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RESEARCH ARTICLE

Pharmacy students' perceptions and satisfaction with blended instruction in quantitative chemical analysis course

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Abstract

Background: Course satisfaction in blended learning has become a priority among educators to keep students on track during their studies. This study investigated the Community of Inquiry (CoI) three key components, i.e. teaching, social, and cognitive presences and other factors that affect student satisfaction at Lebanese International University (LIU). **Objective:** The study aimed to examine pharmacy undergraduate students who enrolled in, and the effect of blended learning courses on learning environment perceptions, learning outcomes, and overall academic performance. **Methods:** Exactly 283 second-year students from a private School of Pharmacy registered in the Quantitative Chemical Analysis course participated in this study. Data were collected using an online survey, assessing students' prior pre-pharmacy course experiences. **Results:** The majority of students (58%) commended the course content, organisation, teaching resources, course design, and clarity of directions. Course satisfaction significantly correlated with age and social, cognitive, and instructional presences (Spearman's Rho: 0.739-0.750, $p < 0.05$). **Discussion:** Studies found that blended instruction can improve student engagement, satisfaction, and learning outcomes, which are influenced by the quality of online materials, communication, feedback, and the degree of student and instructor interaction. **Conclusion:** The outcomes of this study support the assumption that blended learning encourages active, in-depth, and self-directed learning.

Introduction

A pharmacy degree can lead to various career options, including community, hospital, medical biology, industry (e.g. manufacturing, quality control, and marketing), and regulatory (Jarab, Al-Qerem & Mukattash, 2021). Due to rising student enrollment and diversification, improving student learning experiences is now more crucial in higher education (Bai *et al.*, 2022). Elements impacting the quality of learning include course material presentation, the type of teaching-learning environment offered, and student impressions of that environment (Closs, Mahat & Imms, 2022). The internet, cloud computing, big data, and artificial intelligence are all profoundly changing our culture and way of life, to say the least, by fusing the real and the virtual, and are also affecting education. Technology has revolutionised learning and teaching through communication evolution, expanded audience, interactive textbooks, eBooks, tablet computing devices, and extended classroom communities (Zhao & Li, 2022).

Courses are classified into four forms of learning, i.e., conventional (entirely face-to-face), web-facilitated, blended/hybrid, and entirely online. A conventional course is presented only face-to-face, without using any Internet technologies. The term "*web-assisted*" refers to a course that uses online technology between one and 29 per cent of the time. Blended courses combine face-to-face sessions with online learning technologies, such as an online discussion between 30 and 79 per cent of the course content. Hence, a course is considered entirely online if it uses online technologies more than 79 per cent of the time (Cancino & Avila, 2021). A fully online course has no face-to-face meetings; all the learning experience, including online discussion and web conferencing, is done through online technology.

Traditional education is viewed as essential to the growth of a sense of community and must be provided at a regular time and place. Online learning can take place in synchronous (real-time) or asynchronous (self-paced) contexts, each of which has various consequences for material accessibility, scheduling compatibility, and content consistency. Blended learning (BL), defined as the combination of traditional face-to-face learning and asynchronous or synchronous e-learning, combines the benefits of both traditional and e-learning (Vallée *et al*., 2020).

While the traditional lecture method is frequently praised for being more efficient, easy to control by the instructor, and conducive to predictable and manageable student learning, it is often criticised for suffocating creative thinking, resulting in little student involvement in decision-making and the lack of intrinsic sources of student motivation. In the traditional educational paradigm, there is a strong emphasis on the instructor, and the information taught is often abstract and out of context. Students do not have the opportunity to benefit from collaborative learning, especially in large-enrollment classrooms. Furthermore, standard lecture-based courses may fail to foster in-depth knowledge since conversations are shallow, spontaneous, and constrained (Sobirova & Karimova, 2021). Fully online courses have the potential to be more student-centred, more flexible, and to foster self-directed learning. E-learning provides greater flexibility in terms of time and geography while allowing for improved communication and interaction possibilities. It also promotes the constructivist instructional design theory, which emphasises the significance of individual discovery and creation of knowledge due to enhanced access to an ever-growing corpus of online material. On the other hand, fully online learning may reduce student-instructor interaction and cause students to feel isolated. The bottleneck for online learning is the lack of resources (connectivity, data limit, data speed, devices, and home environment), which adds to the drawbacks of fully online courses; the situation is even worse for those from remote areas. All these factors contribute to lower course evaluations and have sparked an ongoing debate about the relative usefulness of online and traditional learning modalities (Almahasees, Mohsen & Amin, 2021; Barrot, Llenares & del Rosario, 2021).

A growing number of institutions, professors, and students are choosing BL alternative learning options, including full online learning (Ibrahim & Nat, 2019). BL was created to address the shortcomings of online or face-to-face-only classes by giving students a more flexible, convenient, and engaging learning experience. It is a blend of educational approaches combining classroom efficacy and socialisation prospects with online learning technology advancements. This mix includes a paradigm shift, with the focus changing from teaching to learning. BL is a fundamental rethinking of the educational model, moving from lecture-centred towards student-centred instruction, where students participate actively in their learning (Anthony Jr. *et al.,* 2022). BL also accounts for several educational principles outlined by Chickering and Gamson, including "*encourage active learning*," "*give prompt feedback*," and "*respect diverse talents and ways of learning*," supporting the notion that BL can enhance student educational experiences (Tanis, 2020).

