Higher Education Research
2024, Vol. 9, No. 6, pp. 216-226
https://doi.org/10.11648/j.her.20240906.19

Research Article

Exploring the Application of an Integrated (Blended) Teaching Model in Brewing Engineering Courses at a Local Chinese University

Cong Nie, Haojun Zhang*

The School of Bioengineering, Qilu University of Technology (Shandong Academy of Sciences), Jinan, China

Abstract

Brewing engineering is a subject that studies the application of biology, chemistry/biochemistry, sensory evaluation, and process engineering in the production of alcoholic beverages on an industrial scale. Like many courses in higher education in the past several years, brewing engineering courses underwent changes of their delivery from in-person to online learning due to the governmental regulations of physical and social distancing. This article explores the application of an integrated teaching model also referred to as blended teaching model in the article to promote the lecturer's teaching presence and learners' engagement in online settings to embrace online studies and blended learning. A case study is provided in this article to illustrate learner achievement between the integrated teaching model, 100% in-person, and 100% online teaching methods. The final marks of six student cohorts (n = 453 students) enrolled in the Brewing Engineering course from 2019 to 2023 at a local Chinese university are presented. The results show that the blended teaching model was the most effective one for teaching brewing engineering at the local Chinese university compared to 100% in-person and 100% online with overall class achieving higher grades. 100% in-person delivery showed that learners had slightly higher scores in their final grade, while 100% online delivery showed learners scoring the lowest mean grade overall and the lowest passing rates (i.e. 60% is the passing mark) out of the three delivery methods of learning. Moving forward, it would be beneficial for educators to consider using the integrated teaching model rather than in-person or online for course delivery in higher education.

Keywords

Learner-centered, Blended Learning, Brewing Engineering, Lecturer Preparation and Presence, Student Engagement

1. Introduction

For a long time, higher education has been restricted to the learners that could afford the time and resources to study. This is due to the in-class tutorials, experiments, and lectures that are delivered in-person with no recordings. In addition, some higher education institutions require participation to pass the course and it is mandatory to engage in discussions organized by the course facilitator. However, the events of the COVID-19 have changed how higher education was traditionally delivered and have increased students participation in distance learning. Distance learning is defined as an alternative method of course delivery where the student is physically separated from the facilitator, therefore the obligation of attending class at specific

*Corresponding author: haojunzhang@qlu.edu.cn (Haojun Zhang)

Received: 19 November 2024; **Accepted:** 29 November 2024; **Published:** 16 December 2024

times and location is removed [15]. Past research has indicated that students have positive attitude towards distance learning, however, it was noted that students did experience boredom due to studying the course content alone [15]. In another study conducted by Wang [31], Wang [31] noted that there are seven barriers to online distance learning for Chinese students. These barriers include communication and interaction, teaching and courses, learning resources, learning support services, external support and economic burdens, computer and network operation skills, and lastly conditions for accessing the internet. The main barrier to online distance learning for Chinese students highlighted by Wang [31] was communication and interaction. Chinese online distance learning students were concerned with the lack of interaction such as 'student-to-student' and 'student-to-teacher' relationship fostered within in-person lecture settings [31]. Therefore, apart from the course material, communication and interaction are important where the facilitator should create opportunities for the 'student-to-student' and 'student-to-teacher' interactions. However, since the outbreak of the COVID-19 virus, the advancement of information communication technologies (ICTs) has improved significantly with materials such as pre-recorded media and online interaction available to students, allowing more higher education courses to be delivered online. Technologies enable lecturers and learners to participate and interact in teaching and learning at a time and place convenient to them.

1.1. Forms of Online Teaching and Learning

Online teaching and learning can come in different forms. Coldeway's Quadrants demonstrated four different teaching types based on time and location in higher education, these being the same time, same place (ST-SP); different time, same place (DT-SP); same time, different place (ST-DP); different time, different place (DT-DP) [27].

ST-SP represents traditional face-to-face teaching, whereas DT-SP, ST-DP, and DT-DP can be considered as approaches to online teaching and learning. DT-SP means that participants in the learning and teaching process interact in the same space but at a time they choose; for example, learning in asynchronous online discussion forums. ST-DP means students from different geographical places connect synchronously using online communication platforms, such as Skype or Teams, this replicates many aspects of face-to-face spaces with all participants having access to the same resources, files, and synchronous discussion at the same time [23]. DT-DP entails students and lecturers being separated geographically and also by time, which was considered as the genuine form of distance education; for example, Massive Open Online Courses (MOOC) were developed for distance education.

1.2. Current Online Teaching Platform – Opportunities and Challenges

Massive Open Online Courses (commonly referred as MOOC) was first introduced in 2008 by Robert Moore from the University of Florida. It has grown rapidly since 2012, and MOOCs in different disciplines have been created by many institutes. The well-known MOOC giants are Coursera, Udacity, edX, and FutureLearn. In the past five years, the development of MOOC has become increasingly popular for higher education in China, with major platforms for higher education including CUMOOC (Chinese University MOOC), Xuetangx, and Treenity. MOOC provides an open learning source and environment which favors the DT-DP learning type around the world [35]; it allows learners to have opportunities to study quality courses from arrange of universities [2]; it also provides flexibility to meet the study pace of learners with varying academic backgrounds. The problems of MOOCs have also been reported by different researchers [17, 25]. For example, MOOC is less learner-centric, because of the huge number of learners that have various academic backgrounds and different learning needs; impossible to interact with learners and limited supervision often leads to a high dropout rate, especially for learners with poor self-motivation [33]. In addition, Kang and He [17] also pointed out that MOOCs might not be accepted by learners from different cultural backgrounds or those who are used to traditional face to face teaching.

