops their self-directed learning abilities to complete their learning independently. Asynchronous online materials facilitated students to take responsibility for their learning (Burns, Holford, and Andronicos 2020). Students also reported their improved media literacy due to their extensive learner-content interaction. However, poor time management, as reported by some other students as a negative experience, points to the need to provide some guidance for students to work autonomously and manage time effectively (Wang, Shannon, and Ross 2013).

Commendable pedagogical practices

The student-content interaction behaviors discovered through learning analytics also reveal a list of commendable pedagogical practices that can enhance student-content interaction. These include populating the online course with relevant resources, providing individual tasks, providing weekly learning resources, providing activities that directly benefit students' course performance (e.g. quizzes), providing a one-stop compilation of learning items, and aligning online tasks with live class activities. These practices align with the proposed strategies to foster student engagement by Heilporn, Lakhal, and Bélisle (2021), who highlight the importance of a well-structured, continuous online course with a clear connection between asynchronous and synchronous activities.

Student-instructor interaction

The student-instructor interaction behaviors were examined via live class attendance reports analyses, live class interaction observation, live chat analysis, and social messaging chat analysis. The discovered student-instructor interaction behaviors again indicate the need for the instructor to perform regular check-ins with passive students. Heilporn, Lakhal, and Bélisle (2021) highlight the importance of providing guidance and support to students from the beginning and throughout the semester, either in a large group or individually, to foster their emotional and cognitive engagement.

Virtual communication

The analyses reveal students' preference for text-based interaction and their more active participation in questions requiring short responses during live classes. The limited access to good connectivity in some areas also points to the need to provide low bandwidth platforms (Fawns, Jones, and Aitken 2020). These insights inform practices that encourage interaction in the community of inquiry via appropriate communication channels, as depicted in Anderson's model.

Online distance learning increases the difficulty in communication with peers and instructors. In this study, reluctance and shyness have been determined as among the top reasons for their non-participation in virtual interaction, besides poor connectivity, which disrupted smooth synchronous virtual communication. Lack of non-verbal cues and the sense of instructor presence (Olivier 2016), and the fear of miscommunication (Zaltsman 2009) may explain the passive participation. Furthermore, due to the pandemic, students in this study did not have the chance to meet their instructor and other peers in person, and communication with individuals viewed as foreigners can be challenging (Shen 2004).

Student-student interaction

The social messaging chat analysis provides evidence of the occurrences of student-student interaction when students used the medium to obtain and share course-related information. The online survey also revealed some challenges in this type of interaction while working on their course assignments. However, this study did not tap into student-to-student interactions that may occur in other messaging groups created by students.

Virtual collaboration

Collaborative work requires group members to integrate cognitive, motivational, and emotional elements (Borge, Ong, and Rosé 2018). The lack of participation in group work, as reported by some students of this study, may indicate some missing elements. Students' lack of collaborative skills is one of

the main obstacles to effective student collaboration (Le, Janssen, and Wubbels 2018). Hence, guidance and coaching on effective and efficient virtual collaboration are needed to build students' competencies. Le, Janssen, and Wubbels (2018) also point out the need for the instructor to re-examine the collaborative learning goals, provided instruction, and student collaboration assessment. Such actions strengthen the implementation of the collaborative learning element, as depicted in Anderson's model of online learning.

CONCLUSION

This study reveals that employing the qualitative method, through LMS analytics reports analysis, observation of live classes, and interactions analysis within the social messaging app and virtual live classes, is feasible to determine students' interaction behaviors. In addition, interviews and surveys are feasible methods to gain insights into students' online learning experiences. Figure 7 depicts the dynamic of interaction types derived from insights gained via uncovered interaction behaviors and experiences in which the understanding of a specific interaction type triggers the need for more interaction either of a similar or different type. Results from this case study also point to the need for conducive learning environments, regular check-ins with students, and the benefit of learning flexibility. It also provides insights into commendable pedagogical practices and some virtual communication and collaboration considerations. Although these results are specifically meant for students of the chosen course, they also point to learning issues that are relevant to other Malaysian higher education students, similar to those reported in Azlan et al. (2020), and Sia and Adamu (2020). Future studies may replicate the method employed in this study in other courses to gather further evidence for making informed online pedagogical decisions. Replications in different contexts will also help improve the findings' generalizability.

ACKNOWLEDGMENTS

The author acknowledges the support provided by Universiti Malaysia Sarawak through the Malaysia Comprehensive University Network Grant Scheme [GL/F04/MCUN/20/2020].

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