Reasons to use blended learning

BL has six objectives, i.e. pedagogical richness, knowledge availability, social interaction, personal agency, cost-effectiveness, and ease of revision (Ashraf, Tsegay & Meijia, 2021). Instructors chose a BL method primarily to enhance pedagogy, expand access and flexibility, and reduce costs. BL is a flexible educational strategy that caters to student individual needs by directing all available resources towards maximising their potential (Cuesta Medina, 2018). The objective is to promote learner engagement, which will lead to more effective learning. In a word, it is about personalised, mastery-based, and meaningful learning. Students develop personally relevant criteria while also gaining greater control over their studies. Meta-analyses have compared web-based and BL training to classroom instruction. For declarative and procedural knowledge outputs, BL outperformed classroom instruction. The mixed learning strategy, as opposed to the online or face-to-face models, increases student interest in the topic. Unlike fully online or conventional courses, BL fosters a profound feeling of community among students (Heilporn, Lakhal & Bélisle, 2021; Li, 2022). The advantages of BL from the standpoint of students are individualised learning paths, learner-centredness, increased motivation and engagement,

participation, self-paced learning, flexibility, improved learning outcomes, critical thinking abilities, peer support and collaboration, one-on-one tutoring, group tutoring, and feedback (Ashraf *et al.,* 2022).

The perceived drawbacks of BL are merely hypothetical. Success, improved learning outcomes, and increased competitiveness in the global learning environment result from embracing new trends and meeting the significant expectations of course users. If the new challenges presented by BL could be overcome, learning centres would become more international and successful. To provide students with a successful BL experience, universities must support course redesign, which includes determining the course objectives that are best suited for online learning activities and those that are best accomplished in the classroom, in addition to how to integrate these two learning environments (Luo, 2021).

Student Evaluation of Teaching (SET)

Researchers and institutions use various terminologies to refer to SET, e.g. student evaluations, SET effectiveness, student contentment, and student views of teaching (Zhao *et al.,* 2022). SET is described as the information sought from students to help academics and administrators develop their programmes (Constantinou & Wijnen-Meijer, 2022). It is an informal assessment completed by students at the end of a course or programme, where they are often asked to rate the effectiveness of the instructor or the quality of the programme (Medina *et al.,* 2019) and reflect on how their skills and attitudes have evolved throughout a particular course (Clayson, 2022).

Interaction and student satisfaction

Student satisfaction can only be sustained and have lasting value when it is connected to a positive learning experience. Clear expectations, interaction, and feedback are all closely related to learning and contentment. Student satisfaction is decreased by a lack of support but increased by a feeling of community (Tian *et al.,* 2021). Students may learn more by interacting with their friends and lecturers online, utilising synchronous and asynchronous online communication platforms. Interaction and satisfaction are associated (especially with the instructor). The teaching staff can simultaneously construct face-to-face learning activities based on their online interactions to meet student expectations. BL is more than just adding online tools to current face-to-face sessions. It requires the integration of online and face-to-face learning by faculty (Pratiwi *et al.,* 2021).

Student engagement in higher education significantly affects learning and performance. It provides insights into a student's university experience and serves as a solid indicator of future academic success and institutional productivity (Rajabalee, Santally & Rennie, 2020). Student engagement is the involvement of students in educational materials and activities meant to promote learning (Mebert *et al.,* 2020). The development of educational technology has given institutions and instructors a significant opportunity to engage students in new ways. Technology, when used properly, can improve student performance and course satisfaction by increasing student involvement. Technology-mediated courses, such as those provided entirely online or using blended learning modes, give students the freedom to engage in their classes at their own pace and in their environment, enabling interactions that would otherwise be impractical in conventional classrooms. The concept of a community and the availability of help promote social connection and lessen the isolation that may be brought on by the lack of in-person social engagement in online learning. The physical presence and authentic interactions that take place in the classroom have also been said to be irreplaceable by online platforms (Bryan *et al.,* 2018; Caton *et al.,* 2021; Sonji *et al.,* 2022). Despite improvements in modern education, students still long for a personal touch (Law *et al.,* 2022). The challenge for higher education is to harness the transformational power of technology by defining and tailoring learning opportunities while keeping in mind the value of human interaction. One promising solution is BL, which combines the advantages of both in-person and online learning (Xing & Saghaian, 2022).

Five research hypotheses were examined in this study to decide which ones should be accepted and which ones should be rejected. H1: There is no link between a teacher's presence in class and student satisfaction. H2: Social presence and course satisfaction are not correlated. H3: Cognitive presence and course satisfaction do not correlate. H4: There is no relationship between course satisfaction and age. H5: Gender and course satisfaction are not correlated. The *p*-value has been employed in this investigation to examine these five hypotheses. A *p*-value of 0.05 or less rejects the null hypothesis at the 5% level.

Description of the blended course in quantitative chemical analysis

In the spring term of the academic year 2021/2022, the LIU School of Pharmacy has implemented BL in several courses, including the quantitative chemical analysis course (PHAR205).

