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Editorial – Volume 21, Issue 4

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Welcome to the last *IRRODL* issue of 2020. I hope that all our readers are staying safe amid the spread of the worldwide COVID-19 pandemic. In this issue submissions from Malaysia, Iran, Turkey, Indonesia, Israel, France, Portugal, and the United States shed light on implementations of open and online learning in a wide variety of international contexts. This issue leads off with four articles investigating the student and teacher experiences in open, online learning followed by two articles relating features of the online learning environment in Iran. Then three articles on mobile learning, and lastly two submissions on MOOCs.

The first article, *Identifying Student Perceptions of Different Instantiations of Open Pedagogy* by **Hilton, Hilton, Ikahihifo, Chaffee, Darrow, Guilmett,** and **Wiley** describes instructional practices in open pedagogy and the perceptions of students who are charged with creating a syllabus. They conclude that there are a wide variety of approaches to open pedagogy and that more research is needed to examine its efficacy.

Teoh and **Tan** use online questionnaires and the technology acceptance model (TAM) in their study *Predicting Behavioural Intention of Manufacturing Engineers in Malaysia to Use E-Learning in the Workplace*. Their results conform the mediating role of perceived ease of use and usefulness, providing insights to guide organizations in designing online learning in the workplace.

Both students and faculty in a statewide community college system in the United States were surveyed in **Gaddis'** study, *Faculty and Student Technology Use to Enhance Student Learning*. Although the study provides no information on actual learning achievement, students report that the use of technology enhanced their learning and their preference for technology suggested that they were actively engaged, affecting positively their multimodal learning. This research could be used to inform strategic planning processes and institutional learning outcome development.

In **Michaeli, Kroparo,** and **Hershkovitz's** article, *Teachers' Use of Education Dashboards and Professional Growth,* dashboards were used as visual aids for reflection among Israeli elementary teachers. Using a framework roadmap for empowering learners' framework, they surveyed teachers finding that the use of dashboards was associated with professional growth. An additional qualitative study demonstrated which teachers benefited most from their dashboard use.

Samuel's contribution, *Zones of Agency: Understanding Online Faculty Experiences of Presence* introduces the Zones of Agency for Online Instructors model, which reveals five determinants of presence for online instructors: content, format, strategies, technology, and students. The crucial factor in determining instructors' experience of presence was the degree of agency the instructor had over these determinants.

E-learning in Iran is described in the next two articles. The first, *E-Learning Challenges in Iran: A Research Synthesis* by **Kasani, Mourkani, Seraji, Rezaeizadeh,** and **Abedi** analyses Iranian e-learning studies and determined that the system faces problems in eight dimensions: legal, human, educational, technological, sociocultural, support, economic, and managerial-organizational. They suggest that their results could serve as a model for other countries with similar technology infrastructure and cultural features. **Dashtestani** focused on the perspectives of Iranian higher education stakeholders on the online teaching English as a Foreign Language (TEFL). Participants in this study showed significant improvement in their achievement in their online course; however, the survey identified several challenges in online learning: including lack of rigour', lack of credibility of certificates, lack of technological infrastructure, technical problems, lack of practical content, lack of human interaction, students' low knowledge of the content, and employers' lack of interest in employing graduates of online courses.

The following three articles investigate mobile learning, looking at teachers' beliefs and acceptance of mobile technologies, and mobile personal learning environments. The first of which takes us to Indonesia, where **Saiful's** mixed method study looks at *Mobile Teacher Professional Development (MTPD): Delving into English Teachers' Beliefs in Indonesia*. His qualitative and quantitative analyses showed favourable results in the majority of teachers' perception of the use of mobile devices.

In their study, *Mobile Technology Acceptance Scale for Learning Mathematics: Development, Validity, and Reliability Studies*, **Açıkgül** and **Şad** measured Turkish highs school students' level of acceptance of mobile technologies developing and implementing a Mobile Technology Acceptance Scale for Learning Mathematics (m-TASLM). Results were favourable in terms of validity and reliability.

Bidarra and **Sousa** examined two Portuguese distance learning courses to test the impact of mobile devices on personal learning environments (PLE) in their paper, *Implementing Mobile Learning Within Personal Learning Environments: A Study of Two Online Courses*. Their findings suggest that all students' have adapted well to mobile learning and that the learning resources available were more critical than either gender or age on the makeup of an individual's PLE.

The final two papers in this edition focus on MOOCs. **Chaker** and **Bachelet**'s paper, *Internationalizing Professional Development: Using Educational Data Mining to Analyze Learners' Performance and Dropouts in a French MOOC,* employs data mining to study francophone learners' performance in different countries. Their investigation revealed disparities between students in partner institutions versus self-enrolled learners, in European learners versus learners in developing countries, and active versus inactive learners.

The last research paper in this issue, *Heterogeneity of Learners' Behavioral Patterns of Watching Videos and Completing Assessments in Massive Open Online Courses (MOOCs): A Latent Class Analysis* by **Gu Kang** makes use of latent class analysis to determine learner sub-groups: *completing, disengaging, auditing, sampling*, and *enrolling*. They suggest tailored instructional strategies to address the concerns of the at-risk sub-groups.

In the Notes From the Field section, **Kotera, Green, Rhodes, Williams, Chircop, Spink, Rawson,** and **Okere** at the University of Derby in the UK, expound on the benefits of morning virtual get-togethers, described as "huddles," for teachers newly-exposed to online learning due to the COVID-19 pandemic. In the next note, **Finlayson** describes the writing process and platform options in the creation of an OER course on World Geography.

In the Literature Review section, MOOCs are the subject of the following papers, the first is a systematic literature survey of MOOCs by **Khalid, Lundqvist,** and **Yates** and the second is a an extensive bibliometric analysis of growth and collaboration in MOOCs by **Wahid, Ahmi,** and **Alam**.

The Editors of IRRODL wish all our readers and their families in more than 80 countries all the best in the coming holiday season. Please stay safe and be careful during this pandemic.

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Identifying Student Perceptions of Different Instantiations of Open Pedagogy

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Abstract

As the adoption of open educational resources (OER) continues to increase, instructors have started using these resources for more than simply delivering content. *Open pedagogy* is a term used to describe a range of instructional practices that often incorporate OER into the learning process. This study examined student perceptions of two approaches to open pedagogy—student creation of multiple-choice questions and student creation of the syllabus and corresponding course assignments. The sample included responses from 84 students at two colleges in the United States. Results showed that students who created the syllabus and assignments had a more positive experience and were more likely to enroll in a future course that implements this strategy. Those in the multiple-choice course felt that the approach was less conducive to learning than traditional learning activities. The significant differences in student feedback on two different approaches, both of which could be termed open pedagogy, indicate that more research is needed to examine the efficacy of the wide variety of approaches to open pedagogy. Moreover, the perceived efficacy of one instantiation of open pedagogy does not equal the effectiveness of open pedagogy, broadly defined.

Keywords: open educational resources, OER, open pedagogy, OER-enabled pedagogy

Introduction

Open pedagogy is an increasingly popular choice for instructors seeking to motivate students toward deeper levels of learning, synthesis, networking, and collaboration. Instructors employing open pedagogy often use Open Educational Resources (OER) to facilitate student-directed education. Different instantiations of open pedagogy occur when instructors use OER for different elements of course material (Wiley & Hilton, 2018). For example, Jhangiani (2017) uses OER by assigning students the task of creating multiple-choice questions. DeRosa and Robison (2017) use OER by assigning students the task of editing Wikipedia articles.

These different instantiations of open pedagogy create different experiences for students and instructors. Consider the case of Jhangiani's (2017) open pedagogy task of creating multiple-choice questions in contrast to DeRosa and Robison's (2017) open pedagogy task of editing Wikipedia articles. Hypothetically, students might be less motivated towards developing multiple-choice questions and more motivated towards editing Wikipedia articles. This potential variance in motivation could lead to widely different open pedagogy research outcomes. A lack of specific and concrete definitions in open pedagogy tasks means that research regarding open pedagogy has yet to account for differences resulting from different instantiations of forms of teaching that claim the title "open pedagogy." In this paper, we examine specific forms of open pedagogy in order to determine whether there is variance in open pedagogy instantiations and motivate future research for achieving optimal open-pedagogy outcomes. We include a literature review of open pedagogy, introduce and examine the results of two instantiations of open pedagogy, and then describe our methodology and findings.

Review of Literature

Open education research highlights "the tendency for 'open' to encompass many different interpretations and the capacity for the field to evolve accordingly" (Cronin & MacLaren, 2018, p. 135). A review of open pedagogy in the extant literature demonstrates that some view open pedagogy as an evolving subset of the expansive definition of open educational practices (OEP) (Cronin & MacLaren, 2018). We note that the term open pedagogy itself has shifted over time.

Earlier definitions of open pedagogy describe a classroom setting where the teacher facilitates informal discussions, thereby assisting students with co-creating the context of the class (Elliott, 1973). Mai (1978) viewed open pedagogy as an "informal classroom where children might be trusted to learn by exploring according to their own interests, instead of being bored, demeaned, and alienated" (p. 231).

In more recent years, the focus of open pedagogy has shifted towards student-centered technological approaches that emphasize collaboration outside the classroom (Hegarty, 2015; Hodgkinson-Williams & Gray, 2009; Mackintosh, McGreal, & Taylor, 2011). Weller (2013) found that new technologies facilitate an open pedagogy which "...places an emphasis on the network and the learner's connections within it" (p. 10). The evolving Internet-enabled definition of open pedagogy demonstrates a dramatic shift from simpler student-directed learning definitions of yesteryear to sharing and participatory definitions of today. For some, an important aspect of these collaborations is the presence of open educational resources (OER). Weller (2013) stated that open pedagogy "makes use of ... abundant, open content (such as open educational resources, videos, podcasts)" (p. 10). DeRosa and Robison (2017) defined open pedagogy as the use of OER "for remaking our courses so that they become not just repositories for content, but platforms for learning, collaboration and engagement with the world outside the classroom" (p. 118). Wiley (2013) suggested OER was a mandatory component of open pedagogy, stating:

> This is the ultimate test of whether or not a particular approach or technique can rightly be called "open pedagogy"—is it possible without the free access and 4R [Wiley later added a 5^{th} R (Wiley, 2014)] permissions characteristic of open educational resources? If the answer is yes, then you may have an effective educational practice but you don't have an instance of open pedagogy (p. 1).

This is an important point that continues to be debated. The evolving definition of open pedagogy has led researchers to question whether OER is truly a prerequisite of open pedagogy, arguing that more important issues may be democratizing educational processes (Cronin & MacLaren, 2018; Bali, 2017). But if OER are not a part of open pedagogy, the question arises: What separates effective pedagogy from open pedagogy? In response, some, such as Wiley and Hilton (2018), have focused on a narrower term—*OER-enabled pedagogies*—as being "the set of teaching and learning practices that are only possible or practical in the context of the 5R permissions which are characteristic of OER" (p. 135).

This brief overview clearly demonstrates that open pedagogy contains many different interpretations and is continuing to develop. This evolution may be a net positive, as scholars continue to explore how open pedagogy influences learning, teaching, technology, and social justice. However, as practices of open pedagogy have continued to evolve, we hypothesized that research regarding open pedagogy, broadly defined, would not be useful to practitioners given that one instantiation of open pedagogy would differ significantly from another, and that one form may be more efficacious or well received than another. The aim of the present study was to test our hypothesis by examining student perceptions of two different instantiations of open pedagogy. For the purposes of this study, we adopted a broad definition of open pedagogy, postulated by DeRosa and Robison (2017) as a platform for "learning, collaboration and engagement with the world outside the classroom" (p. 118). We note that some would likely disagree with this definition as being too expansive, while others might find it too narrow. This highlights one of the challenges of studying open pedagogy. We investigated two specific instantiations of open pedagogy by examining the perceptions of students who were either (a) in a class where they created multiple-choice questions, or (b) in a class in which they co-created the syllabus and assignments. Specifically, our research questions were as follows:

1. How do students perceive the educational value of creating multiple-choice questions relative to traditional teaching approaches?

2. How do students perceive the educational value of creating the syllabus and assignments relative to traditional teaching approaches?

3. What differences (if any) are found in student perceptions of these two approaches to open pedagogy?

Method

Our dataset includes two instructors teaching in colleges in the United States who used open pedagogy during the spring of 2018. These instructors had been part of a seminar in open pedagogy and agreed to share their experiences in using it. Although their approaches differed significantly, both faculty members believed that they were implementing a form of open pedagogy. At the end of the semester, students in both classes were given a Qualtrics survey regarding their experiences with the open pedagogy activities in the course (Appendix). Quantitative data were reported through descriptive statistics, and the data analysis software SPSS was used to conduct chi-square tests to make cross-group comparisons on student perceptions of open pedagogy. Instructor data were collected through one-on-one interviews and e-mail correspondence. All research activities were cleared through an institutional review board.

Context

One of the instructors adopted an open textbook and used supplemental materials that she had created for the course. Her purpose in using OER was not only to save money, but more specifically to start conversations with class members about how their work might extend outside their classroom. In connection with her OER adoption, she had students create their own multiple-choice questions in lieu of doing the more traditional assignments she had used in the past. Her purpose was to have students do a renewable assignment, a renewable assignment being one that could be used in future courses to increase student learning (Hendricks, 2015; Wiley, 2013). In this case, the theory was that openly-licensed questions created by current students could benefit future students. This instructor stated that implementing her version of open pedagogy was an opportunity for her to learn new pedagogical strategies and improve her instruction. Throughout this paper, this course will be referred to as the *Create MC Course* (*N*=43).