Small private online Course (SPOC) is another type of online learning that was first proposed by Professor Armando Fox in 2013, which is an alternative to the traditional higher education such as universities and polytechnics [17]. SPOC is derived from MOOC but focuses on providing education to a limited number of learners. It is designed for learners for a specific program that fulfils the needs of the industry such as agriculture and information technology industry. With carefully selected online resources, SPOC is more learner-centric, and able to meet learners' specific needs and levels, thus leading to more purposeful teaching [17]. The SPOC teaching mode comprises three major parts, namely, cognition (before class), internalization (during class), and increase (after class) [17]. Before class, learners do online independent learning using the contents from MOOC; during class, the teacher facilitates a 'discussion session' to answer questions from learners to help them master the knowledge; After class, learners can consolidate the knowledge by doing practice, extra readings and collaborate with other learners in group exercises. SPOC has been used for teaching different specialized subjects in higher education, such as IT English, organic chemistry, computer engineering, system programming and medicine [2, 16, 19, 21, 32]. Although SPOC seems promising for learners, there are limitations. These limitations are similar to MOOC where personal contact between learner and facilitator is limited, feedback is slow and immediate compared to the lectures, motivation where learners must complete the required work before attending the class for the interaction to be meaningful, and the learner must have computer skills before enrolling into the course [13].

In terms of course evaluation and feedback, many courses

in higher education have course evaluations where learners can express their views about the course in a number of ways. For example, learner's completion rate, classroom representative meeting, and end of course surveys [11]. During the height of the COVID-19 pandemic, many researchers have recorded similar findings to Wang [31], where the learner and facilitator were limited. For example, both the lecturers and students from Bangalore colleges and universities (India) reported a lack of interaction between lecturers and learners during online classes; 87% of both the lecturers and the students reported that they preferred in-person over online course delivery [20]. In another study, Garcia-Alberti et al. [12] showed that students in civil engineering courses from Spain and Peru experienced difficulties of learner engagement and motivation. In addition, Garcia-Alberti et al. [12] indicated areas in which other facilitators should be aware including the lack of information clarity, resistance to remote education, digital competences in the professors and also learner's integrity regarding examination and ownership of work. It is common to see that online discussions have limited student-to-student interaction, as students may not be available to do the required activities at the same time or preference of the time of day when completing the online course. When an online forum is created by the lecturer, the online forum is predominately occupied by a hand full of learners and the lecturer. Other learners either do not participate or the encouragement is relatively limited to the topic. Neuwirth et al. [22] reported from an American university that learners will not voluntarily use discussion forums, and observed engagement-related issues as well as the lack of virtual class etiquette. Neuwirth et al. [22] suggested that online activities should be integrated into the outcome assessments; the discussion forums will not be effective in promoting interactions between the members of the class, unless students are explicitly directed to read and comment on posts of their colleagues.

In light of some of the issues identified by the researchers mentioned previously, technology in learning and teaching will be an integral part of higher education. With more higher institutions offering online courses, more lecturers and teachers are going to use technology platforms to deliver their courses. Anderson et al [3] pointed out that an online teaching environment lacks non-verbal communication and paralinguistic information compared with the traditional face-to-face setting. The following issues need to be addressed by higher educators. Firstly, lecturers need to develop compensatory behaviours to improve non-verbal and paralinguistic communication; and secondly, lecturers need to adapt to a learning facilitator role in the transition from a full face-to-face teaching to an online teaching approach.

To facilitate an online course effectively, the lecturers need to adapt to a range of skills and knowledge including managing virtual classrooms incorporated with internet etiquette, rearranging learning resources, providing technical support on the use of different digital devices and apps, and particularly in the application of suitable pedagogical approaches. In addition, the lecturers need to be capable of providing social and emotional well-being to students [23]. The enforced social distancing that was put in place during COVID-19 pandemic led to a sudden transition from traditional in-person learning to completely online deliver of courses; this did not allow enough time for lecturers to adapt to the 'facilitating' role and develop the essential skills mentioned above. On the other hand, the need for online teaching during COVID-19 pandemic has promoted more apps to be developed and allowed lecturers to reflect on if their current pedagogy can be amended.

1.3. Education Informatization

In recent decades, many countries have included education informatization as an important part of education reform. Education informatization is defined as the application of integrating information technology into education, to provide solutions in teaching, management and learning support [34]. The Ministry of Education in China has launched the Ten-Year Development Plan for Education Informatization (2011-2020) [30]. The development of education information requires three stages: (1) developing educational material for computer-assisted medium and learning materials for the learner for selected courses, (2) the emergence of the distance and online learning, and (3) lastly, additional and more comprehensive learning material and support in a variety of courses and services [34]. Although the COVID-19 caused many disruptions across all industries, COVID-19 accelerated the development and acceptance of education informatization. Additionally, more methods of educational delivery were created such as flexible learning, mixed learning, or blended delivery. Blended learning is a learning delivery method which combines online learning material and in-person learning activities in higher education institutions. Theoretical and conceptual components of the course are conducted as online learning materials, while activities and experimentations are carried as in-person teaching activities.

Blended learning is an effective integration of online learning platforms and using in-person teaching to reinforce ideas and theoretical concepts. The blended learning portion consists of activities and information that are familiar to the learner, while new theoretical concepts are consolidated in the in-person learning. For example, in the blended learning model, learners acquire the majority of their learning materials online and spend a small portion of their time in the classroom. As a new way of thinking, blended learning adopts the teaching concept of learners as individuals with a sense of agency, where the learner can identify and address the areas of the course where they require assistance. Traditional in-person teaching assumes that the learner may not know the information or class materials are catered towards the group of learners with the least amount of knowledge in the course. Therefore, slowing down the lecture to allow information to be acquired by all learners in the class. Blended learning on

the other hand, allows flexibility in learning the online course material and information. The online learning material is self-directed and the lecturer provides conceptual adjustments when the learner wants more clarity during the in-person classroom activities. The self-directed learning allows learners to effectively synthesize information without the external disruption of other learners and removes the competitive nature of knowledge acquisitions. Unlike the traditional model of in-person teaching, the lecturer and learner can also foster a more dynamic relationship where the learner can question information at a higher level and share information that is based on the learner's view.