PHAR205 is a 12-week course delivered in the pre-pharmacy programme during the spring term. It is mandatory for all second-year students and is offered and managed by the School of Pharmacy, with an annual enrolment of approximately 300 students. Quantitative Chemical Analysis is well-suited to blended courses because it enables the acquisition of both complex academic knowledge and basic skills through a combination of online and in-person instruction. The course content was divided into face-to-face and online delivery modalities, with a distribution ratio of 42% to 58%, respectively. The blended course content included online study sessions with texts, videos, and self-assessment quizzes on Google Classroom and on-campus meetings.

The online component was identical to the face-to-face section in terms of content and organisation. The course material, i.e., the course syllabus, announcements, self-assessment quizzes, assignments, and links to relevant websites and search engines, was uploaded to the Google Classroom platform. PowerPoint presentations and extra notes were uploaded consecutively according to the course timeline, and students were urged to practice online problems at the end of each chapter presentation.

The face-to-face meetings focused on summarising the material the students had studied, highlighting critical ideas, providing clarification on ambiguous or challenging topics, and engaging in self-evaluation and monitoring activities. The face-to-face component of the course consisted of laboratory sessions on campus where students were supervised by faculty and laboratory assistants. To optimise the benefit of these sessions, students received laboratory information in advance to prevent cognitive overload. Pre-laboratory videos were designed to help students become more independent and self-assured when conducting experiments. Students could view the movie at their pace, watching again any portions that seemed confusing to them and identifying their weak points. All these elements helped students prepare for the laboratory sessions by providing them with knowledge beforehand. The course covered fundamentals of basic statistics, chemical equilibria (solubility, acid-base, complexation, precipitation, and redox titrations), electroanalytical techniques, and introductory spectroscopy. Assessments in the course included a midterm test (30%), a final exam (35%), quizzes and assignments (15%), and laboratory reports (20%). The exams required students to understand the terminology, chemical techniques, calculations, chemical formulae, equations, and, in some instances, safety considerations and issues related to laboratory sessions.

Purpose of study

This research focused on a blended quantitative chemical analysis course offered to second-year pharmacy students at the Lebanese International University (LIU) School of Pharmacy. It aimed to measure student participation and interest in this style of learning and identify challenges faced throughout this new approach.

Methods

This study employed quantitative research methods and an online survey to collect and analyse data. A total of 291 students were enrolled in the LIU blended quantitative chemical analysis course during the study period. Toward the end of the term, all enrolled undergraduate students were surveyed. Following ethical approval from the School Research and Ethics Committee, 283 students (203 females and 80 males, in 16 sections on 8 campuses) responded willingly and anonymously to an online survey via Google Classroom. The questionnaire items were scored using a five-point Likert scale ranging from 1 (strongly disagree) to 5 (strongly agree). The questionnaire assessed course structure and organisation, active learning, self-directed learning, contextual learning, collaborative learning, tutor interpersonal behaviour, and student satisfaction. Additionally, two open-ended questions were added to elicit more feedback on student experiences and evaluations of the entire procedure.

The survey comprised 42 questions divided into four sections, i.e. demographic data, student satisfaction with PHAR205 curriculum and teaching methods, course format preferences, and BL evaluation. The blended course was assessed based on student satisfaction and knowledge acquisition, considering the following elements: student level of involvement in the course, the effectiveness of instructor communication, instructor clearly specifying assignments, student connection to one another, and instructors successfully integrating faith and learning. Research questions also investigated the preferred course format and assessment method. Questions about age, gender, and academic year were included in the initial section of the survey. Student perceptions of the teaching presence, social presence, and cognitive presence were measured using the validated Community of Inquiry (CoI) instrument (Arbaugh *et al.,* 2008). The CoI instrument has been used regularly to evaluate pedagogical, social, and cognitive presence in online and blended learning contexts (Liman Kaban, 2021; Huizinga *et al.,* 2022). Peer-reviewed studies that used CoI found strong reliability, indicating the degree of internal consistency across the instrument

items, with Cronbach alpha values ranging from 0.91 to 0.97 (Martin *et al.,* 2022; Purwandari, Junus & Santoso, 2022). Likewise, the high dependability of CoI was revealed by the current investigation. Student satisfaction with the entire blended learning experience at LIU was measured using Student Satisfaction with Blended Learning, a modified version of the instrument developed by Shin (Shin, 2003).

Data analysis

The relationship between the predictor variables and the criterion was studied using the standard multiple regression analysis. The criterion variable in this study was student satisfaction, whereas the predictor variables were CoI's main elements (teaching, social, and cognitive presences), gender, and age. This study attempted to predict the significance of each of these factors regarding course satisfaction. The 0.05 level of significance was used for all data analyses. Statistical analysis was performed using IBM Statistical Package for Social Sciences (IBM SPSS) version 26.0. The fundamental findings of the study were illustrated using descriptive analyses, such as means and standard deviations. Moreover, correlation studies were carried out to examine the connections between the predictors and the criteria variables and the correlations among the predictors. The independent variables were subjected to standard multiple regression analysis to determine whether they significantly affected student satisfaction. The Independent Samples t-test and Pearson correlation were used to assess the influence of student background factors, including gender and age, on student satisfaction.

Results

Missing data

The online survey was filled out by 283 students. The first assessment of missing data found that eight participants did not complete it entirely. These participants were visibly disengaged, as indicated by their frequent question-skipping. Missing data with mild implications may be acceptable at 5% or below (Schafer, 1999). The missing data analysis for these eight students found that the percentage ranged from 15 to 40 %. As a result, the replies of these eight participants were deleted.