The second instructor adopted an existing open textbook that she and other faculty contributors edited. Her implementation of open pedagogy was centered around students in the class collectively creating a course syllabus for the class (within certain parameters). Students then chose their own projects for the course that had to extend outside of the classroom in some way. This was considered open pedagogy in that it put significantly more control than normal into the hands of the students who were, in a sense, co-creators of the course. Throughout this paper, this course will be referred to as the *Create Assignments Course* (*N*=41).

Results

In this section, we first examine the student perceptions of the pedagogy in the Create MC Course. Subsequently, we do the same for students in the Create Assignments Course. Finally, we compare the results of the two courses.

Student Perceptions of Creating Multiple-Choice Questions

Students in the Create MC Course were asked, “Was the educational value of creating multiple-choice questions better, worse, or the same as that of traditional learning activities (e.g., writing papers, taking quizzes, etc.)?" Seven students (16%) said creating multiple-choice questions was better than traditional learning activities, with eighteen (42%) saying it was the same, and eighteen (42%) stating it was worse. Students provided responses explaining their beliefs about the educational value of creating multiple-choice questions.

An analysis of factors prompting students to mark *better* centered on themes of increased understanding and depth of thought. For example, student comments included: "I had to understand what the topic is," "[I] made application of concepts more in depth," and "[It] made me think about the problem more." Students who felt creating multiple-choice questions had less educational value focused on a feeling that the assignment did not help them effectively learn. For example, one student stated, "We were … required to regurgitate somewhat ultimately arbitrary information which didn't necessarily require critical thinking on the whole." Another student wrote, "I still had to read the entire chapter if I wanted to do good on the multiple-choice questions, therefore I still got the same information out of doing the multiple-choice questions as I would if we were to take quizzes."

Students in the Create MC Course were asked the following question: "Imagine a future course you are required to take. If two different sections of this course were offered by the same instructor during equally desirable time slots, but one section had traditional learning activities (such as writing papers and taking tests), and the other used learning activities like creating multiple-choice questions, in which section would you prefer to enroll?"

Students were more negative than positive about their desire to enroll in future courses using this type of open pedagogy activity. Eighteen students (42%) said they would enroll in a course with traditional learning activities, twelve (28%) said they would enroll in a course with activities like creating multiple-choice questions, and thirteen (30%) expressed no preference.

Students selecting "I would enroll in the section with traditional learning activities" focused on themes of consistency, reliability, learning better, and earning better grades. For example, one student stated, "I learn better in those types of classes." Another student wrote, "It's what I'm used to and [excel] in."

It is interesting to note that students who said they would enroll in the sections with activities like creating multiple-choice questions also included themes of learning better and earning better grades, as well as more in-depth learning. One student stated, "It keeps you reading and keeps you understanding the content," and another wrote, "You are able to understand a concept more when you have to create questions, you have to really wrap your head around the ideas."

Students were asked to compare five different aspects of the educational efficacy of creating multiple-choice questions with traditional learning activities. Table 1 summarizes their responses.

Table 1

Student Perceptions of Open Pedagogy With Multiple-Choice Question Creation

Outcome	Open pedagogy compared with traditional activities		
	More	Same	Less
Mastery of core academic content	11 (26%)	17 (40%)	15 (35%)
Skills in collaborative learning	6 (14%)	28 (65%)	9 (21%)
Critical thinking and problem solving	11 (26%)	28 (65%)	4 (9%)
Effective communication	3 (7%)	32 (76%)	7 (17%)
Learning how to learn	6 (14%)	32 (76%)	4 (10%)
Aggregate learning outcomes	37 (17%)	137 (64%)	39 (18%)

Note. *N* = 43.

Ten students provided a free response comment on how this approach to open pedagogy helped them master core academic content more than traditional learning activities. One student wrote, “I learned the information better by having to actually think of a question to ask,” and another said, “Until I could understand the topic well, I couldn’t create multiple questions.” In contrast, eleven students wrote about why they had lower concept mastery, focusing on a lack of learning. Two representative quotations are as follows: “I felt I was too worried about the formation of a question that I never really gave the material much thought,” and “I was unable to grasp all aspects of the readings, focusing on the graded aspect of my question formatting.”

When asked to explain why the activities helped them become more or less collaborative learners than in traditional learning activities, the most consistent response was that they collaborated less. Five students bluntly made statements such as, “There was nothing collaborative about [this assignment].”

Students who felt writing multiple-choice questions helped them learn to think critically or solve complex problems more than traditional learning activities wrote about depth of learning and application of knowledge. For example, one student wrote, “It made me have to apply knowledge and think more in depth about the topic.” Two students wrote about why this pedagogy was less effective for critical thinking. One wrote, “I didn’t think critically or solve any complex problems.”

When asked to explain why creating multiple-choice questions helped them learn to communicate more effectively than traditional learning activities, one student wrote, “Framing thoughts, organizing material.” Two students provided statements about why the activities were less useful in learning to communicate effectively. One wrote, “I couldn’t really communicate anything, I was just writing questions.”

With respect to learning how to learn, three students provided statements about why their outcome was more positive, centering on a theme of understanding. For example, one student wrote, “I had to understand the questions/material itself before actually creating the questions.” Two students provided statements about why their outcome was less positive. The students’ responses centered on a lack of focus. For example, one student wrote, “I wasn’t able to focus on understanding the material as a whole. Instead I had to focus on the section I was assigned and try to make a question, often out of the most trivial aspects of its subject material, leaving me with a very loose understanding of the material.”

Student Perceptions of Creating the Syllabus and Assignments

As with the students in the course with multiple-choice questions, students in the class that created the syllabus and assignments were asked, “Was the educational value of creating the syllabus and assignments better, worse, or the same as that of traditional learning activities (e.g., writing papers, taking quizzes, etc.)?” Twenty-seven students (64%) said creating the syllabus and assignments was better, with eleven (26%) saying it was the same, and four (10%) stating it was worse.

The students who felt that creating a syllabus and assignments was better than traditional learning activities mentioned several factors including ownership over learning, self-pacing the course, increased engagement, development of skills such as communication and independence, the applicability of concepts, and the feeling that students were doing “less busy work” than they would have in a traditional course. The general sentiment was summarized by one student who said that the course “allowed [the students] to really take control of how [they] wanted the class to be run, and set [them] up for great success in the class.”

The students who felt that creating a syllabus and assignment was the same as traditional learning activities felt that the information itself didn’t change in a significant way. For example, one student wrote, “We ended up getting the same information, we were just given it in a different way.”

Students who felt creating a syllabus and assignment was worse than traditional learning activities focused on factors such as lack of structure and priorities. For example, one student wrote, “Nothing is set in stone and I am unaware of what to prioritize and what the goals of the class are.” This indicates that at least some students felt that a drawback of this form of open pedagogy was a lack of desired structure.

In response to the question regarding student preference in taking a future course using activities similar to creating a syllabus or assignments versus traditional activities, the majority of students in the Create Assignments Course were willing to enroll in the section using this style of open pedagogy activity. Twenty-four students (60%) said they would enroll in a course with activities like creating a syllabus and assignments, seven (18%) said they would enroll in a course with traditional learning activities, and nine (23%) expressed no preference (total does not equal 100% due to rounding).

When asked why they would choose to enroll in a class with this type of open pedagogy activity, sixteen students responded. Their statements centered on themes of engagement, freedom, control, and ease of learning. Student comments included: "[This pedagogy] allows more freedom for the student which I like a lot more than the traditional style," "It gives me an option to structure the class how I would want to learn and be able to understand the information better," and "It's an easier way to learn and a way to choose what I want to work on."

When asked why they chose traditional activities, seven students provided responses centered on themes of preferring current norms and habits of learning. A representative comment is as follows: "I am used to [a structured class] and I feel in a course that connects to my major I can succeed more if I study and find the initiative to do good on a test rather than figure everything out on my own and be independent in my research."

Table 2 summarizes student responses to five different aspects of the educational efficacy of creating a syllabus and assignments when compared with traditional learning activities.

Table 2

Student Perceptions of Open Pedagogy Co-Creating the Syllabus and Learning Activities

Outcome	Open pedagogy compared with traditional activities		
	More	Same	Less
Mastery of core academic content	22 (54%)	16 (39%)	3 (7%)
Skills in collaborative learning	23 (56%)	18 (44%)	0 (0.00%)
Critical thinking and problem solving	23 (56%)	15 (37%)	3 (7%)
Effective communication	19 (46%)	22 (54%)	0 (0.00%)
Learning how to learn	16 (39%)	21 (51%)	4 (10%)
Aggregate learning outcomes	103 (50%)	92 (45%)	10 (5%)

Note. *N* = 41.

Seventeen students provided comments about how the open pedagogy helped them master content more than traditional approaches. Students stated that they were more involved, connected to the content, and that it allowed them to "fully understand the process of [their] tasks and the reason why [they] are doing something." One student noted, "In a typical classroom, most students learn the information just so that they can do well on the test," whereas in this course, the student felt that the new knowledge was adding to a larger body of knowledge and skills.

Nineteen students explained how creating a syllabus and their own assignments made them a more collaborative learner; no students provided a response stating that it did not. Students felt that working with others on their course and assignments encouraged them to develop skills related to collaborative work and that doing so increased accountability to themselves and those around them. They also felt that it not only increased collaboration with students but between the professor and students as well. One student stated that they "work[ed] in groups a lot more than in a traditional class."

Eighteen students wrote about how the open pedagogy helped them learn to think critically or solve complex problems more than traditional learning activities. These responses discussed engagement, collaboration, and imagination. For example, one student wrote, "Engaging with students made me think more about my opinion and other students." Another student stated, "I had to come up with ways to solve real problems."

When asked to explain why creating a syllabus and learning activities helped them communicate more effectively, thirteen students wrote about how communication was vital to succeeding on the assignment. For example, one student wrote, "I had to communicate with group members, and without effective communication our product would have been crap."

With respect to how students perceived the open pedagogy helping them learn how to learn more effectively, twelve students focused on themes such as involvement, responsibility, independence, and a new style of thinking. One student wrote, "Creating a syllabus makes you responsible and forces you to be an independent learner." Another said, "It helped me think from a different angle and to look outside the box when trying to find an answer." Three students provided statements about why this approach to open pedagogy helped them learn less than traditional teaching activities. These students were concerned about the effectiveness of group participation. As one representative comment stated, "We chose how we learned which meant people could slack off in their work."

Comparing Student Perceptions of Two Instantiations of Open Pedagogy

There were strong and significant differences in how students perceived these two approaches to open pedagogy.

In response to the question, "Was the educational value of [the open pedagogy activity] better, worse, or the same as that of traditional learning activities?" students in the Create MC Course were much more likely to state that open pedagogy was worse. A chi-square test of independence was performed to examine the relation between the Create MC Course and the Create Assignments Course. The relation between these variables was significant (χ^2 (2, N=84) = 22.35, $p < .001$). Students in the Create Assignments Course were more likely to state the open pedagogy had higher educational value.

Similarly, students were asked this question: "Imagine a future course you are required to take. If two different sections of this course were offered by the same instructor during equally desirable time slots, but one section had traditional learning activities (such as writing papers and taking tests), and the other used learning activities like [the open pedagogy activity implemented in your class], in which section would you prefer to enroll?"

Students in the Create MC Course were much more likely to state they would enroll in a class with traditional learning activities. A chi-square test of independence was performed to examine the relation between the Create MC Course and the Create Assignments Course. The relation between these variables was significant (χ^2 (2, N=83) = 9.47, p < .01). Students in the Create Assignments Course were more likely to state that open pedagogy was better.

Likewise, there were significant differences in each of the five questions asking students to compare aspects of the learning with open pedagogy versus traditional activities, as described in Table 3.

Table 3

Frequencies and Chi-Square Results for Student Perception of the Efficacy of Two Open Pedagogy Methods Compared to Traditional Learning Activities

	Create MC course (*N*=43)			Create assignments course (*N*=41)			$\chi^2(2)$	*p*
	More	Same	Less	More	Same	Less		
Mastery of core academic content	11	17	15	22	16	3	11.656	<.01
Skills in collaborative learning	6	28	9	23	18	0	21.104	<.001
Critical thinking and problem solving	11	28	4	23	15	3	8.265	.016
Effective communication	3	32	7	19	22	0	20.479	<.001
Learning how to learn	6	32	4	16	21	4	6.817	.03

Discussion

The results indicate that a strong minority of students (42%) felt that creating multiple-choice questions had less educational value than traditional learning activities. Only 16% of those who created multiple-choice questions felt this approach had more educational value than traditional learning activities. In contrast, students who engaged in creating their own syllabus and learning activities were generally (although not universally) positive, with nearly two-thirds reporting that it was better than traditional learning activities and an additional one-fourth stating that they had the same value.

There were statistically significant differences in how students viewed these two open pedagogy activities. Students consistently rated creating multiple-choice questions as being less conducive to learning, and stated that they would be less likely to choose a class with this approach to open pedagogy than the one focused on students creating their own syllabus and activities.

These data cannot be used to conclusively declare that creating multiple-choice questions is a poor form of open pedagogy or that students creating their own syllabus and/or learning activities is a successful one. There are several factors that we were not able to measure as part of this study that could have had significant bearing on how students perceived the specific learning activities. However, the significant differences in student attitudes towards these two approaches to open pedagogy support our hypothesis that research or rhetoric regarding open pedagogy, broadly defined, will not be particularly useful to practitioners. Had our study only focused on the Create MC Course, the results would have indicated that open pedagogy is less effective and that students dislike open pedagogy. In contrast, had we only studied the Create Assignments Course, some might have concluded that open pedagogy is an overwhelming success loved by most students.

These results suggest caution when researching and/or making claims about open pedagogy. One successful implementation of an open pedagogy approach is not enough to state that open pedagogy, broadly defined, benefits student learning. More research is needed to investigate specific aspects of open pedagogy in order to explore the relative benefits and drawbacks of different approaches. These findings suggest the importance of more specific definitions of open pedagogy so that the efficacy of a specific approach can be more critically examined. For practitioners to successfully implement open pedagogy in a way that will benefit students, specific methods need to be identified together with best practices for their implementation.