Modern learning theory believes that learners are not passive receivers, therefore, the learning activities are re-designed to meet individual needs providing a more personalized and self-directed learning experience. It is important to note that learners construct new concepts by drawing on previous experience and knowledge to solidify the new information [1]. The learner is provided with information that are relevant to their world-view and are asked about the application of the theoretical concepts during in-person classes. Blended learning can help stimulate learners' initiative and creativity in learning, and also improve learning outcomes, as well as increase learners' sense of belong [7]. In the in-person portion of blended courses, learners are asked to share their thoughts and their online activities to the class to promote learner engagement and critical evaluate their decision-making process.

Researchers have studied the application of MOOC in different subjects to improve teaching and learning experiences in recent years. Zhu et al. [35] investigated 166 MOOC related research articles in the last ten years; approximately 50% of MOOC studies were focused on subjects of computer science, education, business and management and language studies; and only approximately 10% focused on engineering related subjects. The model of integrated online and face-to-face teaching in brewing engineering has not been investigated. In our constantly changing world, helping learners develop self-directed learning skills should be emphasized and practiced. This article discusses the development of the blended teaching model for brewing engineering courses to integrate the lecturer's teaching presence and learners' engagement via neutering healthy collaborative learning relationships between lecturers and learners. This article also compared the blended teaching model with traditional 100% in-person teaching and 100% online teaching to evaluate the effectiveness of this teaching mode in brewing engineering courses.

Brewing engineering is a subject that studies the application of biology, chemistry/biochemistry, sensory evaluation and process engineering in the production of alcoholic beverages on an industrial scale. Although brewing engineering includes theoretical concepts, this discipline includes a variety of practical components such as fermentation, agriculture, operational design of a brewery, microbiology, chemistry, and sensory evaluation that cannot be replicated via online delivery. In comparison with humanities and commerce subjects where courses can be taught online without practical or developing laboratory skills, the delivery of any science, technology, and engineering in this case brewing engineering courses completely online can be very challenging.

2. Case Study: Blended Learning Model and In-person Delivery in the Beer Brewing Program

The article should be written in English. An article should be between 6 and 25 pages, and exceed 2000 words. For original research articles, it should include the headings Introduction, Materials and Methods, Results, Discussion and Conclusions. Other types of articles can be written with a more flexible structure.

In response to the COVID-19 pandemic, learners in the academic year of 2020 and 2021 were moved to the online learning platform CUMOOC due to the health and safety regulations imposed by authorities. Real-time computer conferencing (ST-DP) was employed, coupled with study materials such as the lecturer's PowerPoint slides and extension readings (DT-DP) were uploaded onto CUMOOC, in an attempt to deliver the same course content to meet learning outcomes. These two teaching and learning approaches aligned with the finding from Bond et al. [5] who reported that the educational technology used for emergency remote teaching were mostly synchronous collaborative tools coupled with text-based tools. At the initial stage, the online space was largely a repository of documents or links to websites with rarely any interactions between learner-to-lecturer or learner-to-learner. In terms of course development, a blended learning model was developed for the Bachelor of Brewing Engineering Programme at Qilu University of Technology after the lifting of the social distancing measures imposed by authorities. This blended teaching model and in-person model are displayed in Figure 1. For online-learning, learners carried out autonomous learning using the provided CUMOOC resources (mainly a combination of DT-SP and DT-DP); In in-person learning, the lecturer provided guidance and facilitated project-based learning; followed by another module of online learning where learners completed learning activities, group projects, and extended readings at their own pace (mainly DT-DP). This model can be potentially applied to different subjects and topics in this programme with modifications to suit different learning outcomes and course contents.