Descriptive Statistics

Table I shows participants' demographic features, where 57.6% of students were under the age of 20, 41.3% were between 20 and 30, and 1.1% were above 30. The population was 28.3% male and 71.7% female. Finally, 95.8% were enrolled in their second year, while the remaining 4.2% were third-year pharmacy students.

Table I: Demographic characteristics of the students

Demographic Variables	Frequency	Percentage
Gender		
Male	80	28.3%
Female	203	71.7%
Student Age		
<20	163	57.6%
Between 20 and 30	117	41.3%
>30	3	1.1%
Academic Year		
Second	271	95.8%
Third	12	4.2%

Table II presents student perceptions of BL, including course structure, course content (effective course design that combines goals and learning objectives, active involvement of students, and content that is easy to grasp), instructor competence (technical and communication skills), interactivity (active engagement of both lecturer and students throughout the lesson), flexibility (convenience for both teacher and learner), motivation (learner goal-directed behaviour), discipline, and comprehension of course topics in comparison to face-to-face and online learning and evaluation criteria. The majority of respondents (64%) wanted to take at least one test on campus, and about 45% of students preferred BL if PHAR205 was available in multiple formats. Additionally, 58% of students reported being satisfied with the curriculum and teaching methods.

Outliers

An observation that does not fit the pattern of the data is an outlier. Finding outliers is one of the crucial steps in doing an accurate analysis. Information from outliers may be unreliable and deceptive. Outliers may also significantly affect the results of a small-scale study. Hence, locating outliers is essential before undertaking statistical studies (Kwak & Kim, 2017). Boxplots were used to find outliers; no extreme examples of outliers were found in the boxplots.

Table II: Learner perceptions of blended learning

Question	Strongly agree (%)	Agree (%)	No opinion (%)	Disagree (%)	Strongly disagree (%)	Mean	SD
The learning objectives of PHAR205 that I should know were clearly stated at the beginning of the course.	31.1	35.7	23.3	5.7	4.2	3.84	1.06
The amount of personal work and labour required from me was specified at the beginning of the course.	29.7	36.7	24.4	4.2	4.9	3.82	1.06
The proportions of online and in-person learning were clearly stated by my instructor.	36.4	31.8	22.3	6	3.5	3.92	1.07
The course syllabus stated what I was expected to complete in this blended course and how grades were distributed.	40.6	36	15.9	3.9	3.5	4.06	1.02
The teaching methods utilised in the BL format enabled successful learning.	24.7	31.4	26.5	11	6.4	3.57	1.16
The instructor motivated me to investigate new concepts in this course.	31.4	30.7	26.5	6.4	4.9	3.77	1.11
The instructor offered timely comments that assisted me in understanding my strengths and limitations.	29.7	35	20.5	11	3.9	3.76	1.11
This BL course was well-organised and simple to follow.	25.8	31.1	27.6	11	4.6	3.63	1.12
The course was a vital part of my education.	24.7	37.5	27.2	7.4	3.2	3.73	1.02
I think the time necessary to complete the work in this BL course was acceptable for the topics and the desired learning outcomes.	18.7	37.1	31.1	8.8	4.2	3.57	1.03
Exams and course assessments reflected the information covered in class.	26.1	39.9	20.8	9.9	3.2	3.76	1.05
I felt my grade accurately represented my in-person and online learning efforts.	16.3	31.4	33.6	12.4	6.4	3.39	1.09
The online and in-person elements complemented one another.	19.1	32.2	32.5	11.3	4.9	3.49	1.08
The combination of online and face-to-face learning approaches would promote meaningful and real learning. BL encourages self-regulated learning.	22.6	32.2	31.1	8.5	5.7	3.58	1.1
Employing a combination of online and traditional in-class delivery is more effective than using one-way information delivery.	23	30.4	31.1	7.8	7.8	3.53	1.16
Overall, I was satisfied with this BL course.	23	33.9	24.7	8.8	9.5	3.52	1.21
If given the chance, I would take another course with both online and face-to-face components in the future.	23.7	29.7	26.9	7.8	12	3.45	1.27
Conversation and collaboration in this BL course were both engaging for me.	26.1	39.6	23	7.8	3.5	3.77	1.03
I found it simple to obtain course materials, communicate with the instructor and other students, and submit my assignments.	27.9	36	25.1	7.8	3.2	3.78	1.04
The difficulties that have been presented have sparked my curiosity about the topics covered in class.	19.1	37.1	32.2	9.2	2.5	3.61	0.98
I think I am capable of applying the knowledge gained in this course and utilising it in future courses.	24.4	40.6	26.5	5.7	2.8	3.78	0.97
I can use what I learned in this course to solve practical problems and assess real-world events.	18.7	41.3	30	7.4	2.5	3.66	0.95
The readings, assignments, and discussions that were provided to me helped me get a deeper grasp of the subject.	31.4	35.7	21.9	6.4	4.6	3.83	1.08
The course sparked my interest in the field.	22.3	35.7	27.2	10.6	4.2	3.61	1.07
Only online assessments can assess my understanding of the course.	9.5	16.6	39.2	16.6	18	2.83	1.19
Online class delivery, in my opinion, is more effective than traditional in-class delivery.	14.8	17	26.1	20.5	21.6	2.83	1.34
I prefer only face-to-face instruction.	30.7	27.2	24	12.7	5.3	3.65	1.19
Only on-campus assessments can assess my understanding of the course.	18	25.1	38.2	11	7.8	3.35	1.13
At least ONE on-campus assessment component should be present in order to evaluate how deeply I understood the course.	23	41.3	24	5.7	6	3.7	1.07
Any assessment regardless of its mode can evaluate how deeply I understood the course.	20.1	31.4	33.2	8.5	6.7	3.5	1.11