Limitations

There are several limitations in this exploratory study, and our results must be understood in that light. First, there was no attempt to control for instructor variables. The instructor who assigned students to create multiple-choice questions was attempting this approach for the first time and would likely approach it differently were she to use this technique again in the future. In contrast, the instructor who assigned students to create their own syllabus and assignments had used this pedagogy frequently in the past. Thus, what was measured in the present study may not be the efficacy of the strategy itself but, rather, the difficulty of implementing a new pedagogical approach. Similarly, it is possible that the instructor who had students create their own syllabus and assignments may have done so in a masterful way that could only be easily accomplished by a minority of faculty. Replication by a variety of instructors in different settings, as well as studying individual teachers over successive semesters would be necessary before generalizing the results of the present study.

A second weakness is that no attempt was made to control for student differences. Nearly all the students in the Create Assignments Course were in their first semester of college versus only a third in the Create MC Course (the majority of the remainder had completed between one and four semesters). This could be a significant factor in how students responded to the various approaches to open pedagogy. Further research could remedy these limitations by systematically using different approaches to open pedagogies in similar courses and with similar student populations.

Finally, we acknowledge limitations in our survey questions. We used the terms *open* and *traditional* which could have different connotations to different people. It is possible that individual students may have a negative (or positive) perspective of traditional assignments that could have skewed their responses.

Conclusion

To our knowledge, the present study is the first of its kind to analyze specific implementations of open pedagogy and make comparisons between them. This study shows that some implementations of open pedagogy can be viewed poorly by students. We do not believe we have sufficient data to demonstrate that one approach to open pedagogy is more efficacious than another. Much more research is needed in order to determine whether specific approaches to open pedagogy are more beneficial than others. However, we do believe that broad claims such as "open pedagogy is a high-impact practice that empowers students" ("Introduction to Open Pedagogy," 2018, para. 3) currently lack empirical support.

This study has demonstrated that attempting to measure the impact of the open pedagogy, broadly defined, may be a fruitless quest. Specific approaches to open pedagogy must be examined, each in a variety of contexts with careful attention to how they are implemented. Discussions regarding open pedagogy should focus on specific testable interventions that can be shown to improve learning. Only then will we be able to make valid claims regarding the efficacy of specific approaches to open pedagogy.

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Appendix

Survey Taken by Students

The following are general questions related to you and your courses at the college.

Q1 How many terms/semesters have you completed in college?

- Less than 1 (1)
- 1-2 (2)
- 3-4 (3)
- 5-6 (4)
- 7-8 (5)
- 9-10 (6)
- More than 10 (7)

Q2 What is your cumulative college Grade Point Average (GPA) on a 4.0 scale?

- 0.0 - 1.4 (1)
- 1.5 - 2.0 (2)
- 2.1 - 2.5 (3)
- 2.6 - 3.0 (4)
- 3.1 - 3.5 (5)
- 3.6 - 4.0 (6)
- This is my first term (7)
- I don't know

Q3 In general, how often do you *rent* the required course materials for the courses you take?

- Never (1)
- Rarely (2)
- About Half the Time (3)
- Often (4)
- Always (5)

Q4 In general, how often do you *purchase* the required course materials for the courses you take?

- Never (1)
- Rarely (2)
- About Half the Time (3)
- Often (4)
- Always (5)

Q5 Have you ever not purchased course materials for a class because of the cost of the course materials?

a. No
b. Yes

Q6 (If yes to 5) Do you think that not purchasing the course materials influenced your grade in the course in a negative way?

a. No
b. Yes

Q7 (If yes to 5) Has not purchasing course materials contributed to your decision to drop a course?

a. No
b. Yes

Q8 (If yes to 5) Has not purchasing course materials ever caused you to fail or withdraw from a course?

a. No
b. Yes

Q9 Have you ever delayed purchasing course materials for a class because of the cost of the course materials?

a. No
b. Yes

Q10 (if yes to 9) Do you think that delaying purchasing the course materials influenced your grade in a negative way?

a. No
b. Yes

Q11 Have you ever registered for fewer courses because of course materials costs?

a. No
b. Yes

Q12 Have you ever not registered for a specific section of a course because of course materials costs?

a. No
b. Yes

Your instructor included the following open pedagogy activity in your course: [insert open pedagogy phrase]. The following questions relate to your participation in the course's [insert open pedagogy phrase] in which [insert description of open pedagogy used]. In the questions below this is referred to as "the course's [insert open pedagogy phrase]."

Q13 Have you ever completed an assignment similar to participating in the course's [insert open pedagogy phrase] in another class?

Q14 Was the educational value of participating in the course's [insert open pedagogy phrase] BETTER, WORSE, or the SAME AS that of traditional learning activities (e.g., writing papers, taking quizzes, etc.).

a. Better
b. Same
c. Worse

14.1 [if Better in 14] in what ways was it better?
14.2 [if Same in 14] in what ways was it the same?
14.3 [if Worse in 14] in what ways was it worse?

Q15 When your instructor asked you to participate in the course's [insert open pedagogy phrase], did this change your opinion of your instructor?

a. Yes
b. No

Q16 [if yes to 15] How did your perception of your instructor change?

Q17 Suppose that certain types of learning activities lead to certain learning outcomes. For example, reviewing flash cards might lead to memorizing facts. What types of learning outcomes do you think are the result of participating in the course's [insert open pedagogy phrase]?

Q18 Imagine a future course you are required to take. If two different sections of this course were offered by the same instructor during equally desirable time slots, but one section had traditional learning activities (such as writing papers and taking tests), and the other used learning activities like participating in the course's [insert open pedagogy phrase], in which section would you prefer to enroll?

- I would enroll in the section with TRADITIONAL LEARNING ACTIVITIES
- I would enroll in the section with ACTIVITIES LIKE PARTICIPATING IN AN [insert open pedagogy phrase]
- I would have no preference

Q18.1 [if TRADITIONAL] Why would you choose a class with traditional learning activities?

Q18.2 [if ACTIVITIES LIKE PARTICIPATING IN AN [insert open pedagogy phrase]] Why would you choose a class with activities like participating in [insert open pedagogy phrase]?

Q19 In this course, did you create any resources that were shared online or intended for reuse by others in the future?

Q 19.1 (if yes to Q19) Did you use an open license, like a Creative Commons license, to license any of the resources you created for this course?

Yes
No

Q 19.2 (if yes to Q19) Did you feel pressured to license your work in a certain way?

Yes
No

Q 19.3 (if yes to Q19.2) Please share how you felt pressured to license your work and how this impacted you.

Q20 How did participating in the course's [insert open pedagogy phrase] help you master core academic content, compared to the way engaging in traditional learning activities (like writing essays or taking quizzes) would have?

- Participating in the course's [insert open pedagogy phrase] helped me master MORE core academic content than traditional learning activities would have

- Participating in the course's [insert open pedagogy phrase] helped me master THE SAME AMOUNT of core academic content as traditional learning activities would have
- Participating in the course's [insert open pedagogy phrase] helped me master LESS core academic content than traditional learning activities would have

20.1 [if more] Why did participating in the course's [insert open pedagogy phrase] help you master MORE core academic content than traditional learning activities would have?
20.2 [if less] Why did participating in the course's [insert open pedagogy phrase] help you master LESS core academic content than traditional learning activities would have?

Q21 Reflect on the collaborative nature of the [insert open pedagogy phrase]. Select one of the following:

- Participating in the course's [insert open pedagogy phrase] helped me become a MORE collaborative learner than traditional learning activities would have
- Participating in the course's [insert open pedagogy phrase] helped me collaborate with other learners THE SAME AMOUNT that traditional learning activities would have
- Participating in the course's [insert open pedagogy phrase] helped me become a LESS collaborative learner than traditional learning activities would have

21.1 [if more] Why did participating in the course's [insert open pedagogy phrase] help you become a MORE collaborative learner than traditional learning activities would have?
21.2 [if less] Why did participating in the course's [insert open pedagogy phrase] help you become a LESS collaborative learner than traditional learning activities would have

Q22 Reflect on how the [insert open pedagogy phrase] helped you learn to think critically or solve complex problems. Select one of the following:

- Participating in the course's [insert open pedagogy phrase] helped me become a MORE critical thinker and better problem solver than traditional learning activities would have
- Participating in the course's [insert open pedagogy phrase] helped my critical thinking or problem solving skills THE SAME AMOUNT that traditional learning activities would have
- Participating in the course's [insert open pedagogy phrase] helped me become a LESS critical thinker and worse problem solver than traditional learning activities would have

22.1 [if more] Why did participating in the course's [insert open pedagogy phrase] help you learn to think critically or solve complex problems MORE than traditional learning activities would have?
22.2 [if less] Why did participating in the course's [insert open pedagogy phrase] help you learn to think critically or solve complex problems LESS than traditional learning activities would have?

Q23 Reflect on how the [insert open pedagogy phrase] helped you learn to communicate effectively. Select one of the following:

- Participating in the course's [insert open pedagogy phrase] helped me become a MORE effective communicator than traditional learning activities would have
- Participating in the course's [insert open pedagogy phrase] helped my critical thinking or problem solving skills THE SAME AMOUNT that traditional learning activities would have
- Participating in the course's [insert open pedagogy phrase] helped me become a LESS critical thinker and worse problem solver than traditional learning activities would have

23.1 [if more] Why did participating in the course's [insert open pedagogy phrase] help you become a MORE effective communicator than traditional learning activities would have?

23.2 [if less] Why did participating in the course's [insert open pedagogy phrase] help you become a LESS effective communicator than traditional learning activities would have?

Q24 Reflect on how the [insert open pedagogy phrase] helped you learn more effectively. Select one of the following:

- Participating in the course's [insert open pedagogy phrase] helped me learn MORE effectively than traditional learning activities would have
- Participating in the course's [insert open pedagogy phrase] helped me learn THE SAME AMOUNT that traditional learning activities would have
- Participating in the course's [insert open pedagogy phrase] helped me learn LESS effectively than traditional learning activities would have

24.1 [if more] Why did participating in the course's [insert open pedagogy phrase] help you learn MORE effectively than traditional learning activities would have?
24.2 [if less] Why did participating in the course's [insert open pedagogy phrase] help you learn LESS effectively than traditional learning activities would have?

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Predicting Behavioural Intention of Manufacturing Engineers in Malaysia to Use E-Learning in the Workplace

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Abstract

This study aims to understand factors that affect the behavioural intention of manufacturing engineers in Malaysia to use e-learning in the workplace. Two hundred usable online questionnaires were collected from respondents who were engineers in Malaysian manufacturing companies. The data were analyzed using SPSS and Smart PLS version 3.2.6. Results supported all direct relationships except for the influence of prior experience in perceived ease of use. Interestingly, perceived usefulness and perceived ease of use fully mediated between computer self-efficacy and behavioural intention to adopt. The study provides theoretical implication to the technology acceptance model by confirming the mediating role of perceived ease of use and perceived usefulness in the context of a manufacturing setting in an emerging market. In practical terms, the study provides insights to guide organizations in designing e-learning systems that are well-received by employees at the workplace.

Keywords: e-learning, workplace learning, behavioural intention, Malaysia

Introduction

In today's dynamic business environment, organizational learning is key to achieving sustainable competitive advantage. Through organizational learning, businesses are able to increase employees' competencies, enhance decision making, and fulfill needs such as cost effectiveness while addressing knowledge gaps (O'Brien, McCarthy, Hamburg, & Delaney, 2019). As such, organizations should focus on workplace learning processes where organizational learning effectiveness determines competitiveness.

Information technology has enabled knowledge to be created, saved, and shared in the workplace (Yoo & Huang, 2015). The evolution of digital technology has made a wide range of tools and applications available in the market to enhance teaching and learning processes (Werkel, Schmidt, Dikke, & Schwantzer, 2015) such that e-learning now greatly influences all learning that takes place in organizations. Batalla-Busquets and Pacheco-Bernal (2013) found European bank workers perceived e-learning as a more adaptable and current training methodology. Teräs and Kartoğlu (2017) discovered that a well-designed e-learning process is similar to the way professional learning occurs in workplace settings. Ravenscroft, Schmidt, Cook, and Bradley (2012) recommended organizations effectively design social media for workplace learning.

Driven by the dynamism of organizations' human capital development in the digital era as well as the new norm of workplace training post-Covid-19, this study aims to address current research gaps and further explore the interplay of key determinants that may predict behavioural intention to use e-learning in the workplace.

One of the Malaysian government's strategies under the *Ninth Malaysia Plan* was to build world-class human capital. E-learning was at the forefront of this strategy and the government took initiatives to establish the National Steering Committee for e-learning. In 2018, Internet users numbered 28.7 million or 87.4% of the population, showing a significant increase, while the use of the Internet at the workplace increased to 61.9% in the same year (Malaysian Communications and Multimedia Commission, 2020). The Internet has indeed transformed how people search for information and learn for work-related matters.

The manufacturing sector made up 22.3% of Malaysia's gross domestic product in 2019 (Department of Statistics Malaysia, 2020). Engineers are technical personnel who work on design, testing, problem solving, and product development, playing a crucial role in the operation of manufacturing firms. As engineers are knowledge-based workers, their learning needs to be always up-to-date and continuously improved to support organizational sustainability. The e-learning system is vital to nurturing the competencies of engineers. Hence, understanding factors influencing engineers' behavioural intention to use e-learning at the workplace is crucial.

Behavioural intention to use e-learning is very much dependent on factors such as a user's previous experience, ability, computer anxiety, and education background (Holt & Brockett, 2012) and it varies across countries and cultures (Haverila & Barkhi, 2009). There are many studies that have investigated e-learning usage in the context of academic institutions (e.g., Cigdem & Ozturk, 2016).