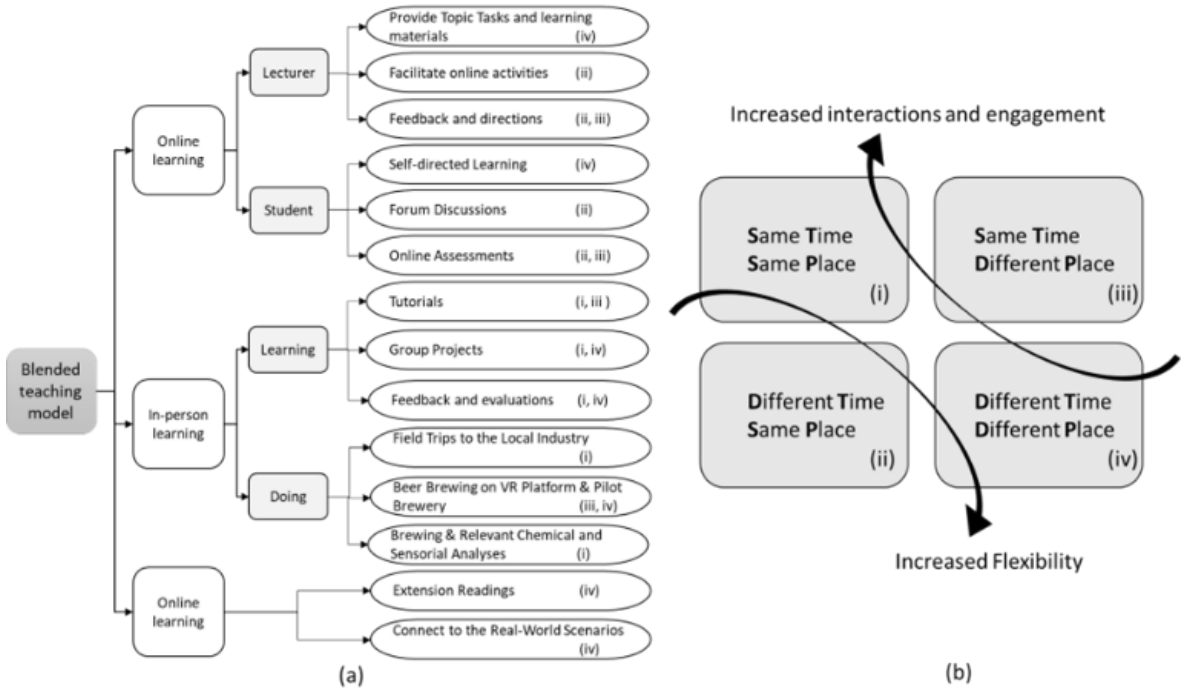

Figure 1. *Blended Teaching Model (a) and Coldeway's Quadrant (b) modified from the description by Simonson [27]. The teaching and learning activities categorized by the different approaches with (i) same time, same place, (ii) different-time, same-place, (iii) same-time, different-place, and (iv) different-time, different-place. When more than one Roman Numerals is prescribed next to the activity, this means that these activities can be completed in different teaching modes and is not restricted on one of the Coldeway's quadrants. For example, the group project can be self-directed and conducted outside classroom time (e.g. iv), while the final presentation and feedback can be conducted face-to-face in front of the class (e.g. i).*

In this teaching model, two factors are considered – time and place, and the variables are whether they are the same or different. When the teaching and learning are conducted at the same time and place (ST-SP), there is an increase in interactions and engagement compared to other teaching and learning forms; consequently, there is reduced flexibility when one or more factor settings to be 'the same'. When one of the factors is set to be "the same" and the other set to be "different" (for instance, DT-SP or ST-DP), it seems to be in the middle ground to embrace somewhat good interactions and relatively good flexibility.

2.1. Lecturer Preparation for the Beer Brewing Program

For the CUMOOC to be effective, lecturers need to be aware that their online (virtual) presence is different from traditional face-to-face settings with a reduction of the non-verbal communication challenging the role of the long-established conceptual image built in the context of traditional in-person teaching. Teaching presence was defined as the design, facilitation, and direction of cognitive and social processes to realize personally meaningful and educationally worthwhile learning outcomes [3].

With technologies-enabled blended learning, lecturers re-designed learning materials towards a constructivist approach; this included setting curriculum and topic objectives, learning and selecting high-quality MOOC resources, collecting learning materials, and developing teaching design [19]. In the model, lecturers completed a four-step process to complete learning materials.

Step 1: Creating 'Topic Tasks'.

Teaching design directly affects how well learners were able to complete the course content [19]. In the teaching model, lecturers first needed to create the 'Topic Tasks' according to the syllabus and learning outcomes. 'Topic Tasks' states the topic of learning outcomes and outlines the tasks that learners need to complete.

Constructing the course in a digital format forces the lecturer to think through the process, structure, interaction, and evaluation components of the course. Understanding of learners' learning styles is imperative when designing an integrated teaching and learning session [24]. Therefore, the learning styles of the learners in our programme were assessed continuously and the teaching and learning design were modified accordingly based on the feedback.

Step 2: Collecting learning resources for the online space

In blended teaching and learning, the quality of MOOC resources was very important. Therefore, lecturers need to carefully select the quality online learning materials with the consideration of the level of the course and the teaching and learning styles. In addition, some lecturers may provide less content in order to leave space with the aim to increase quantity and quality of the online discussion [23]. Learning mate-

rials include a glossary of terminologies, an introductory video, a summary video, and readings.

Step 3: Developing interactive activities

Forums, online chatting groups, polling and voting can be used for discussion, sharing opinions and feedback. Such activities should be used for developing productive conversations to deepen learners' knowledge. Live streamed sessions can be used to provide further explanations for the difficult concepts in course content and to emphasize the key points to assist students' reflection.

Group activities and practical sessions (e.g., beer sensory evaluation, beer chemistry laboratory, and field trips) are designed to enhance the theory learning and meet the specific learning outcomes.

The above-mentioned activities can be completed in different modes (Figure 1), giving the lecturers flexibility to adjust their delivery modes for the following topics while considering how learners react to these activities. As such, it is important to reflect on how the session has gone, and evaluate how well learners have achieved.

Step 4: Evaluation and feedback

Tools such as Kahoot can be used as a platform for formative assessment of topics. Short questionnaires can be used to collect ideas from students regarding how well the session went and if there was any confusion about the course content.

2.2. Implementation of teaching

2.2.1. Online-Learning

The online-learning starts with the release of the 'Topic tasks' by the facilitator (Figure 1). Topic Tasks included the introduction of the subject (providing the learning outcomes), studying the relevant glossary, watching the required MOOC online videos (DT-DP), online discussion and reflection (DT-SP). Indicative time allocation as well as the required submission times for activities should be advised for each of the learning activities, with learners having the flexibility to plan their time to complete such activities prior to live-streamed teaching sessions (ST-DP). Learners were required to complete the learning activities according to the Topic Tasks. The role of the lecturer was to monitor learners' participation in these online sessions and facilitate online discussion. Although timely reply from the lecturer was highly desirable regarding online discussion, lecturers had the opportunity to reflect on the question before giving constructive feedback. Higher-order thinking can be made more explicit in online discussion, as both the lecturer and student can refer back to learning materials before responding. The asynchronous nature of the online learning environment provides an equal opportunity for all students to participate as compared to face-to-face setting where a few students tend to dominate class discussions [9].

Reflection was used for summarizing the learning session which can be done by completing a "two-minute paper" (online survey). "Two-minute paper" has been suggested to be used as a cool-down learning activity at the end of a learning session [4] to investigate how well learners understood the topic and achieved the learning outcomes. A two-minute paper could have many variations. The simplest form of a two-minute paper could pose the following types of questions:

1) What is the most important thing you learned about this topic?
2) What is the most difficult part of the topic to understand?
3) What could be improved in this learning session?