Validity and reliability

Cronbach's alpha measured the internal consistency of the questionnaire items or how closely connected they were to one another as a group. The reliability is categorised into excellent (α>0.9), good (0.8 <α<0.9), acceptable (0.7<α<0.8), questionable (0.6<α<0.7), poor (0.5<α<0.6), and unacceptable (α<0.5) (Cronbach, 1951). In this study, Cronbach's alpha values (α) ranged between 0.81 and 0.92. The alpha value for the Teaching Presence and Course Satisfaction scales was 0.92, followed by 0.9 for the Cognitive Presence scale, and 0.81 for the Social Presence scale, indicating high levels of internal reliability.

Assumptions

All independent variables were simultaneously incorporated into the regression model in standard multiple regression. Student satisfaction with BL was used as the criterion variable. Inter-correlation results showed that all predictor variables, including age, social presence, cognitive presence, and teaching presence, were positively linked with the outcome variable (Table III). The results of the correlation study showed strong correlations between age, teaching presence, social presence, and cognitive presence, as well as student satisfaction with blended learning. These positive correlations suggested that the increase in student satisfaction with BL is related to the increase in their perceptions of instructional presence, social presence, cognitive presence, and age. The unstandardised regression coefficients (B) from the multiple regression analysis can be used to forecast student happiness with BL. The standardised regression coefficient (β), which may be used to assess the relative importance of all four factors, is also displayed in the regression analysis. As shown in Table IV, teaching presence (β= 0.302, p < 0.001), cognitive presence (β= 0.268, p < 0.01), social presence (β= 0.247, p < 0.01), and age (β= 0.620, p < 0.05).

Table III: Summary of the correlation between CoI presences, age, gender, and overall course satisfaction

			Overall course satisfaction score	Teaching presence score	Social presence score	Cognitive presence score	Age (under 20/between 20 and 30)	Gender
Spearman's rho	**Overall course satisfaction score**	**Correlation Coefficient**	1.000	0.739**	0.738**	0.727**	0.183**	0.055
		Sig. (2-tailed)		0.0001	0.0001	0.0001	0.002	0.361
		N	277	277	277	277	277	277
	Teaching presence score	**Correlation Coefficient**	0.739**	1.000	0.835**	0.802**	0.122*	-0.042
		Sig. (2-tailed)	0.0001		0.0001	0.0001	0.042	0.488
		N	277	277	277	277	277	277
	Social presence score	**Correlation Coefficient**	0.738**	0.835**	1.000	0.824**	0.120*	0.023
		Sig. (2-tailed)	0.0001	0.0001		0.0001	0.045	0.706
		N	277	277	277	277	277	277
	Cognitive presence score	**Correlation Coefficient**	0.727**	0.802**	0.824**	1.000	0.137*	0.016
		Sig. (2-tailed)	0.0001	0.0001	0.0001		0.022	0.785
		N	277	277	277	277	277	277
	Age (under 20/between 20 and 30)	**Correlation Coefficient**	0.183**	0.122*	0.120*	0.137*	1.000	0.236**
		Sig. (2-tailed)	0.002	0.042	0.045	0.022		0.0001
		N	277	277	277	277	277	277
	Gender	**Correlation Coefficient**	0.055	-0.042	0.023	0.016	0.236**	1.000
		Sig. (2-tailed)	0.361	0.488	0.706	0.785	0.0001	
		N	277	277	277	277	277	277

**. Correlation is significant at the 0.01 level (2-tailed).

*. Correlation is significant at the 0.05 level (2-tailed).

Table IV: Summary of multiple regression analysis for age, social presence, cognitive presence, and teaching presence as predictors of course satisfaction (n = 382)

Model		Unstandardised Coefficients		Standardised Coefficients		
		Beta	**Std. Error**	**Beta**	***t***	***p*-value**
4	(Constant)	6.018	1.477		4.073	0.000
	Teaching presence score	0.409	0.103	0.302	3.970	0.000
	Cognitive presence score	0.533	0.152	0.268	3.506	0.001
	Social presence score	1.097	0.344	0.247	3.191	0.002
	age_dummy	1.364	0.620	0.083	2.199	0.029

[a] Dependent Variable: Overall course satisfaction score

In Figure 1, boxplots display the normality distribution of four key variables. They show some outliers in the teaching presence and cognitive presence scores but not in the social presence score.