While enterprises have embarked on technology-based training in the workplace hoping to capitalize on lower training cost as well as reliable and accessible content (Garg & Sharma, 2020), the acceptance of such e-learning at the workplace in the context of Malaysia has been unclear. Furthermore, empirical evidence on e-learning in the workplace is scarce and outdated (Ong, Lai, & Wang, 2004; Hashim, 2008; Veloo & Masood, 2014). Therefore, this study aims to uncover the factors contributing to behavioural intention to use e-learning at the workplace among manufacturing engineers in Malaysia.

Significance of Study

Theoretically, this research integrated social cognitive theory (SCT) and the technology acceptance model (TAM) in predicting behavioural intention to use e-learning in the workplace, extending TAM with aspects of SCT that reflect personal, cognitive, and environmental factors. Furthermore, this study tested the mediating roles of perceived ease of use and perceived usefulness in furthering TAM.

This research is timely and contributes practically as e-learning has become crucial in developing employees' competencies to suit organizational needs in the current business dynamic. Uncovering the significant factors and addressing them allows organizations to ensure increased use of workplace e-learning through promoting behavioural intention among employees.

Despite having been conducted in Malaysia, findings from this study can be applied to emerging markets in other regions as the data were collected mainly from manufacturing engineers working in multinational corporations (MNCs). Manufacturing firms operating in emerging countries are largely MNCs from developed countries that are more advanced in terms of using e-learning systems to train technical workforces such as engineers.

Theoretical Foundation and Literature Review

Supporting Theories

Social cognitive theory (SCT) focuses on knowledge acquisition and internal mental structures (Bower & Hilgard, 1980) and emphasizes what learners know and how they come to get knowledge from the perspective of the interrelationship between the personal, behavioural, and environmental (Jonassen, 1991). The knowledge acquired potentially alters learners' subsequent behaviour. Among the important factors examined within SCT studies are computer self-efficacy and prior experience.

The technology acceptance model (TAM) examines perceived usefulness and perceived ease of use as two unique variables which are theorized to explain users' behavioural intention toward a technology. Perceived usefulness investigates the degree to which users think that the technology can enhance an outcome, while perceived ease of use concerns the degree to which users think that minimal effort is needed to adopt a technology (Davis, 1989).

As SCT is commonly used in studies involving learning, knowledge management, human resource development, and career development (Kim & Park, 2018) and TAM is fundamental in exploring determinants of information technology usage (Choudhury & Pattniak, 2020; Zheng & Li, 2020), integrating these theories is appropriate to investigating behavioural intention to use e-learning. This study adopted computer self-efficacy and prior experience from SCT as well as perceived usefulness and perceived ease of use from TAM to form an integrated research model.

Behavioural Intention to Use E-Learning in the Workplace (BI)

E-learning refers to education or learning via digital technology to acquire new skills and knowledge, and its success depends on how it's used. Behavioural intention to use an e-learning system refers to an individual's perceived likelihood of having the intention to use an e-learning system (Rezaei Dolatabadi, Ranjbarian, & Zade, 2012) and can be affected by social, technological, and organizational factors (Choudhury & Pattniak, 2020).

Behavioural intention towards e-learning was found to be positively influenced by perceived usefulness (Zheng & Li, 2020) and negatively influenced by attitude (Lee, Hsieh, & Chen, 2013) or positively influenced by both perceived usefulness and attitude (Boateng, Mbrokoh, Boateng, Senyo, & Ansong, 2016). Perceived usefulness and perceived ease of use were found to increase behavioural intention to use e-learning (Ndubisi, 2004). Lee, Hsieh, and Ma (2011) examined the influence of individual, organizational, and task characteristics, as well as subjective norms as determinants of behavioural intention to use e-learning in an organizational context. Garg and Sharma (2020) found ease of use influenced user satisfaction which resulted in users' intention to continuously use e-training in the workplace.

Perceived Ease of Use (PEU)

Perceived ease of use (PEU) refers to an individual's degree of belief that using a system is effortless (Boateng et al., 2016). PEU and perceived usefulness (Zheng & Li, 2020) positively impact both behavioural intention to use e-learning and actual usage (Rahmawati, 2019). Nevertheless, it has been found that PEU positively influences behavioural intention only through perceived usefulness and a positive attitude toward e-learning (Lee et al., 2013).

Further studies have reinforced that PEU is a good predictor for perceived usefulness (Veloo & Masood, 2014; Elkaseh, Wong, & Fung, 2016; Zheng & Li, 2020). Prior experience and computer self-efficacy were found to positively influence PEU (Lee et al., 2013), while computer self-efficacy positively influences PEU, where PEU has a positive significant relationship towards behavioural intention (Hsia, Chang, & Tseng, 2014).

Perceived Usefulness (PU)

Perceived usefulness (PU) refers to how much a person believes that a certain technology or system can help enhance job performance (Davis, 1989). Past studies have shown that PU, either on its own (Chen & Tseng, 2012; Veloo & Masood, 2014) or together with perceived comfortableness and PEU (Hashim, 2008; Joo, Park, & Shin, 2017), is positively related to adoption of behavioural intention towards e-learning. Lee, Hsieh, and Chen (2013) found perceived usefulness had a positive influence on behavioural intention and perceived ease of use had positive influence on perceived usefulness. PU was found to be a major construct that influenced user satisfaction, which led to continual usage intention of e-learning systems by students (Lwoga, 2014).

Computer Self-Efficacy (CSE)

Computer self-efficacy (CSE) refers to the capability of a person to use a computer for task completion. CSE is a significant influence on technology usage (Compeau & Higgins, 1995) that contributes to e-learning adoption (Rahmawati, 2019) and behavioural intention to use an e-learning system for teachers and students (Khasawneh, 2015; Kim & Park, 2018). CSE predicts PU and PEU positively, and predicts perceived credibility negatively, which, in the end, positively influences behavioural intention to use an e-learning system (Ong et al., 2004).

CSE has marginal influence on perceived behavioural control, and the perceived behavioural control strongly predicts the behavioural intention of e-learning usage (Ndubisi, 2004). This relationship is also mediated through PEU (Boateng et al., 2016). Kim and Park (2018) found CSE strongly predicted the behaviour intention for both learners and instructors, either as a mediating or direct variable.

When individuals have higher CSE, they are more likely to feel that a computer is easy to use, which causes them to perceive that an information system is also easy to use. Past studies have found that CSE has a positive influence on PEU (Boateng et al., 2016; Hsia et al., 2014; Ong et al., 2004).

When individuals have CSE, their ability to use an information system increases and influences their perception of an e-learning system's usefulness. Past studies have revealed that CSE has a positive relationship with PU (Zogheib, Rabaa'i, Zogheib, & Elsaheli, 2015; Chen & Tseng, 2012). Thus, we postulate that:

Hypothesis 1: There is a positive and significant relationship between CSE and PEU.

Hypothesis 2: There is a positive and significant relationship between CSE and PU.

Prior Experience (PE)

Prior experience (PE) refers to previous e-learning involvement and has been found to: (a) positively influence e-learning effectiveness (Haverila, 2011); (b) improve perceived behavioural control (Ndubisi, 2004); and (c) affect perceived usefulness and perceived ease of use, which, in turn, influence behavioural intention (Lee et al., 2013).

Lee et al. (2013) argued that PE has a positive and significant influence on both PEU and PU; as individuals gain more experience on how to use an e-learning system, they become more familiar with that system and then tend to perceive that the system is easy to use. PE shows that users who have previous exposure to e-learning already have some knowledge on how to use a new e-learning system. Hence, it will be easier to use e-learning. Lee et al. (2013) provided evidence that PE has a positive relationship with PU. Thus, we postulate that:

Hypothesis 3: There is a positive and significant relationship between PE and PEU.

Hypothesis 4: There is a positive and significant relationship between PE and PU.

PEU and PU

Past studies have indicated that when an individual has PEU of an e-learning system, he/she will also have PU towards that e-learning system (Zogheib et al., 2015). Furthermore, several studies have proven that PEU has a positive and significant relationship with PU (Boateng et al., 2016; Lee et al., 2013; Ong et al., 2004). Thus, we postulate that:

Hypothesis 5: There is a positive and significant relationship between PEU and PU.

PEU, PU, CSE, PE, and BI

When individuals find that e-learning is easy to use, their intention to use the e-learning system will increase. Al-Gahtani (2016) discovered that PEU positively influences behavioural intention. Most studies have supported the idea that PEU has a positive and significant relationship with BI (Lee et al., 2013; Garg & Sharma, 2020).

When individuals find an e-learning system useful, they will have the intention to use the e-learning system. Lee et al. (2013) highlighted that PU has a positive and significant relationship with behavioural intention to use e-learning. Other studies (Ong et al., 2004; Al-Gahtani, 2016) have also supported this finding.

Computer self-efficacy positively influences behavioural intention to use e-learning (Ong et al., 2004; Hsia et al., 2014). CSE contributes towards e-learning adoption (Rahmawati, 2019) and behavioural intention to use e-learning systems among teachers and students (Khasawneh, 2015; Kim & Park, 2018). However, Yuen and Ma (2008) found no significant direct relationship between CSE and BI, while Md Ariff, Yeow, Zakuan, Jusoh, and Bahari (2012) found only an indirect relationship between CSE and BI, which was through PU and PE.

Prior experience was found to positively influence behavioural intention to use e-learning in education (Lee, et al., 2013; Ndubisi, 2004) as well as in the workplace (Wang & Lin, 2014). Thus, we postulate that:

Hypothesis 6: There is a positive and significant relationship between PEU and BI.

Hypothesis 7: There is a positive and significant relationship between PU and BI.

Hypothesis 8: There is a positive and significant relationship between CSE and BI.

Hypothesis 9: There is a positive and significant relationship between PE and BI.

Perceived Ease of Use (PEU) as Mediator

Past studies have indicated that PEU is a good mediator (Venkatesh, 1999). Furthermore, positive PE of e-learning was revealed to have positive influence on the adoption of online learning (Burton-Jones & Hubona, 2006). Haverila (2011) highlighted that PE is very important to determine e-learning outcomes. Kim and Park (2018) found CSE directly and indirectly influences adoption of e-learning. Thus, we postulate that:

Hypothesis 10: PEU mediates the relationship between CSE and PU.

Hypothesis 11: PEU mediates the relationship between CSE and BI.

Hypothesis 12: PEU mediates the relationship between PE and PU.

Hypothesis 13: PEU mediates the relationship between PE and BI.

Perceived Usefulness (PU) as Mediator

As a mediator, PU positively influences the relationships of motivation, computer anxiety, Internet self-efficacy (Hashim, 2008; Joo et al., 2017), PEU, and attitude (Boateng et al., 2016) with behavioural intention. Several studies have indicated that PU is a good mediator (Venkatesh, 1999; Burton-Jones & Hubona, 2006). Wei (2009) claimed that PU mediated the relationship of perceived compatibility of a technology system and BI. Huynh and Thi (2014) found PU mediates the relationship between PEU and BI. Thus, we postulate that:

Hypothesis 14: PU mediates the relationship between CSE and BI.

Hypothesis 15: PU mediates the relationship between PE and BI.

Hypothesis 16: PU mediates the relationship between PEU and BI.

Therefore, we developed a research model as follows (see Figure 1).

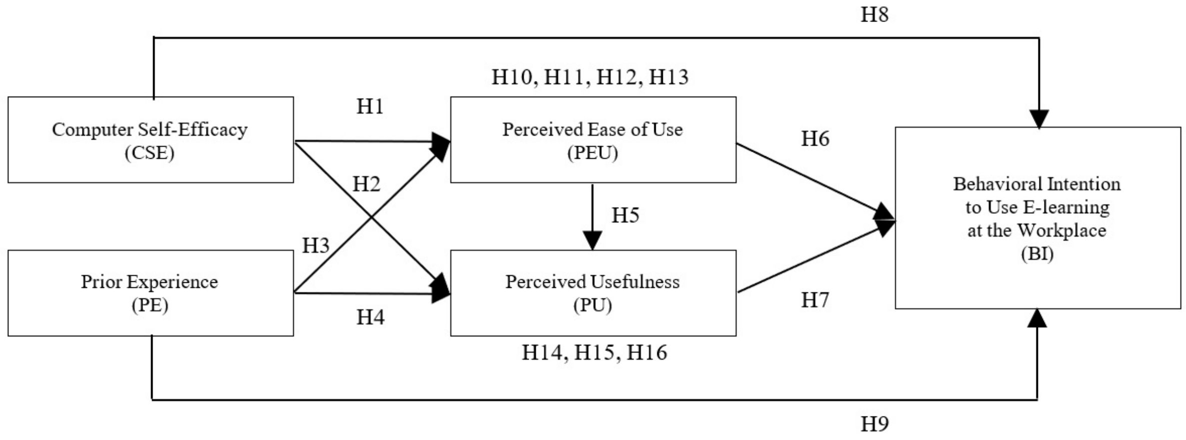

Figure 1. Research model to determine behavioural intention to use e-learning in the workplace.

In addressing gaps in literature, the research model integrates SCT and TAM to evaluate behavioural intention to use e-learning in the workplace. This study attempts to address certain SCT limitations which emphasize that learning occurs within a person and do not consider external factors (Garcia Carreño, 2014).

Most of the past SCT and TAM studies have centered on traditional learning in the classroom, and e-learning of students and teachers. This study extends the traditional TAM by testing the mediating effects of PEU and PU in predicting BI in the context of e-learning in the workplace.

Methodology

This quantitative study used non-probability purposive sampling and collected two hundred effective responses from engineers working in Malaysian manufacturing companies via an online survey conducted in November 2019. The unit of analysis was the individual. The first two sections of the questionnaire explored the organizational background, e-learning system used, and demographic information of the respondents. The third section included questions related to the predictors and mediating variables. The last section included questions on the dependent variable. A Likert-type scale was used to rate the items in each variable. Measurement items were adapted from Lee et al. (2013), Kim and Park (2018), and Hsia, Chang, and Tseng (2014). The survey instrument was reviewed by two experts to determine its validity and clarity.