Based on the two-minute paper together with online assessment, the lecturer can reflect on what could be improved in future teaching, and explain and clarify difficult concepts in learner-centred or project-based learning in in-person teaching.

The second part of online learning is optional (Figure 1), and intended as an extension post the in-person learning when learners have gained fundamental knowledge and are ready to engage in higher-order thinking to address real-world problems. Rather than remembering and understanding basic concepts which should've already occurred in the first part of the online learning, the second part of the online learning should focus on analysing real-world scenarios, evaluating various approaches to solving the problem and generating new ideas. For example, learners could design their own brewery or create a beer recipe based on the scenario provided by the lecturer, encouraging learners to develop their own framework and think creatively.

2.2.2. In-person Teaching and Learning

In the case study, a real-world scenario can be demonstrated in the class to explain the theory or concept introduced in the online-learning platform. Alternatively, the flipped class can be used: case studies can be assigned to different learning groups, learners presenting their findings or learnings as a group to their peers. The role of the lecturer was to organize and facilitate a 'Q & A' (question and answer) session, provide feedback on the presentation, and re-emphasize the connection between each case and the covered theory.

The content of learning was used to consolidate in the 'Doing' part (Figure 1). This part of teaching was conducted through a field trip to the local brewery. Local brewers could share their experience for example, in the production creation of a beer – from raw materials to final product, and reasons for equipment selection and brewery design. An alternative to field trips may include using virtual reality (VR) technology, learners are no longer need to physically present in the brewery. "Doing" also included chemical and sensory analysis to physicochemical parameters of beer quality and to connect the chemical composition in beer to sensorial attributes. This part was to gain firsthand experience from hands-on work or from authentic scenarios.

3. Case Study: Sample, Data Collection and Statistical Analysis

The sample was comprised of learners enrolled in a brewing engineering course studying towards a bachelor's degree in Bioengineering at the Qilu University of Technology, Shandong, China. The learning outcomes of the brewing engineering course include, understanding the principles of brewery design and the major components of a brewhouse; familiarising with the equipment in relation to the brewing process; comparing and contrasting the variations in equipment set ups; evaluating and improving the equipment set ups according to the intended style of the beer. Brewing engineering is not only theory-based, but also involves a large amount of practical work, such as horticulture (hop plantation), brewery design including the equipment selection, brewing processes, and the analyses both physiochemically and sensorially.

The sample was composed of 487 students (age: 19 – 23) enrolled in the course from 2019 to 2023. There were six cohorts (F, OL1, OL2, B1, B2, and B3); Cohort F enrolled in the course before the COVID-19 pandemic, and was taught in the traditional in-person (face-to-face) teaching; Cohort OL1 and OL2 enrolled in the course during the pandemic lockdown, and was taught fully online; and Cohort B1, B2, and B3 enrolled after the pandemic, and was taught with the blended teaching model developed in the current study. Of 453 students who participated in the current study, 194 were female (43%) and 259 were male (57%).

Final course marks were used to assess learners' academic learning performance. The final course marks of 453 students were collected. Statistical analyses were conducted using XLSTAT (Lumivero, Colorado, USA). Students' final exam marks were analyzed using descriptive statistics and one-way analysis of variance (ANOVA), with between-cohort differences assessed via Tukey's Honest Significant Difference (HSD) test.

4. Case Study Summary

The study compared the final marks of six student cohorts (F, OL1, OL2, B1, B2, and B3) to investigate the effectiveness of the integrated teaching model (Table 1). The final marks of the OL cohorts were significantly lower than the rest of the cohorts ($p < 0.05$) (Figure 2). For the distribution of final marks, OL1 and OL2 had lower marks towards the Mean and Median values, 25% of students from each cohort scored 66 and 69, respectively; some students who failed the course badly were also observed for OL1 and OL2. In comparison, F had a similar distribution of final marks but had fewer students who badly failed the course.

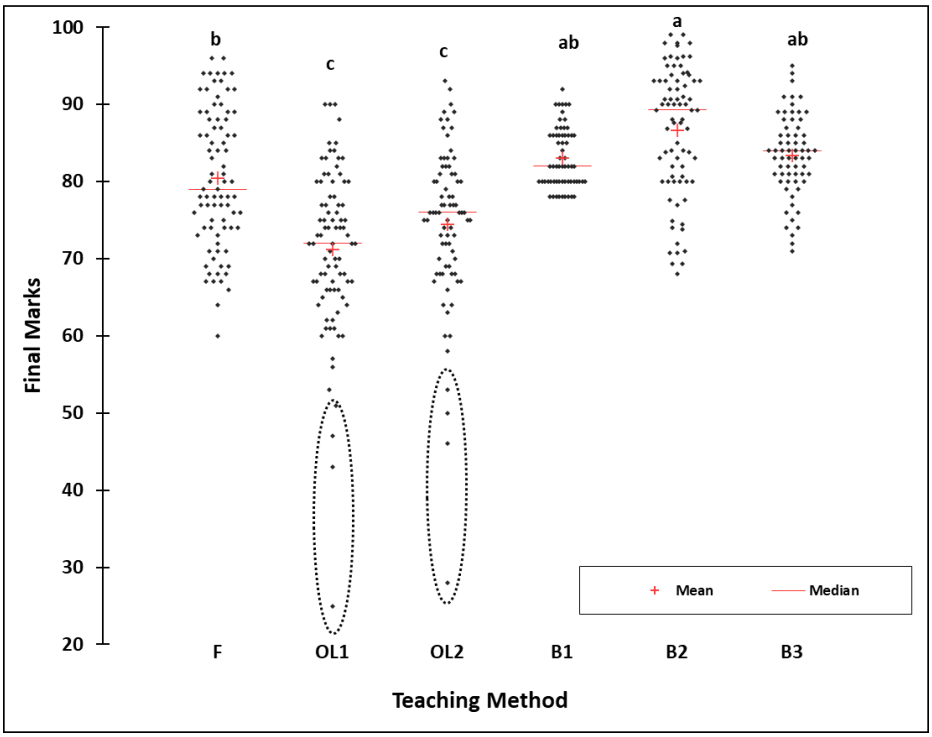

Figure 2. *Distribution of final marks of different student cohorts. Samples that do not share the same letter (a-c) are significantly different ($p < 0.05$). F: face to face teaching; OL: online teaching; B: blended teaching.*