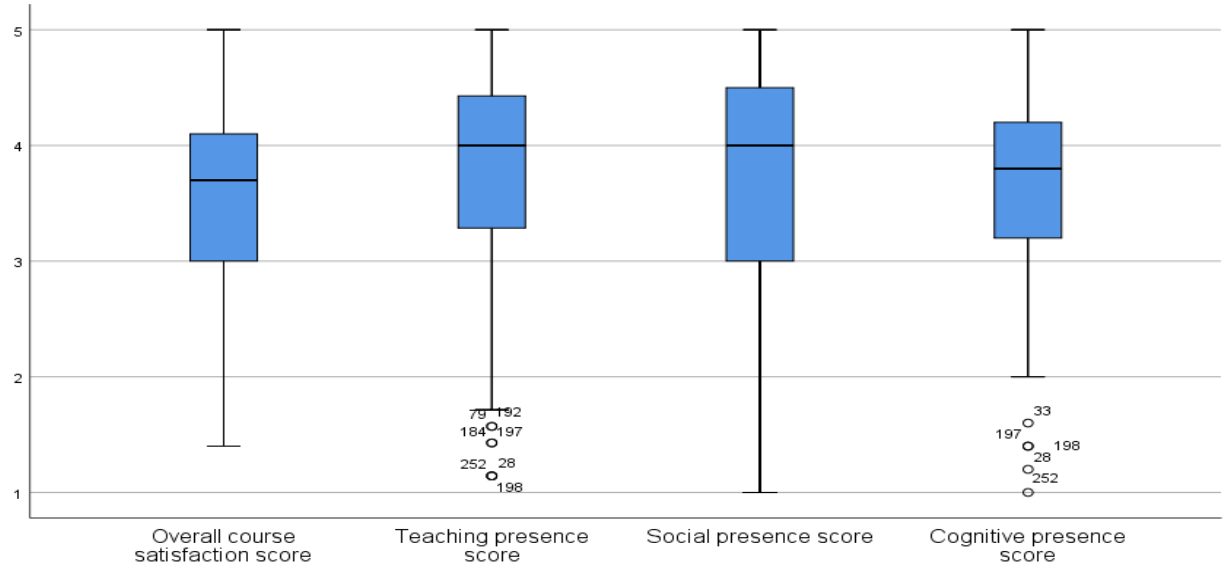

Figure 1: Boxplots for teaching presence, social presence, cognitive presence, and course satisfaction scales (n= 283)

Null Hypothesis 1: There is no correlation between teaching presence and course satisfaction.

Based on the Spearman correlation, there was a significant positive and high correlation between teaching presence and course satisfaction (Rho=0.739, $p < 0.05$), so the null hypothesis was rejected, and high teaching presence was positively associated with high overall course satisfaction (Table III).

Null Hypothesis 2: There is no correlation between social presence and course satisfaction.

Inferring from the Spearman correlation that there is a significant positive and high correlation between social presence and course satisfaction (Rho=0.738, $p < 0.05$), the null hypothesis was rejected, and high social presence was positively correlated with high overall course satisfaction (Table III).

Null Hypothesis 3: There is no correlation between the cognitive presence and course satisfaction.

The null hypothesis was rejected because there was a significant positive and high correlation between cognitive presence and course satisfaction, as shown by the Spearman correlation (Rho=0.727, $p < 0.05$). High cognitive presence was also positively correlated with high overall course satisfaction (Table III).

Question 1: Is there an association between age and course satisfaction?

Age and course satisfaction were positively correlated using the Spearman correlation (Table III). Age had an influence on course satisfaction since it was a statistically significant predictor of course satisfaction.

Question 2: Is there a difference between gender (male/female) on course satisfaction?

The null hypothesis H0 (No correlation between sex and course satisfaction) was accepted, which means that the gender of students did not affect their perception of the course, as the study did not find noticeable differences in course satisfaction between genders.

Question 3: How do cognitive, social, or instructional presences and other relevant variables (age, year of study) combine to predict course satisfaction?

Stepwise multiple regression was used to build models and identify the optimal one (Model 4). The categorical variables included gender, age, and current enrolment. Two dummy variables were established to facilitate regression building. For age, age<20 was coded as 0, and age between 20 and 30 was coded as 1. For current enrollment, the second year was coded as 0, and the third year was coded as 1. The statistically significant predictors for course satisfaction were teaching presence, cognitive presence, social presence, and age (R=0.785).

Based on Table IV, the regression equation linking course satisfaction to other predictors was:

Course satisfaction score = 6.018 + 0.409 × teaching presence score + 0.533 × cognitive presence score + 1.097 × social presence score + 1.364 × (age_dummy=1), where age_dummy=1 refers to age between 20 and 30, and age<20 is the reference class.

There was a high correlation between age and overall satisfaction level (coefficient =1.364) and between overall satisfaction level and social presence (coefficient =1.097). The enrollment variable (year of study) was not a statistically significant predictor for course satisfaction and was removed from analysis using a stepwise method.

Discussion

This study aimed to examine the benefits of BL in supporting and expanding student learning experiences. It also investigated how students perceived BL and the influence of teaching presence, social presence, cognitive presence, and other associated characteristics on student course satisfaction with a Quantitative Chemical Analysis blended course taken at LIU. The significance of each of these factors in relation to course satisfaction was predicted. The data were properly handled and structured for analysis in order to answer the study research objectives.

In this study, course satisfaction and teaching presence had a high positive association, corroborated by previous findings showing that teacher presence was crucial to enhancing online learning efficacy (Wang *et al.,* 2021). One possible explanation for the increased student involvement is the instructor's implementation of strategies to encourage and recognise student contributions, create a positive learning atmosphere, attract participation, and inspire debate. The instructor also provided clear instructions for tasks and activities, which encouraged student involvement.