Statistical Package for Social Science (SPSS) and Smart PLS 3.2.6 were used to analyse the data. SPSS was used to do frequency and descriptive analysis as well as testing for common method variance (CMV). Smart PLS was used to analyse the measurement and structural models. The measurement model measured the outer model for validity and reliability, including discriminant validity, convergent validity, composite reliability, construct validity, and reliability analyses. The structural model measured the inner model on regression analysis and tested the hypotheses. Path coefficients were obtained in terms of direct and indirect effects. T-values and p-values were also acquired to determine whether the hypotheses should be rejected or accepted. The confidence level was set at 95%, with a significance level of 0.05 under a one-tailed test. In this study, PLS was used to perform a nonparametric bootstrap procedure based on the assumption that data were not normally distributed.

Data Analysis and Findings

Profile of Respondents

The majority of respondents were male (61%), within the age group of 26 to 30 years old (40.5%). Furthermore, 54.5% were single and possessed a bachelor's degree (68%). Most (72%) worked in large manufacturing organizations, and 79% of the respondents' companies had developed in-house e-learning systems. Slightly more than half of the companies (56.5%) did not force their employees to use e-learning systems; rather, it was on a voluntary basis.

Common Method Variance

Data were examined using SPSS; factors were unrotated, and the extraction method was principal component analysis. The results showed that six extracted factors explained 73.65% of the total variances. The first factor explained 45.13% of the variance extracted, which was less than the required criteria of 50%. Hence, there was no single factor representing a majority of the total variance extracted, and the samples were therefore considered to be free from common method bias (Podsakoff, MacKenzie, Lee, & Podsakoff, 2003).

Assessment of the Measurement Model

Hair, Hult, Ringle, and Sarstedt (2016) recommended a cut-off value of 0.50 for significant loadings. All the individual items of each construct consisted of the highest loadings, and all the cross loadings were lower than the main loadings respectively (see Table 1). Hence, the constructs were valid.

For a variable to demonstrate convergent validity, the average variance extracted (AVE) must be more than 0.50 (Hair, Hult, Ringle, & Sarstedt, 2016). All AVE values were above the 0.50 threshold, indicating the model showed convergent validity.

Cronbach's alpha, composite reliability and Rho_A must be higher than 0.70 to demonstrate the reliability of the research model (Hair et al., 2016). Cronbach's alpha is said to have limitations as it assumes all indicators are equally reliable and have equal loadings on the construct but Rho_A is loading oriented (Hair et al., 2016). Cronbach's alpha, composite reliability and Rho_A values of each variable were higher than 0.70 (see Table 1). As such, the model was considered reliable.

Table 1

Convergent Validity

Variable	Item	Loading	AVE	Rho_A	Cronbach's Alpha	Composite Reliability
BI	BI1	0.813	0.746	0.915	0.914	0.936
	BI2	0.877				
	BI3	0.861				
	BI4	0.885				
	BI5	0.879				
PEU	PEU1	0.803	0.721	0.877	0.870	0.912
	PEU2	0.846				
	PEU3	0.921				
	PEU4	0.822				
PU	PU1	0.858	0.741	0.914	0.912	0.935
	PU2	0.880				
	PU3	0.828				
	PU4	0.872				
	PU5	0.863				
CSE	CSE1	0.879	0.678	0.861	0.841	0.893
	CSE2	0.870				
	CSE3	0.792				
	CSE4	0.744				
PE	E1	0.743	0.616	0.871	0.847	0.889
	E2	0.816				
	E3	0.807				
	E4	0.761				
	E5	0.793				

Note. BI = behavioural intention; PEU = perceived ease of use; PU = perceived usefulness; CSE = computer self-efficacy; PE = prior experience.

The heterotrait-monotrait ratio of correlations (HTMT) is recommended by Henseler, Ringle, and Sarstedt (2014) to measure discriminant validity and test if items involved in a study are unrelated in order to avoid potential bias or confusion. As a rule of thumb, the HTMT value should be below 0.9. The HTMT results in Table 2 indicate that all questions were different from one another and would not cause confusion to the respondents. Hence, the model for this study demonstrated discriminant validity.

Table 2

HTMT Criterion for Discriminant Validity

	1	2	3	4	5
1. BI	–				
2. CSE	0.644	–			
3. PE	0.350	0.537	–		
4. PEU	0.757	0.754	0.357	–	
5. PU	0.796	0.792	0.421	0.836	–

Note. BI = behavioural intention; CSE = computer self-efficacy; PE = prior experience; PEU = perceived ease of use; PU = perceived usefulness.

Standardized Root Mean Square Residual (SRMR)

To eliminate model misspecification, the standardized root mean square residual (SRMR) was calculated. The SRMR should have a value of less than 0.10 for reasonable model fit. The SRMR in this study was 0.074 indicating acceptable model fit.

Assessment of Structural Model

To assess the structural model, a one-tailed test was used with a significance level of 0.05, indicating a 95% confidence level (see Table 3).

Table 3

Path Coefficients and Hypotheses Testing (Direct Relationships)

Hypothesis	Path	Path Coefficient	T-value (One Tail)	Result
H1	CSE → PEU	0.638	8.290**	Supported
H2	CSE → PU	0.352	3.301*	Supported
H3	PE → PEU	0.033	0.351	Not supported
H4	PE → PU	0.059	0.832	Not supported
H5	PEU → PU	0.498	5.866**	Supported
H6	PEU → BI	0.297	2.974*	Supported
H7	PU → BI	0.480	4.071**	Supported
H8	CSE → BI	0.031	0.343	Not supported
H9	PE → BI	0.017	0.244	Not supported

Note. BI = behavioural intention; CSE = computer self-efficacy; PE = prior experience; PEU = perceived ease of use; PU = perceived usefulness. ***p* < 0.001. **p* < 0.05.

Table 4 shows the detailed results of mediation analysis. Of the seven hypotheses tested, four were supported as the indirect paths were significant. The lower and upper limits of confidence interval bias did not straddle '0', indicating there was mediation (Preacher & Hayes, 2008).

If the direct relationship between the independent variable and the dependent variable is significant and the indirect relationship is also significant, then partial mediation occurs; however, if the direct relationship is not significant while indirect is significant, then full mediation occurs (Zhao, Lynch, & Chen, 2010).

Table 4

Path Coefficients and Hypotheses Testing (Indirect Relationships)

Hypothesis	Path	Path Coefficient	T-value (One Tail)	Confidence Interval Bias Corrected		Result	Type of Mediation
				5% (*LL*)	95.0% (*UL*)		
H10	CSE→PEU→PU	0.318	4.464**	0.215	0.445	Supported	Partial
H11	CSE→PEU→BI	0.189	2.859*	0.091	0.306	Supported	Full
H12	PE→PEU→PU	0.017	0.347	-0.068	0.092	Not supported	None
H13	PE→PEU→BI	0.010	0.312	-0.039	0.065	Not supported	None
H14	CSE→PU→BI	0.169	2.552*	0.079	0.302	Supported	Full
H15	PE→PU→BI	0.028	0.858	-0.019	0.083	Not supported	None
H16	PEU→PU→BI	0.239	3.071**	0.126	0.384	Supported	Partial

Note. BI = behavioural intention; CSE = computer self-efficacy; PE = prior experience; PEU = perceived ease of use; PU = perceived usefulness. **$p < 0.001$. *$p < 0.05$.

Hair et al. (2016) stated that when measuring the goodness of fit of a model using R^2, 0.25 is weak, 0.50 is moderate, and 0.75 is strong. The R^2 values calculated in this study show an overall moderate goodness of fit. Specifically, the R^2 of perceived ease of use (PEU) was 0.428 which indicates almost moderate goodness of fit, where 42.8% of its variance can be explained by computer self-efficacy (CSE) and prior experience (PE). However, the R^2 of perceived usefulness (PU) was 0.645 indicating PU clearly has a moderate goodness of fit, and 64.5% of its variance can be represented by CSE, PE, and PEU. Lastly, the R^2 of behavioural intention (BI) was 0.576 showing a moderate goodness of fit, with 57.6% of its variance explained by PEU and PU.

Discussion and Implications

Hypothesis H_1, which describes a positive relationship between computer self-efficacy and perceived ease of use, was supported with a T-value of 8.290 (see Table 3). Consistent with previous studies (Lee et al., 2013; Hsia et al., 2014; Boateng et al., 2016), individuals with computer self-efficacy were found to have higher perceived ease of use with e-learning systems in the context of workplace learning. Computer self-efficacy exists if an individual can complete certain tasks using a computer. This individual perceives that the problems faced are not difficult although others might feel otherwise (Hsia et al., 2014). With computer self-efficacy, an individual feels more comfortable when using an e-learning system (Lee et al., 2013).

Hypothesis H_2, which postulates that there is a positive relationship between computer self-efficacy and perceived usefulness, was accepted with a T-value of 3.301 (see Table 3). This confirms that individuals with higher computer self-efficacy have higher perceived usefulness towards an e-learning system (Zogheib et al., 2015) in a workplace. Computer self-efficacy was a crucial factor to be considered because it had a significant and positive influence on perceived usefulness, consistent with previous findings (Chen & Tseng, 2012; Rabaa'i, 2016). Computer self-efficacy positively predicts perceived usefulness because an individual with high computer self-efficacy also has higher learning effectiveness. Computer self-efficacy improves knowledge transfer, which leads to better practical usage of technology systems.

Hypothesis H_3, which suggests a positive relationship between prior experience and perceived ease of use, was not supported, with a T-value of 0.351 (see Table 3). This means that prior experience had no influence on perceived ease of use which contradicts several past studies discussed earlier. However, this finding may also indicate that, for an individual, prior exposure to or practice with a technology system is not a significant factor that influences the perceived ease of use (Adewole-Odeshi, 2014). Every individual has different learning characteristics which indirectly influence their thoughts towards ease of use of an e-learning system (Haverila & Barkhi, 2009). Prior experience gained by anyone may be unique. Most of the respondents in this study, being engineers, would have graduated from higher education institutions and therefore would have had experience with e-learning systems.

Hypothesis H_4, which assumes a positive relationship exists between prior experience and perceived usefulness, was not supported, with a T-value of 0.832 (see Table 3). Despite having more experience with e-learning systems, in both this study and in Lee et al. (2013), engineers' perceptions of usefulness were not influenced by prior experience.

Hypothesis H_5, which postulates there is a relationship between perceived ease of use and perceived usefulness, was supported, with a T-value of 5.866 (see Table 3). This is consistent with previous findings (Chen & Tseng, 2012; Lee et al., 2013; Punnoose, 2012) that have shown that an individual who perceives that e-learning is easy to use also directly perceives that the e-learning system is useful. Furthermore, this supports the findings of studies that have demonstrated that perceived ease of use has a significant and direct effect on perceived usefulness in e-learning adoption (Al-Gahtani, 2016; Huynh & Thi, 2014; Zogheib et al., 2015).

Hypotheses H_6 and H_7 predict that behavioural intention to use e-learning at the workplace will be positively and significantly influenced by perceived ease of use and perceived usefulness. Both hypotheses were supported with T-values of 2.974 and 4.071 respectively (see Table 3). The findings revealed that perceived ease of use and perceived usefulness were antecedents to the intention to use an e-learning system at the workplace. Since perceived ease of use, perceived usefulness, and behavioural intention to use e-learning at the workplace are the main constructs in TAM, which is a well-established research model, many past studies have provided evidence of this significant relationship (Chen & Tseng, 2012; Huynh & Thi, 2014; Al-Gahtani, 2016). It is believed that when an e-learning system is perceived to be easy to use and provides advantages at the workplace, the probability of intention to use will be higher.

Hypotheses H_8 and H_9 predict that behavioural intention to use will be positively and significantly influenced by computer self-efficacy and prior experience respectively. Both hypotheses were not supported as the T-values were 0.343 and 0.244 (see Table 3). Although previous studies (Lee et al., 2013; Wang & Lin, 2014; Ndubisi, 2004) have found significant relationships, this study suggests that prior experience does not influence behavioural intention. Surprisingly, computer self-efficacy did not directly influence behavioural intention. Similar observations have been made in previous studies such as Yuen and Ma (2008) and Md Ariff et al. (2012).

The mediating effect of the TAM beliefs (perceived ease of use and perceived usefulness) were examined in hypotheses H_{10} to H_{16}. Full mediating effects were found for hypotheses H_{11} and H_{14}, but H_{10} and H_{16} showed only partial mediation (see Table 4). This is consistent with past studies (Venkatesh, 1999; Burton-Jones & Hubona, 2006; Svendsen, Johnsen, Almås-Sørensen, & Vittersø, 2013) that have demonstrated that perceived ease of use and perceived usefulness are able to act as mediating variables in TAM. Interestingly, hypotheses $H_{12,}$ H_{13}, and H_{15} were not supported (see Table 4), which contradicts previous findings (Haverila, 2011; Burton-Jones & Hubona, 2006). In this study, the relationship between prior experience and perceived ease of use was not significant in the context of e-learning in the workplace. Consequently, perceived ease of use did not show a mediating effect between prior experience and perceived usefulness, and between prior experience and behavioural intention.

Theoretical Implications

This study confirms the mediating role of the TAM beliefs (perceived ease of use and perceived usefulness). Both perceived ease of use and perceived usefulness were found to mediate the relationship of the antecedents (except for prior experience) with behavioural intention to use e-learning at the workplace. This finding contributes to TAM as past studies have neglected these two beliefs as mediators. This study has also validated the integrated framework of SCT and TAM in predicting the behavioural intention to use e-learning in the workplace. Past studies were conducted mainly on students in universities, while limited studies were carried out within the industrial or workplace context, adopting either one of these theories independently.