Table 1. *Descriptive statistics of final marks from different student cohorts.*

Teaching method	N	Aver.	Min.	Max.	Lower Quartile	Upper Quartile
F	83	80 ±9	60	96	74	88
OL1	86	71 ±11	25	90	66	78
OL2	78	74 ±11	28	93	69	81
B1	53	83 ±4	78	92	80	86
B2	78	87 ±8	68	99	80	93
B3	65	83 ±8	71	95	81	87

Note: N, number of students in a cohort; Aver, average grade out of 100 with standard deviation indicated; Min, lowest grade; Max, highest grade; Lower Quartile, student grade stays at 25% centile; Upper Quartile, student grade stays at 75% centile.

Blended teaching significantly improved learner academic results ($p < 0.05$). The average, Min. and Lower Quartile values for B1, B2, and B3 were higher compared to F, indicating that blended learning was especially efficient with lower academic achievers. In addition, the distribution of final marks for B1, B2 and B3 were clustered much tighter with no lower mark outliers.

It was clear that at the beginning of the COVID-19 pandemic, providing online MOOC courses alone resulted in poor academic performance, this might be attributed to the lack of interactions with learners and limited supervision especially for learners with poor self-motivation [33]. Over the years, the university campus has been considered home to many students, and moving away represents a significant upheaval for the individual [6].

From the case study, it was hypothesized that 100% online teaching was relatively difficult for some learners especially for the brewing engineering course as some learners may not be motivated with the online learning material, lacked engagement with the learner-to-lecturer or learner-to-learner, or the peer support. In comparison, learners that were enrolled in the blended learning performed better than 100% online teaching. This can be contributed by learning online materials and also in-person guidance from the lecturer during the in-person class times. With a variety of learning online materials, the learner is able to use the materials for learning and acquiring knowledge. As discussed in the earlier section, learners are able to create their agency in learning with the guidance of the lecturer during the in-person classroom sessions. With interactive activities, students will find their virtual/social presence, less isolation, and keep them engaged.

5. Discussion

With growth in online education during the pandemic, in the post-COVID 19 era, there is an increased need to examine effective methods to provide meaningful and engaging learning opportunities for students. Results have shown that students consistently performed better if the course was delivery using a blended approach (B1, B2 and B3) compared with other teaching methods (F, OL1 and OL2).

In the case study, it is important to note that learner feedback and course evaluation was not systematically acquired. Therefore, we are not able to present learner feedback and to provide qualitative information about their experience. Some points that should be considered is online access, online participation, and learner engagement. From Koh and Daniel's [18] review on the teaching and learning strategies during COVID-19, they noted online access can be a potential challenge for the learners as some learners may not have adequate internet access/connections, noisy environment, tight study or living arrangement and disruption from family members can be contributing factors to lower learner engagement or performance for online learning. In addition, the blended learning model requires the learner and lecturer to have the hardware such as computer, microphone, audio/visual equipment. Although the blended learning model can allow learners to have restrictive access to the online learning materials, the blended learning model may not be equitable to all learners; therefore, the higher education institution and lecturer need to evaluate how learners without the hardware and software compatibilities to access the online learning materials and attend the in-person classes. Lastly, one concern that needs to be addressed is the integrity of the learners and lecturers. From literature, lecturers have implemented various strategies to reduce "cheating" such as randomized questions and allowing open book [12, 18]. However, Garcia-Alberti et al. [12] noted that third-party exam-takers can be used by the learner. Moving forward, it is important to address the equity and integrity of online learning or technology assisted teaching such as the blended learning model.

Central to the teaching and learning experience at Qilu University of Technology, are the collaborative learning relationships with lecturers and a focus on integrating high-quality academic and scholarly work with professional relevance and application. Although COVID-19 is somewhat less relevant as authorities have removed most social dis-

tancing restrictions, it is important to note that online and blended teaching models are likely to be expected or provided to some degree at higher education.

Online learning especially blended learning is expected to emerge as a favourable solution to problems that lecturers face as they work on making the course content accessible via online as well as face-to-face. The design of interactive activities should be a focus in teacher preparation. Interactive activities, such as forum discussions, group projects, and hands-on experiments help create a dynamic learning environment where learners are more likely to actively engage with the learning material. These interactive activities aid lecturers in connecting with learners on a deeper level, guiding them through complex concepts and encouraging critical thinking. In a case study presented by Skinner [28], Skinner discussed the importance of activity design and summarized that the main reason why some learners were reluctant in timely participation in an online discussion was due to a lack of motivation caused by a poorly designed activity.

Although, teacher presence is essential in facilitating cognitive capability and fostering social relationships, peer support plays a critical role in helping learners' transition from traditional in-person learning to fully online environment. Peer support systems, such as study groups, discussion forums can significantly promote learners' sense of belonging and lift the morale in online learning settings. Such support systems can be implemented by the design of interactive activities to force learners into establishing study groups and completing group projects. However, participation is crucial for developing a learning community, and voluntary participation requires a sparkle of personal and emotional interest [28]. To help establish an active and supportive learning community, lecturers need to be flexible and willing to adapt course requirements to meet learners' needs, be inclusive and embrace the diverse background of learners, engage and motivate learners, and be available beyond teaching the course content [14].