Cognitive presence was positively connected to learning engagement, in line with prior findings (Almasi & Zhu, 2020; Harb & Krish, 2020) and was mainly accomplished by increasing student understanding of complicated topics through intellectual dialogue, critical thinking, and complex learning.

The results also demonstrated no noticeable differences in satisfaction with blended learning between male and female students. Numerous studies have investigated gender differences in student satisfaction with blended learning and have found that gender does not have a significant impact on satisfaction with this mode of learning (Kintu *et al*., 2017; Suwantarathip, 2019).

The current study found a statistically significant link between student satisfaction and their age, consistent with previous findings unveiling a significant association between age and student level of satisfaction, where older students tended to be more satisfied than younger ones (El-Hawy *et al*., 2022), but contrary to others showing that age did not significantly affect student satisfaction (Venkatesh *et al*., 2020).

More than 65% of students considered they were adequately informed about the course learning objectives and that the quantity of independent learning expected was appropriately described. Students believed that the proportions of online work and in-class tutorials were clearly defined and that the evaluation processes were adequately detailed.

A high percentage of students (62%) felt that this course was essential to their education and that it sparked their interest in quantitative chemical analysis. A similar percentage of participants reported that BL fosters self-regulated learning and that the course satisfied their learning expectations. The majority (53%) believed that BL was more efficient than a one-way information distribution, and 60% felt that it helped them find solutions to real-world issues such as provision with opportunities to apply their theoretical knowledge in practical and authentic settings. Also, blended learning can allow students to participate in virtual labs and experiments that simulate real-world situations and scenarios, which can prepare them for solving complex issues in the workplace. Regarding the preferred method of learning, the association between BL and improved quality of contact with other students or instructors was investigated. About 36.4% chose

mixed learning, 4.6% online learning, and 59% face-to-face engagement. From these results, it can be concluded that students had a positive experience with instructors, the management of the material, and the suggestions made, in line with previous findings (Extavour & Allison, 2018; Balakrishnan *et al.,* 2021).

When asked which format of the course in PHAR205 would help them most, 43.5% picked mixed learning, 4.6% online, and 51.9% face-to-face. Regarding the question of whether they would rather attend experiments in person or access them online, 37.1% of students answered BL, 4.6% online, and 58.3% face-to-face. Additionally, 33.6% of students demonstrated confidence in carrying out an experiment they had just watched on video, whereas 66.4% lacked it. When asked if they preferred learning PHAR205 calculations in class or through online discussion, 53% chose face-to-face, 9.2% online, 20.8% blended, and 17% had no preference for the delivery mode. Additionally, 37.4% were confident in performing calculations learnt from videos. Most students reported that what they learned from the lecturer in class enhanced what they had learned online. The majority rejected deleting the in-person component and having only the online element. The majority believed that in-person instruction was more beneficial than online instruction. Only 26% of students felt that online examinations could accurately measure their grasp of the course, while 65% declared that on-campus exams correctly evaluated their performance. The majority of students believed that the website helped them with self-evaluation and that their grades accurately reflected their effort. Overall, the students felt that the course gave them the freedom to work at their own pace and reinforced their desire to study. Furthermore, most students considered themselves privileged to be enrolled in the BL course rather than the traditional learning sections. The majority of students felt that their BL experience had been beneficial. Since institutions strongly support the expansion of this type of learning, students should get support throughout their degree programme (for instance, through tutorials or seminars on work practices). The students enjoyed the instructor-led tutorials, which appeared to assist them in planning their learning and increasing their excitement for independent work. In-class tutorial sessions allowed for conversation between students and lecturers and among students themselves. In a course that involves calculations and experiments, the use of blended learning can provide students with the opportunity to have a more dynamic learning experience. In virtual or online classes, students could access videos, lectures, and quizzes to learn about the concepts and theories behind the calculations and experiments. This approach allows students to work at their own pace and review the material as many times as they need to truly understand the concepts. In contrast, the face-to-face portion of the course could involve hands-on experiments to observe the practical applications of the theories and concepts learned online. The face-to-face component of the course could be used to validate the results of online experiments, discuss the implications of these results, and provide guidance and feedback to students to improve their practical skills.

One advantage of a blended learning course is that students can prepare for and review the face-to-face component of their course. This can provide students with more time and resources to apply the theoretical concepts that have been taught to their own individualized experiments. This new approach allows students to have a hands-on experience with the experiments while having access to guidance and feedback from their instructors in class.

Online exams may provide students with more flexibility in terms of when and where they can take the test. This can be particularly useful for students who have work or family responsibilities that make it difficult to commit to a specific exam date or time. Online exams require reliable internet access and technical proficiency. Students who do not have access to a computer or experience technical issues during an online exam may find themselves at a disadvantage.

Some students may feel that online exams are less fair or reliable than on-campus exams. Online exams may be more susceptible to cheating, for example, and some students may feel that the format does not adequately measure their knowledge or abilities.

They also provided a chance to get feedback on how well online exercises and theoretical knowledge have been absorbed. These in-class tutorials should be created in such a way as to encourage communication between students and lecturers and among the students themselves. The success of a blended learning approach hinges on having a balanced mix of online and face-to-face instructional activities that provide students with the flexibility to learn at their own pace while still receiving support from their instructors.