Practical Implications

Findings from this study on the determinants of behavioural intention to use e-learning at the workplace provide guidelines to organizations on significant factors to prioritize when establishing an e-learning system. For instance, it is recommended that organizations ensure computer self-efficacy among employees before implementing an e-learning system. Computer usage culture must be instilled among the employees. Organizations should also ensure the e-learning system is both easy to use and useful for the employees. Organizations can set up a group of pioneer users before officially rolling out the new e-learning system. The pioneer users can try the e-learning system and provide feedback especially in areas of ease of use and usefulness. Organizations can then use this feedback to improve the e-learning system to fit the needs and expectations of employees.

Conclusion and Limitations

Organizational learning is essential to achieving sustainable competitive advantage in the current volatile business environment. Digital transformation in organizations has enabled e-learning at the workplace to drive organizational learning. In gauging behavioural intention to use e-learning, this study developed a research model that integrated SCT and TAM and addressed gaps in previous studies. In this study, we advanced current understanding by predicting behavioural intention to use e-learning at the workplace among manufacturing engineers in an emerging country. Computer self-efficacy was found to positively influence perceived ease of use and perceived usefulness, while indirectly predicting behavioural intention. While prior experience did not affect perceived ease of use, it influenced perceived usefulness. Perceived ease of use influenced perceived usefulness, and both positively impacted behavioural intention. Most importantly, the roles of perceived ease of use and perceived usefulness as mediators have been confirmed in the context of this study.

The scope and model of this study address the importance of individual differences. The R^2 value of the model is 0.615, where factors explained 61.5 % of behavioural intention to use e-learning systems. Thus, approximately 39 % of variances were not explained. Future studies could consider the role of other factors such as system, environment, and expectation in behavioural intention to use e-learning in the workplace. Furthermore, this study focused on the behavioural intention to use e-learning in organizations. Future studies may extend this model to assess the effectiveness of an e-learning system after usage. This study targets engineers of manufacturing organizations in Malaysia. Future studies could collect data from other industries and countries or regions to explore various contexts.

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Faculty and Student Technology Use to Enhance Student Learning

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Abstract

Scholarly research has indicated that technology adoption to facilitate blended learning promotes the academic success of many different types of students and improves the quality of existing educational offerings. To understand how technology enhances learning, surveys queried the faculty and students of a statewide community college system. The results indicated widespread technology use among the faculty and students. The faculty survey revealed details of technology tools employed and the motivations for their use or discontinued use. Details regarding faculty use of learning management systems, textbooks, and other media characterized the current technology adoption climate. The student survey collected information about students' perceptions of how technology influenced their learning, their preferences for specific technology tools, and their student progress. Ninety-three percent of student respondents indicated that technology enhanced their learning. Alignment between the faculty use and student preference for technology tools suggested that students are actively engaged in the technology resources used by faculty to enhance learning. Students described how technology facilitated multimodal learning. They also noted that technology increased communication, access, and inclusion in learning. Successful technology use and integration, accompanied by ongoing scholarly debate and monitoring, has the potential to provide more access, promote learning outcomes, and preserve the investment of technology for the institution. The surveys employed here, when used semi-annually, may provide a low-cost model for technology integration monitoring and evaluation. The responses to the surveys also have the potential to provide technology use and integration data that informs strategic planning processes and institutional learning outcome development.

Keywords: educational technology, higher education, blended learning, technology integration

Introduction

Scholarly research has indicated that technology adoption promotes the academic success of diverse students and improves the quality of existing educational offerings (Allen & Seaman, 2013; Courts & Tucker, 2012; Lewis, Fretwell, Ryan, & Parham, 2013; Lertwanasiriwan, 2010; Simkins, 2002; Zucker & Light, 2009). Technology facilitates a blended learning environment in which teaching presence, as well as social and cognitive development, are enhanced (Garrison, 2017). However, technology integration requires appropriate faculty support and institutional support to promote learning gains (Mbati & Minnaar, 2015; Quillerou, 2011). The long-term goal of this research project is to enhance educational technology integration to increase student learning within their disciplines, and for both faculty and students to increase technology literacy skills required for success in the 21st century workplace. The general problem is that the acquisition of institutional technology is an administrative process, but the implementation of technology is a process that unfolds in variable classroom environments. As a faculty, we rarely hear why or how the technology adopted is chosen, even though we live the outcomes. The specific problem is the absence of monitoring protocols to track technology integration by faculty and subsequent learning outcomes for students.

The goal of this observational research was to provide a picture of how students and faculty interact with the technology available. Since there was no coordinated effort for technology integration and monitoring across the campuses of this rural community college, the complementary surveys released to the faculty and students collected technical and perceptive data about how the technology tools were employed to enhance learning. No student learning assessments accompanied the survey data collection, and no experimental conditions were established before data collection. The qualitative data collected here explored the enhancement of learning with technology use. Quillerou (2011) used similar methods to investigate whether students used the technology tools available in their learning environments.

Learning is the acquisition of knowledge. In the context of this study, if faculty or students perceived that a technology tool enhanced learning, the perception was interpreted as a positive indication of learning. Lancaster and Lundberg (2019) employed similar student-identified learning gain metrics to explore correlations between faculty behavior and student learning gains. From a theoretical perspective, the willingness of adult learners to use technology must be self-motivated for practical reasons. According to theories of andragogy, both self-motivation and the practicality of the subject matter and its real-world context are important parameters for adult learning (Knowles, Holton, & Swanson, 2011; Merrill, 2002). Therefore, students' perceptions of how technology enhances their own learning is a valid data point in the monitoring of technology integration in the learning environment.

The survey results presented here describe the technology adoption climate among the faculty and students of a multi-district, rural community college. These results describe the parameters of technology use at the college. The results also described student perceptions of the value of this technology adoption to their learning experience. Administrators may use these results to characterize the current use value of technology the organization already supports. These results may also provide insight regarding professional development opportunities for faculty to promote increased use of educational technologies, with the goal of technology integration over time. Finally, these results may identify gaps between student perceptions of and faculty preferences for educational technology use.

Use of Technology for Learning

The goal of education technology use is to enhance learning. Scholars have described a number of productive educational advancements facilitated by technology adoption and blended learning (Garrison, 2017; Laurillard, 2013). Educational technology facilitates learning by enriching the course content with multimodal resources that provide opportunities for students to engage with the course content in different ways (Laurillard, 2013; Simkins, 2002). Mathematics education has seen a productive shift from didactic instruction to student-centered, constructivist approaches (Abdulwahed, Jaworski, & Crawford, 2012) and computer-assisted instruction (Potocka, 2010). Technology has transformed language learning by allowing for programmed instruction and self-paced learning (Butler-Pascoe, 2011). Participants have gained knowledge from online self-learning modules (Crall et al., 2010; Gagnon et al., 2015). Instructional video training for pediatric health care professionals (Cheng, Lang, Starr, Pusic, & Cook, 2014) and nurses (Serna et al., 2016), as well as citizen scientists (Crall et al., 2010; Gaddis, 2018) have increased their knowledge and procedural performance. Participants have been more ready to engage in self-directed learning after an online training experience (Gagnon et al., 2015). For students who are working adults, parents, and for those who have encountered other barriers that prevented traditional school attendance, asynchronous instruction has increased access, allowing for a more flexible learning schedule (Johnson, Becker, Estrada, & Freeman, 2014; Yamagata-Lynch, 2014).

Technology Adoption Versus Technology Integration

The use of technology in numerous educational settings is well-documented, but technology adoption and technology integration are not the same phenomenon. Technology adoption concerns the application and ease of technology use, while technology integration concerns the fundamental integration of technology into the organization's educational philosophy, planning, and implementation (Keengwe, Onchwari, & Onchwari, 2009; Mbati & Minnaar, 2015; Russell, 2014). A precursor to technology integration is the holistic acceptance of technology use as both an educational tool and a learning outcome (Courts & Tucker, 2012). Technology adoption and integration are challenging concepts for some educators because they imply that the traditional educational framework is no longer the only effective means to educate students (Johnson, Wisniewski, Kuhlemeyer, Isaacs, & Kryzkowski, 2012).

Faculty may be encouraged to use technology in the classroom, but an administration's failure to explain the educational benefits of its use leaves faculty without solid evidence for its efficacy. Professional development may remedy this outcome by building a learning community among the faculty in which they can share best practices and experiences (Johnson et al., 2012). The technological competencies of faculty remains a consistent scholarly inquiry since the generational constellation of students and faculty is an ever-changing phenomenon (Ajjan & Hartshorne, 2008; Allen, Seaman, Poulin, & Straut, 2016; Moule, Ward, & Lockyer, 2011; Roney, Westrick, Acri, Aronson, & Rebeschi, 2017).

When technology integration is achieved, it expands the technological knowledge of the faculty and students together, thereby strengthening the 21st century skills of both groups. The research described here provides a snapshot of technology adoption by faculty and students, upon which technology integration efforts can grow. Studies exist that assess various characteristics of the technology users and their self-efficacy (Roney et al., 2017). The goal of this investigation was to instill a spirit of monitoring and self-assessment to the technology integration process itself by keeping a pulse on the perceptions and practices of faculty and students regarding technology use over time.

Case Study: Colorado Mountain College

Colorado Mountain College (CMC) is a rural, multi-district community college system with 11 campuses in the intermountain region of Colorado, serving over 20,000 students in an area spanning 12,000 square miles ("Colorado Mountain College: CMC Facts," 2016). Colorado Mountain College ranks in the top 13% of community colleges in the United States, offers five bachelor's degrees, and is recognized as the community college that offers the third-most affordable bachelor's degrees in the United States. Colorado Mountain College is supported by property taxes, governed by a Board of Trustees, and accredited by the Higher Learning Commission ("Colorado Mountain College: Snapshot," 2016). The strategic plan for Colorado Mountain College includes five goals: (a) student success, (b) teaching and learning, (c) access, (d) community and economic development, and (e) organizational effectiveness ("Colorado Mountain College, 2014). The use of technology addresses two of these goals, namely student success, and teaching and learning. According to the strategic plan, CMC will "promote student success with relevant student support services" and will "provide excellent learning opportunities" by improving "the quality of existing educational offerings" (Colorado Mountain College, 2014).

Technology integration has the potential to meet these strategic goals. The research presented here provides a snapshot of current technology use and student perception of its use. Both are measures that may be used to evaluate strategic goal attainment. Colorado Mountain College is a leader in innovation; however, tracking and analyzing the specific technology-based learning innovations employed by faculty is challenging due to the multiple campus design of the college and the sheer volume of instructors teaching for the college.

Methods

Two surveys investigated technology use by CMC faculty. One survey queried the faculty (Appendix A) and the other queried the students (Appendix B). Both were disseminated by campus e-mail servers as well as posted on the organizational internal Web portal called Basecamp. The response period was one month long. The intention was for this survey to be offered semi-annually to collect longitudinal data about the technology adoption and integration process at CMC. These are the results of the pilot release of the study.

Results

The faculty survey included a series of questions that collected information about faculty use of educational technology and teaching experience. The student survey collected information about students' perceptions of how technology influenced their learning, their preferences for specific technology tools, and their student progress. Both surveys included closed response questions for which respondents could select multiple responses if appropriate. These questions also included an opportunity to provide a written response if the options presented by the survey did not characterize the respondent. This was an important design feature because many of the questions provided a common list of technology tools, but it was possible that faculty used tools beyond those choice options. The student survey also included an open-ended question to capture the authentic student responses of how technology enhanced or did not enhance their learning. In the context of this study, a technology tool was defined as a digital resource that was used to enhance the classroom learning experience.

Faculty Survey Results

The survey was responded to by 104 faculty members, of which 63% were adjunct faculty, and 37% were full-time faculty. This mirrored the college-wide instructional profile; 71% of courses were taught by adjunct faculty. Respondents quantified their experience in higher education. The majority of faculty (65%) had 10 or more years of experience. The remaining respondents had six to nine years (18%), three to five years (13%), and zero to two years (4%) of experience (Figure 1). These data indicated that the faculty had significant experience teaching in higher education.

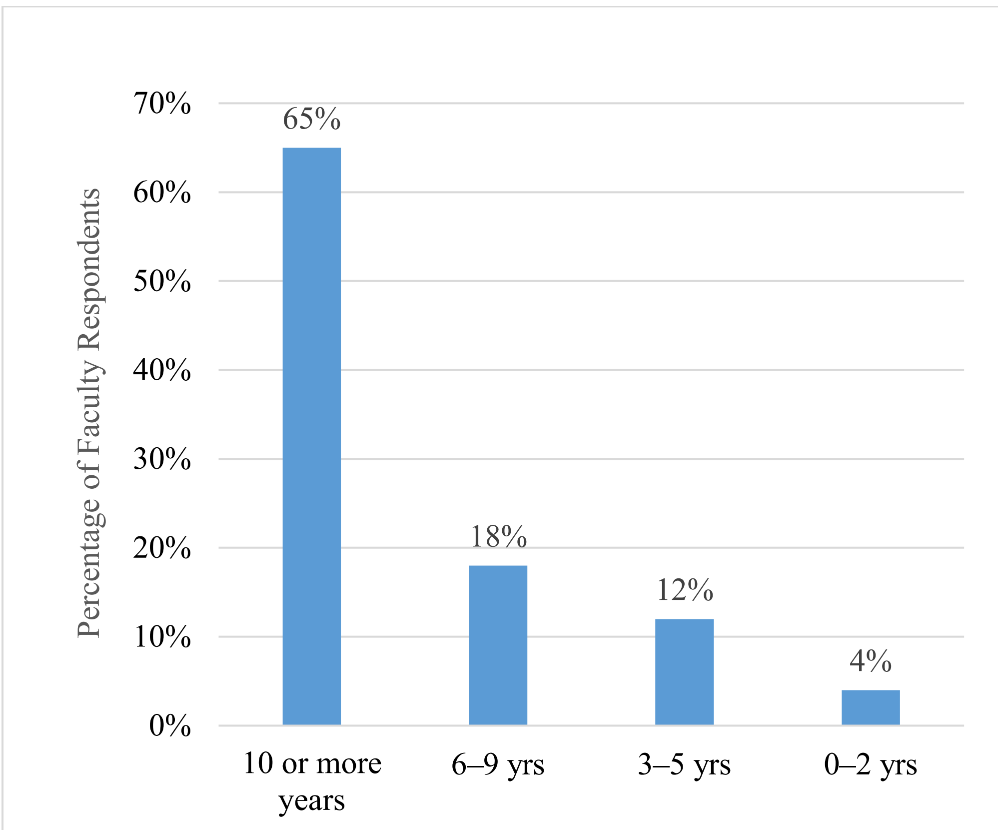

Figure 1. Years of teaching experience.