6. Conclusion and Future Implications

As indicated in our model (Figure 1), some of the learning activities can be easily converted wherever technology enables. For example, the face-to-face tutorials can be easily converted to an online tutorial using platforms like Zoom or Teams; the group projects can be prepared by students online or offline, within a classroom setting or outside classroom time, the following group presentation can be conducted either in front of the class or recorded and uploaded onto a platform for their peers to comment on. The key principle in designing such interactive activities (other than delivering the course content and meeting the learning outcomes), is to ensure learners are fully equipped and ready to engage; alternatively, step back into a more traditional way and reduce the amount of "different" for the two factors (e.g. time and place) as described in the previous section. In the due course, while both lecturers and learners need time to transition to fully embrace the online teaching and learning environment, it is crucial to make small attempts rather than fully transition to online education or assisted teaching with technology. From the case study and previous experience, it is advisable to start implementing activities that incorporate DT-DP. Both DT-SP and ST-DP approaches cooperated to increase lecturer's virtual presence, which in turn will promote learners' engagement. Face-to-face learning (ST-SP) shouldn't be given up all together, especially if hands-on experience is required for a deeper understanding of the course content.

Abbreviations

ICTs	Information Communication Technologies
ST-SP	Same Time, Same Place
DT-SP	Different Time, Same Place
ST-DP	Same Time, Different Place
DT-DP	Different Time, Different Place
MOOC	Massive Open Online Courses
CUMOOC	Chinese University MOOC
SPOC	Small Private Online Course
HSD	Honest Significant Difference
ANOVA	One-way Analysis of Variance
Q & A	Question and Answer
VR	Virtual Reality
ANOVA	Analysis of Variance
HSD	Honest Significant Difference

Author Contributions

Cong Nie: Data curation, Funding acquisition, Investigation, Methodology, Project administration, Writing – original draft

Haojun Zhang: Data curation, Funding acquisition, Investigation, Methodology, Project administration, Writing – review & editing

Acknowledgments

This work is supported by Shandong Provincial Undergraduate Teaching Reform Research Project(Z2022239), Teaching Reform Research Project of Qilu University of Technology (2022zd246).

Conflicts of Interest

The authors declare no conflicts of interest.

References

[1] Adams, P. Exploring social constructivism: theories and practicalities. Education. 2006, 34(3), 243-257. https://doi.org/10.1080/03004270600898893

[2] Alario-Hoyos, C., Estévez-Ayres, I., Delgado Kloos, C., Villena-Román, J. From MOOCs to SPOCs… and from SPOCs to Flipped Classroom. In: Lavoué, É., Drachsler, H., Verbert, K., Broisin, J., Pérez-Sanagustín, M. (eds) Data Driven Approaches in Digital Education. EC-TEL 2017. Lecture Notes in Computer Science(), vol 10474. Springer, Cham. https://doi.org/10.1007/978-3-319-66610-5_25

[3] Anderson, T., Liam, R., Garrison, D. R., and Archer, W. "Assessing Teaching Presence in a Computer Conferencing Context," 2001. https://auspace.athabascau.ca/handle/2149/725

[4] Angelo, T. A., Cross, P. K. Classroom Assessment Techniques: A Handbook for College Teachers. (2nd ed.). John Wiley & Sons Australia. 2005.

[5] Bond, M., Bedenlier, S., Marín, V. and Händel, M. Emergency Remote Teaching in Higher Education: Mapping the First Global Online Semester. International Journal of Educational Technology in Higher Education 18, no. 1 (August 30, 2021): 50. https://doi.org/10.1186/s41239-021-00282-x

[6] Burns, D., Dagnall, N., & Holt, M.. Assessing the Impact of the COVID-19 Pandemic on Student Wellbeing at Universities in the United Kingdom: A Conceptual Analysis. Frontiers in Education, 2020.5. https://doi.org/10.3389/feduc.2020.582882

[7] Chen, M., Suwandej, N., Thongves, M., & Khan, M. S. In Blended Learning, Study the Impact of Teaching Innovation Mediated by Learning Engagement on Student Loyalty. Revista de Gestão Social e Ambiental, 2024, 18(9), e7412–e7412. https://doi.org/10.24857/rgsa.v18n9-126

[8] Cheng, X., He, X., Ren, C. The Teaching Model in China: A Review and Future Trend. Journal of Anqing Normal University. 2022, 41, 96-101. https://doi.org/10.13757/j.cnki.cn34-1329/c.2022.05.014

[9] Conceição, S. C. O. Faculty Lived Experiences in the Online Environment. Adult Education Quarterly 57, no. 1 (November 1, 2006): 26–45. https://doi.org/10.1177/1059601106292247

[10] Duan, T. A New Idea for the Optimization of MOOC-based Teaching. Education and Information Technologies. 2022, 22, 3623-3650. https://doi.org/10.1007/s10639-021-10755-1

[11] Edström, K. Doing course evaluation as if learning matters most. Higher education research & development. 2008, 27(2), 95-106. https://doi.org/10.1080/07294360701805234

[12] García-Alberti, M., Suárez, F., Chiyón, I., & Mosquera Feijoo, J. C. Challenges and experiences of online evaluation in courses of civil engineering during the lockdown learning due to the COVID-19 pandemic. Education Sciences. 2021, 11(2), 59. https://doi.org/10.3390/educsci11020059

[13] Gielen, G. Advantages and Disadvantages of SPOC (Small Private Online Courses): Experiences with Online Learning. In European Distance and E-Learning Network (EDEN) Conference Proceedings (No. 1, pp. 105-111). European Distance and E-Learning Network. 2016.