The instructor-led tutorials serve as a crucial component of this approach, as they help students to plan their learning and stay on track with their progress. These interactive tutorials, facilitated by expert instructors, offer students a chance to ask questions and receive personalized feedback, which is invaluable in ensuring students' learning needs are met. Furthermore, the positive experience of the students with the instructor-led tutorials highlights the importance of having skilled and qualified instructors who can manage the blended learning environment effectively. Instructors who can blend multiple learning modes successfully are an invaluable asset to any educational institution or

organization looking to implement a blended learning approach.

Finally, in-class tutorials helped the students feel secure in their learning processes and motivated them to keep working hard. E-learning experts can help professors create blended courses in both technical and educational areas (Lakhal *et al.,* 2021).

The survey included two open-ended questions: "What did the physical component of this course lack to have the optimal blended learning experience?" and "What did the online component of this course lack to have the optimal blended learning experience?"

Here are some examples of student responses:

> *"The physical component of this course was performed completely";*
>
> *"The physical component of this course has the optimal blended learning experience";*
>
> *"For my part, online or face-to-face learning did not differ much because the doctor is excellent in explaining the course";*
>
> *"We need more physical attendance to be more satisfied with the knowledge being taught in the course";*
>
> *"I think extra exercises and problems could have helped more";*
>
> *"Face-to-face meetings were actually a good choice to interact with our colleagues and instructors and get information that lacked from online smoothly";*
>
> *"The online component was excellent and so comfortable because the videos contained a lot of information and every single detail about the material. Also, the meetings were very important to clarify any misunderstanding".*

The blended method, in which students learn to be self-directed and capable of managing their knowledge through online education, is thought to improve student learning skills (judgement, decision-making, and reflective learning) more than the conventional approach, leading to individualised, engaging, and active learning.

Institutional support is essential for the successful development of BL. Universities must be willing to put in the necessary time and resources to create and maintain a successful mixed-learning environment. As indicated by the remarks in the current study, the most significant ingredient for the effective development of BL is an understanding of the preferred learning techniques and the types of support required by the learner. The seventh of Chickering and Gamson's Seven Principles advocates for steps to appreciate and recognise the "*different skills and ways of learning*" of students (Barlow *et al.,* 2020). Furthermore, the design of BL should illustrate that different abilities and learning styles are recognised through online materials and activities. It is also crucial to look into how delivering BL at the module or unit level might help students learn throughout a programme.

This study collected student thoughts and shed light on such perspectives; therefore, it would probably influence BL techniques used in pharmacy schools in similar courses. The results might also help university professors and administrators create blended courses while reducing dropout rates. It also provided data on how students view interactions with instructors and their peers in blended learning classrooms. Participants' impression of the BL model firmly backed the notion that this is an effective way to provide course material and, as such, it contributes to the expanding body of evidence that supports this assertion (Wai & Seng, 2014; Sáiz-Manzanare *et al.,* 2020; Zheng, Ma & Lin, 2021).

Limitations

Although this study achieved its objectives, it had several limitations. Its main shortcoming was that the findings were based on the experience of only one institution and one area specialisation. Large-scale research of courses in multiple topics is necessary to better understand what makes blended learning successful and what are the most effective combinations of synchronous and asynchronous learning events across diverse disciplines. The non-random response bias is thought to have been caused by several factors having a negative impact on participant motivation (questionnaire design, participant fatigue, and lack of conviction in the value of the response). Compared to in-person interviews, the survey format allowed for fewer questions, and some respondents may have skipped questions that required more feedback. Face-to-face interviews would have been more beneficial in that case.

Conclusion

This study examined how blended learning may be used to enhance student educational experiences, its advantages, and how it was implemented at LIU. Students at LIU unequivocally stated that they preferred face-to-face interactions with professors, despite the fact that they do not report much of a difference between BL and face-to-face learning in terms of engagement between students and lecturers or among students themselves. Some ideas for improving students' perceptions of BL include:

1) Communicate the advantages: Educate students on the benefits of BL, which include flexibility, convenience, personalisation, active learning, and increased engagement.

2) Address the challenges: Recognize and solve the difficulties associated with BL, such as technological concerns, time management, self-regulation, and social isolation. Provide students with the resources and assistance they need to overcome these obstacles.

3) Personalise the experience: Adapt the BL method to individual student learning styles, interests, and requirements. Provide a range of modalities that appeal to diverse learning preferences and goals, such as videos, quizzes, debates, simulations, and projects.

4.) Encourage interaction and cooperation: Use technology to encourage social engagement and collaboration among students, such as through online forums, group assignments, peer reviews, and virtual events. Create activities that encourage students to share their ideas, ask questions, provide feedback, and learn from one another.

5) Monitor and evaluate: Monitor and evaluate the efficacy of the BL method on a regular basis, utilising data analysis, feedback surveys, and performance evaluations. Use this data to refine and alter the BL strategy, as well as to demonstrate the advantages to students and stakeholders.

Ethical considerations

Ethical clearance for this study was obtained from the LIU SOP research committee (2022RC-010-LIUSOP).

Conflict of interest

The authors declare no conflict of interest.

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