Several questions queried faculty use and production of technology tools. When asked what technology tools faculty use, their responses were well-aligned to the student responses. As illustrated in Figure 2, faculty reported using Websites (87%), instructional videos (72%), slide presentations (61%), wiki pages (17%), SoftChalk lessons (12%), and Google communities (12%). Other tools used with lesser frequency included (a) blogs, (b) LinkedIn groups, and (c) Facebook groups. Only one respondent noted using a

Twitter feed. Among the open responses, (a) YouTube, (b) Kahn Academy, (c) GoToMeeting, (d) Kahoot, (e) Camtasia, and (f) 3D and virtual classrooms were written in by faculty. The technology tools chosen for investigation were the tools freely available and/or promoted in faculty professional development offerings. The majority of faculty used up to five technology tools per semester, but not more.

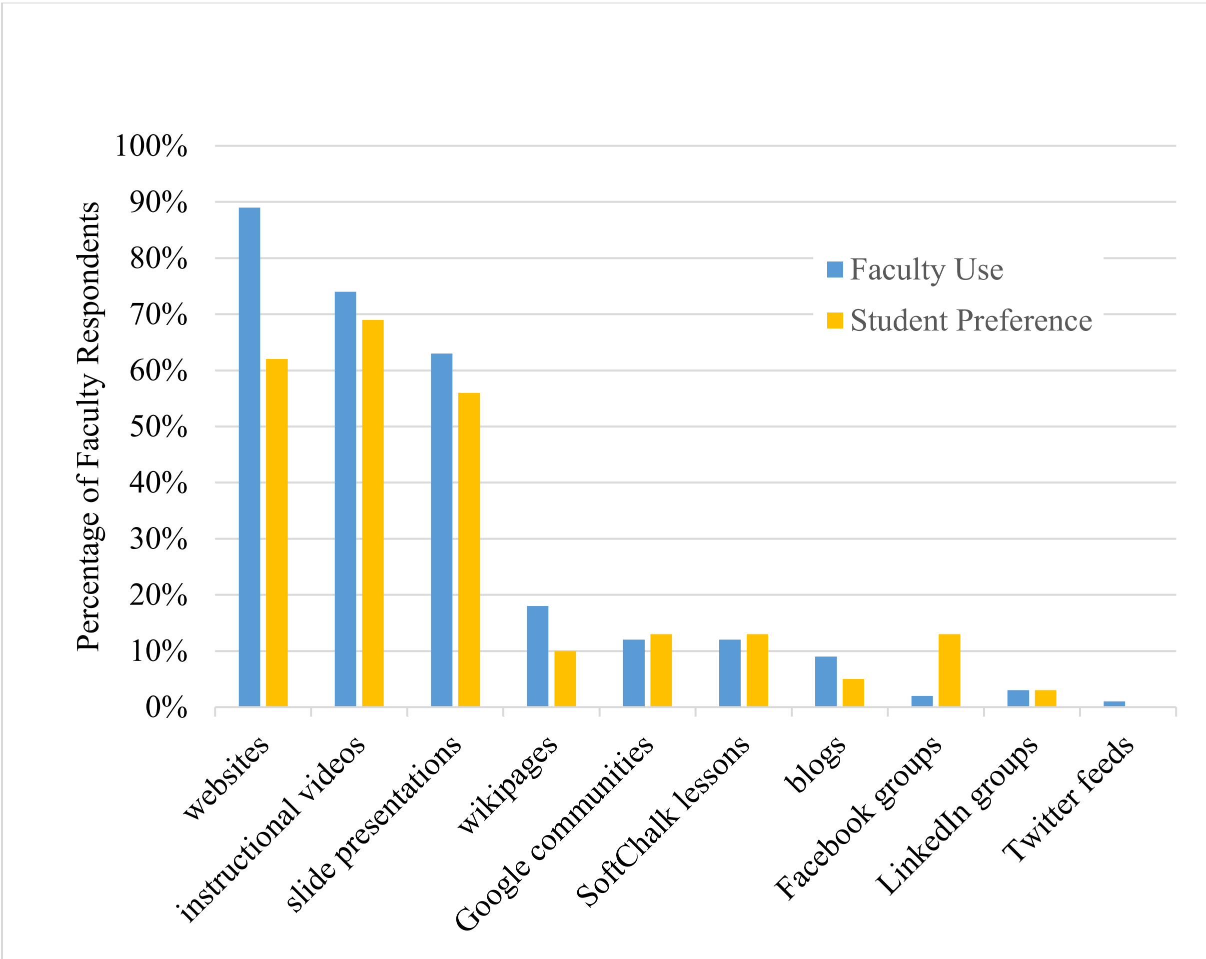

Figure 2. Faculty use and student preferences for technology tools.

To ascertain why faculty members stopped using a technology tool, a survey question offered likely stumbling blocks to technology adoption as choices. The most popular responses included too time-consuming to set-up (57%), not an effective learning tool according to faculty (49%), hard to set up according to students (35%), too difficult to integrate into the learning management system (LMS; 29%), and too costly (8%).

All faculty responded regarding their own production of technology tools. Faculty produced their own slide presentations (81%), instructional videos and/or podcasts (54%), Websites (43%), Web conferences (30%), SoftChalk lessons (18%), and wiki pages (15%). Other tools produced by faculty included (a) blogs, (b) Google communities, (c) Facebook groups, and (d) LinkedIn groups. Faculty wrote in responses to indicate they used (a) 3D and virtual reality environments, (b) Instagram, and (c) VoiceThread. Of all the faculty respondents, 13% never produced a technology tool (see Figure 3). These data suggested that faculty were authoring their own instructional resources in addition to employing the technology itself. This is evidence for technology integration.

These technology tool production patterns were similar to faculty technology tool use patterns but there were some interesting discrepancies to note. The tools used by the majority of faculty respondents included Websites, instructional videos, and slide presentations. The percentages of faculty that produced Websites (43%) and instructional videos (53%) was less than the percentage of faculty that used each tool (Figures 2 and 3). However, in the case of slide presentations, 80% of the faculty produced slide presentations, but only 61% reported using them. Perhaps slide presentations are something all faculty have made at some point but in the age of blended learning, they have found more engaging resources. This is purely speculative since no open response questions queried faculty motivations for their evolving choices. Including open response questions in the faculty survey would have enhanced interpretation of these data.

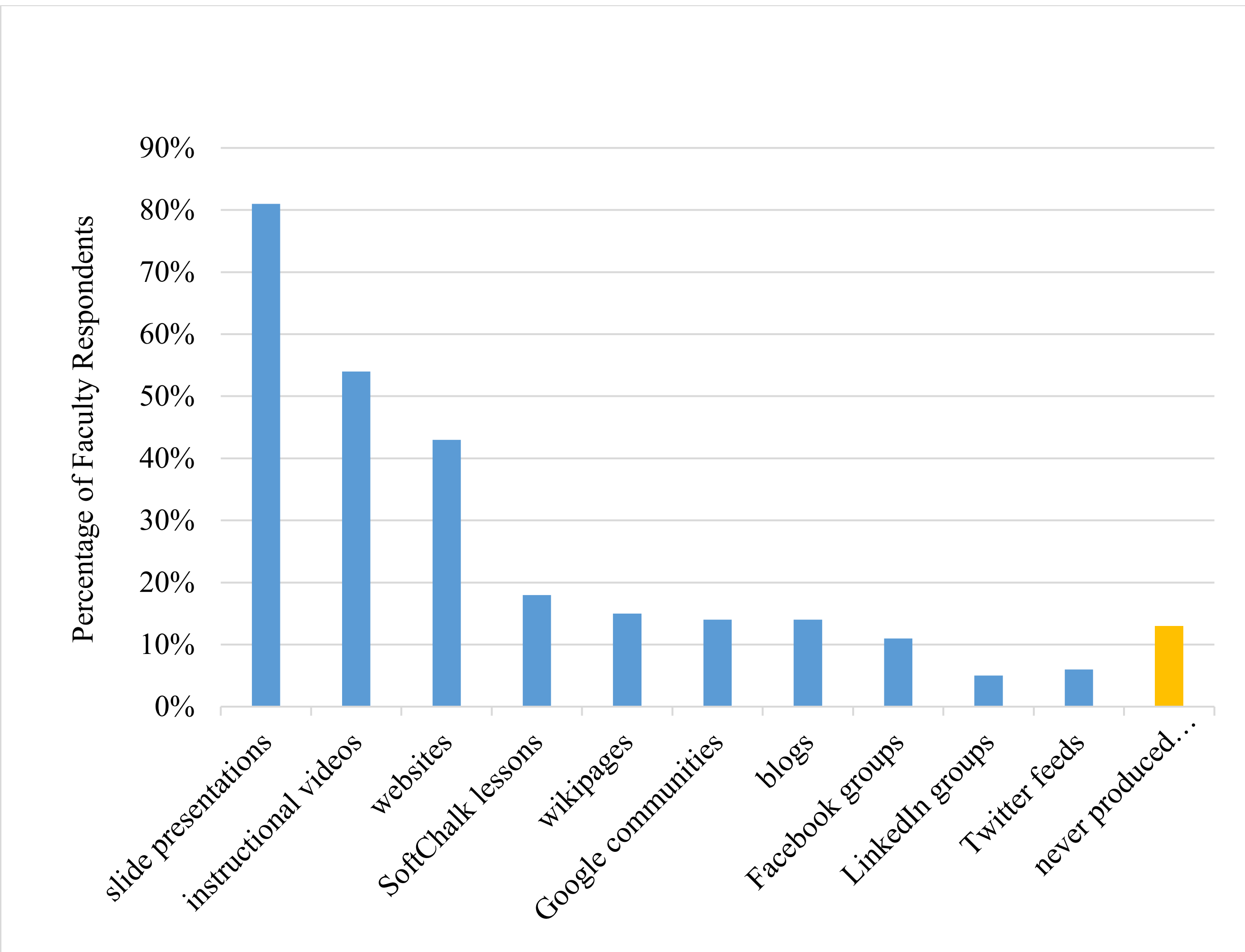

Figure 3. Types of technology tools faculty produced.

When faculty respondents produced media, 73% published these resources to the LMS only, 25% published them in the LMS and on the Internet, and 11% published them on the internet. It will be interesting to see how this trend shifts over time given the movement for open source course media. An Internet search with the limitations site:.edu returns only Web pages published by academic institutions and their affiliates, including faculty. This is an open source treasure trove of instructional materials created by faculty for their students. Additional open response questions in the faculty survey would have strengthened interpretation by offering insights into the motivations behind faculty behaviors regarding publishing their technology tools.

Faculty respondents learned how to use a technology tool by teaching themselves using training resources proprietary to the tool (70%), by taking CMC professional development workshops (60%), by learning from a colleague (51%), by watching videos or tutorials produced by other users (48%), or by taking some other college or university's professional development opportunities (32%). Faculty also wrote in that they were self-taught, just figured it out, or used trial-and-error to learn how to use technology tools.

Faculty apparently learned about the use of technology when they participated in professional development courses. For example, faculty produced and used SoftChalk more than any other technology tools aside from instructional videos, Websites, and slide presentations. The CMC Office of Innovations offered an institutional license and workshops on SoftChalk at the time of the survey. While this study did not connect the number of respondents who participated in professional development to the number of respondents who reported producing these technology tools, it is a reasonable assumption that the high use of this technology tool is related to professional development opportunities. Adding survey questions that identified professional development participation would provide valuable information about the efficacy of these programs. All faculty respondents used Canvas, the LMS used by Colorado Mountain College. Respondents also used Blackboard (76%), D2L/Brightspace (17%), Moodle (17%), Pearson eCollege (9%), and Google Classroom (8%). Respondents wrote in responses to indicate that they used (a) Sakai, (b) Schoology, (c) Angel, (d) Vista, (e) WebCT, and (f) MacMillan LaunchPad (see Figure 4). The college began using Canvas in 2012. The previous LMS was Blackboard. The survey choices were (a) Canvas, (b) Blackboard, (c) D2L/Brightspace, (d) Pearson eCollege, (e) Moodle, and (f) Google classroom. These LMSs were chosen because each were used by Colorado institutions of higher education or were free to use. This question had value in predicting the potential ease with which faculty might adopt a new LMS. However, in retrospect, it did not lend itself to the goal of understanding how technology enhances learning because students experience only the LMS that the institution is currently using when they are enrolled.