[14] Guzzardo, M. T., Khosla, N., Adams, A. L., Bussmann, J. D., Engelman, A., Ingraham, N., Gamba, R., Jones-Bey, A., Moore, M. D., Toosi, N. R., Taylor, S. 'The Ones That Care Make All the Difference': Perspectives on Student-Faculty Relationships. Innovative Higher Education 46, no. 1 (February 1, 2021): 41–58. https://doi.org/10.1007/s10755-020-09522-w

[15] Isik, A. H., Karakis, R., & Güler, G. Postgraduate students' attitudes towards distance learning (The case study of Gazi University). Procedia-Social and Behavioral Sciences. 2010, 9, 218-222. https://doi.org/10.1016/j.sbspro.2010.12.139

[16] Ito, A., Watanabe, K., Fukuzawa, Y., Mitani, K., Fujimoto, S., Matsuda, T., Sugiyama, K., Kitamura, K., Ban, N. Development of Kampo Traditional Japanese Medicine e-learning programme: Evaluation of the Flipped Classroom for Medical Students. Medical Education Online. 2021, 26, 1-10. https://doi.org/10.1080/10872981.2021.1938504

[17] Kang, Z., & He, L. Construction and Practice of SPOC Teaching Mode based on MOOC. International Journal of Education Technology. 2018, 13, 35-49. https://doi.org/10.3991/ijet.v13i12.9702

[18] Koh, J. H. L., & Daniel, B. K. Shifting online during COVID-19: A systematic review of teaching and learning strategies and their outcomes. International Journal of Educational Technology in Higher Education. 2022, 19(1), 56. https://doi.org/10.1186/s41239-022-00361-7

[19] Liu, L. Research on IT English Flipped Classroom Teaching Model Based on SPOC. Hindawi, 2021, 1-9. https://doi.org/10.1155/2021/7273981

[20] Nambiar, D The Impact of Online Learning during COVID-19: Students' and Teachers' Perspective. The International Journal of Indian Psychology 8, no. 2 (2020): 783–93. https://doi.org/10.25215/0802.094

[21] Nejkovic, V., & Tosic, M. Exploring Factors for Effective Use of Online Information in SPOC within the Engineering Education. 2018. https://doi.org/10.1002/cae.21991

[22] Neuwirth, L. S., Jović, S. and Mukherji, B. R. Reimagining Higher Education during and Post-COVID-19: Challenges and Opportunities. Journal of Adult and Continuing Education 27, no. 2 (November 1, 2021): 141–56. https://doi.org/10.1177/1477971420947738

[23] Redmond, P From Face-to-Face Teaching to Online Teaching: Pedagogical Transitions. In Proceedings of the 28th Annual Conference of the Australasian Society for Computers in Learning in Tertiary Education (ASCILITE 2011), edited by Gary Williams, Peta Statham, Noel Brown, and B. Cleland. Gold Coast, Australia: University of Southern Queensland, 2011. https://www.ascilite.org/conferences/hobart11/downloads/papers/Redmond-full.pdf

[24] Schmidt, K. A Model to Integrate Online Teaching and Learning Tools into the Classroom. The Journal of Technology Studies, XX, 86-92. 2020. https://doi.org/10.21061/jots.v30i2.a.4

[25] Sezgin, S., & Cirak, N. S. The Role of MOOCs in Engineering Education: An Exploratory Systemactic Review of Peer-reviewed Lieterature. Computer Applications in Engineering Education, 1-19. 2020.

[26] Shopska, V., Denkova-Kostova, R., and Kostov, G. Modeling in Brewing – A Review. Processes. 2022, 10(10), 267. https://doi.org/10.3390/pr10020267

[27] Simonson, M. Dan Coldeway 1949-2003 Professor and Distance Educator. The Quarterly Review of Distance Education 4, no. 2 (2003): vii–viii.

[28] Skinner, E. Using Community Development Theory to Improve Student Engagement in Online Discussion: A Case Study. ALT-J 17, no. 2 (July 1, 2009): 89–100. https://doi.org/10.1080/09687760902951599

[29] Stewart, G. G., & Priest, F. G. Handbook of Brewing (2nd ed.). Taylor & Francis Group. 2017. https://doi.org/10.1201/9781351228336

[30] The Ministry of Education of the Republic of China.. Notice of the Ministry of Education on the Issuance of the Decade-year Development Plan for Education Informatization (2011-2020): Teaching Technology (5). 2012. http://www.moe.gov.cn/srcsite/A16/s3342/201203/t20120313_133322.html

[31] Wang, Q. A study of barriers to online learning in distance education in China (Doctoral dissertation, University of Nottingham). 2013. http://eprints.nottingham.ac.uk/28966/1/601804.pdf

[32] Wang, T., Chen, C., He, J., Zhu, L., Long, Y. Exploration of the Application of Different Teaching Model on Orgainic Chemistry – A Case Study in Pharmaceutical Programme. Southern Quality Education. 2022, 18, 124-127.

[33] Zhan, D., Sun, C., Xu, X. An Exploration of MOOC + SPOCs Teaching Mode. Software Engineering Education Going Agile. 2016. https://doi.org/10.1007/978-3-319-29166-6_13

[34] Zhang, J., & Zhou, J. An Introduction to Education Informatization for Educational Equity: An Example of Online Education Platform. Journal of Education and Educational Research. 2023, 3(2), 114-118. https://doi.org/10.54097/jeer.v3i2.9047

[35] Zhu, M., Sari A. R., Lee, M. M. Trends and Issues in MOOC Learning Analytics Empirical Research: A Systematic Literature Review (2011-2021). Education and Information Technologies. 2022, 27, 10135-10160. https://doi.org/10.1007/s10639-022-11031-6

Research Field

Cong Nie: Higher Education, Modern beer brewing technology, Hops and beer flavor, Teaching Model, Brewing Machinery and Equipment

Haojun Zhang: Higher Education, Modern beer brewing technology, Hops and beer flavor, Teaching Model, Metabolic Engineering