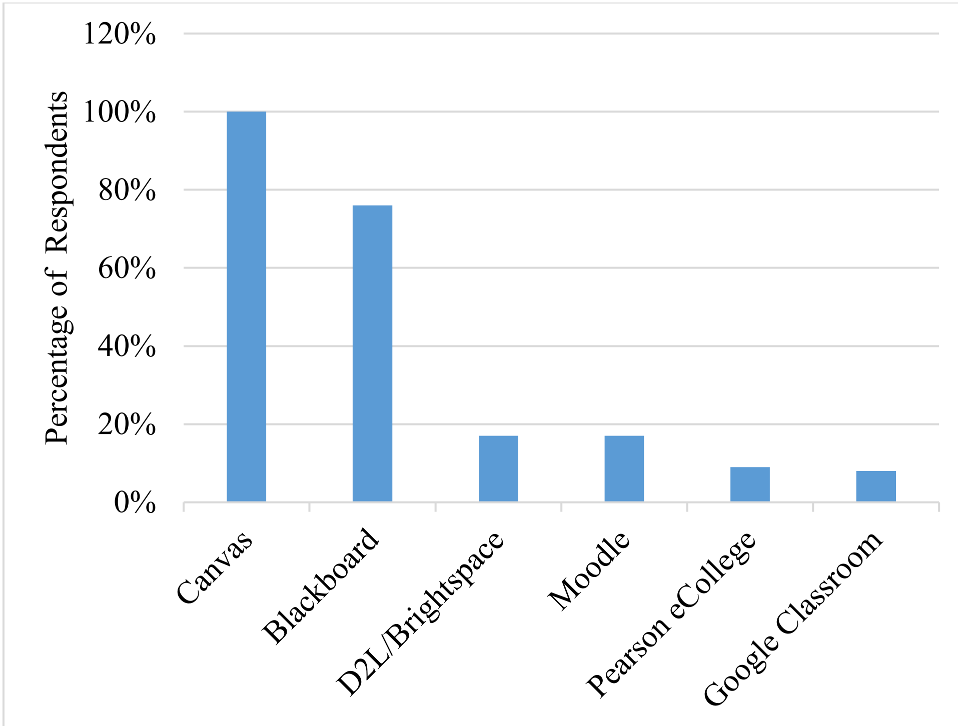

Figure 4. Learning management systems used by faculty.

Regarding the use of the LMS in the classroom, of the instructors who taught for six or more years, 83% used the LMS in the classroom, while only 31% of instructors who taught for up to five years did so. It is possible that using the LMS is a skill one develops after gaining confidence with the practice of teaching itself. The use of open response questions might have elucidated these motivational factors. As shown in Figure 5, faculty respondents used the LMS to manage the gradebook (87%), for assignment submission (82%), to curate documents (68%), to administer tests and quizzes (66%), and to run discussions (61%). In addition to the survey-prompted uses of the LMS, faculty wrote in that they used the LMS to identify goals and objectives and allow for student choice in learning activity. Faculty noted that they used the LMS for (a) announcements, (b) student communication, (c) attendance, (d) posting schedules, syllabi, and class notes, and (e) managing online critique.

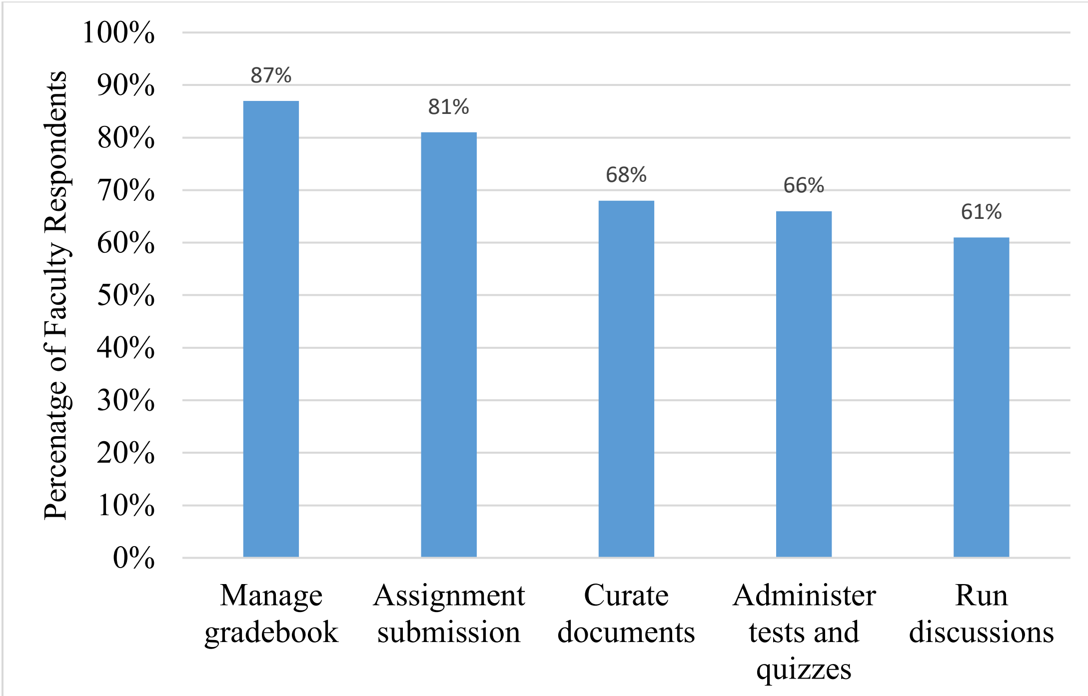

Figure 5. Ways faculty used the learning management systems.

A series of survey questions queried the use of electronic textbooks. Twenty-four percent of faculty used digital textbooks and 24% did not use a textbook at all. One of the great advancements in textbook publishing includes the availability of digital resources that support the textbook. Among faculty who used a textbook, some also used slide presentations (50%), instructional videos (49%), publisher test banks (46%), lecture outlines (28%), adaptive study programs (14%), and virtual labs (9%) provided by the textbook publisher.

Student Survey Results

The student survey probed student perceptions of instructor technology use in the context of their learning and academic progress. Fifty-seven students responded to the survey. Respondents were freshman students (31%), sophomores (21%), juniors (28%), and seniors (21%). The majority of respondents had attended CMC for one to three semesters at the time of the survey. To ascertain the environment in which students experienced technology integration, respondents identified their mode of learning. Sixty-five percent of respondents took online classes, and 80% took face-to-face courses. Thirty-nine percent of respondents had completed one to three online classes to date, 34% had never taken an online course, 12% had completed four to six online courses, and 7% had completed either seven to nine online courses, or 10 or more online courses, to date.

In this study, learning was confirmed by student survey responses. The student survey contained one open-ended question. “How does technology enhance your learning? Please describe here or explain why it does not enhance your learning.” The responses to this question provided an authentic and qualitative perspective of student perceptions of how technology enhances their learning. Additional questions explored the technical details of technology use and the students’ academic progress.

Ninety-three percent of students indicated that technology enhanced their learning (see Figure 6). Respondents noted that technology facilitated self-paced learning and "made going to school more time manageable." Technology "increases interaction with the subject matter," is "available anywhere," and makes "it easier to do research." Other students added the following responses to characterize how technology enhances their learning. "Technology is just part of the world we live in and how we access information and learning. It makes some processes more efficient." "Technology is needed for everyday activities. One cannot conduct business or communication without it."

Several students used the terms "information access" or "access to information" when describing how technology enhanced their learning. One student remarked that "technology helps me to learn a great deal. I love that after a few short minutes I can find a variety of information, studies, blogs, and articles online." "Anything you need to know is right on the Internet." Although information access was not a direct measure of learning, some students interpreted technology's enhancements of their learning as it related to access. At CMC, the students' perception of access enhancement is evidence that technology is facilitating strategic goal attainment for the institution.

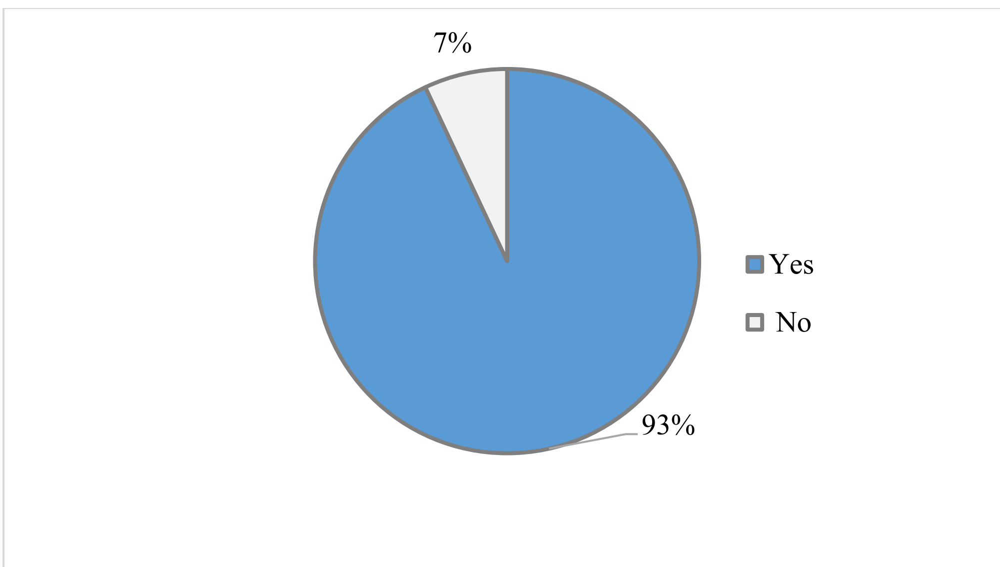

Figure 6. Student responses when asked if they think technology enhances their learning.

Several students discussed how technology allowed for more communication among students and with the instructor, which enhanced their learning. One student described lecture-based instruction as multimodal and noted that it accommodated his or her learning. Another student wrote that technology

> provides an additional access point to instructors and fellow students. That extra communication opportunity is not available without technology tools. Also, better types of content (video, audio, interactive tools, etc.) are available via some tech solutions, adding to the ability for students to learn the material via these non-text methods.

When asked what their favorite technology tools were, students responded with instructional videos (66%), Websites (59%), and slide presentations (54%) which faculty also noted they used with regularity. These comments confirm scholarly research that indicated blended learning facilitates social and cognitive development (Garrison, 2017). These data also indicated that there was a connection between resource access (e.g., learning materials, instructor) and the perception of learning enhancement. Lancaster and Lundberg (2019) drew similar conclusions when they queried faculty and students to explore correlations between faculty behaviors and students' self-perceptions of learning.

Although not the majority opinion, one student remarked that she or he learns "best by the old school lecturing at a chalkboard where the instructor lectures to the notes that he or she writes on the board. In this way, I hear the lecture, see the lecture being written and write the lecture myself, reinforcing the materials through three different mediums at one time."

Discussion and Considerations for Future Research

Regarding the representativeness of the sample, the majority of respondents were adjunct faculty. The response rate for full-time faculty was approximately 30%. Seventy-one percent of courses at CMC were taught by adjuncts. Sixty-three percent of survey respondents were adjuncts. These percentages were well aligned and therefore likely represented the Colorado Mountain College teaching population with some degree of accuracy. The exact number of adjuncts across all 11 campuses was unknown to the researcher due to the dynamic and ever-changing number of adjuncts at any one time. Furthermore, there were fewer adjunct instructors working in the summer semester, so the respondent percentage rate of adjuncts might have been affected by the summer delivery of this survey.

While there were no open-ended questions in the faculty survey, several questions in the faculty survey contained an open field so respondents could write their own answer if it did not align with the multiple-choice options. This afforded a glimpse of technology tools in use that were not supported directly by the institution. In the on-going monitoring of technology use, institutions might use this open field choice for early detection of new technology tools on the horizon that are favored by faculty and/or students and to which resources may be lent in future budgets.

In future iterations of the faculty survey, open-ended questions might elucidate the motivational climate for faculty behaviors reported. For example, questions investigating the use, production, and publication of technology tools by faculty was not accompanied by open-ended questions that would have explained why faculty use, do not use, produce, and/or publish technology tools. One closed-ended question asked why faculty stopped using a technology tool, but no similar questions related motivation and context to other technology use parameters.

There were structural flaws in the survey design. It was difficult to draw comparisons between student and faculty responses because the questions in the student and faculty surveys were not paired. If they were, a chi-squared contingency table could be established to compare technology tool choices to a general faculty or student identity. Additionally, questions that ask respondents to check all that apply should be accompanied by paired questions that select a top choice. With these two pieces of information, a chi-squared analysis could be done.

Student preferences for technology tools were closely aligned with professors' efforts to integrate technology tools. This begs the question: do students like the technology tools professors are using, or is it that professors are responsive to what students want? For example, no students liked using Twitter in an educational context, but only one faculty member reported using Twitter in an educational context. Understanding the causal relationships here would provide valuable information regarding technology trends in higher education.

Conclusions

In this investigation, faculty and student surveys employed at a multi-campus, rural community college revealed the current technology adoption climate, including faculty and student technology tool preferences and perceptions of their own learning gains. The faculty surveys described faculty use, production, and publication of technology tools in addition to details regarding their teaching experience. The student surveys revealed students' perceptions of the effect of technology on their learning and details regarding their academic progress. The overwhelming sentiment from students was that technology enhanced their learning (93%). This perceptive gauge was not accompanied by experimental methods that confirmed or refuted the student self-reported perceptions of technology's effect on their learning. Nonetheless, these data suggested that the organization's efforts to offer and support educational technology were valuable to the student population.

Faculty and students tended to prefer the same technology tools, including instructional videos, websites, and slide presentations. Faculty apparently worked to both produce and provide these resources to their students. While some tools were too challenging or ineffective to continue using, faculty employed, on average, five technology tools each semester. Faculty with more experience were more likely to employ a blended approach in which they used the LMS in the classroom. There were no apparent differences in the behaviors of part-time and full-time faculty, but these conclusions could not be made with statistical analysis due to the survey design. The majority of faculty respondents had 10 or more years of teaching experience, thereby indicating that these data reflect the behaviors of a seasoned faculty who have had time to use and reflect on the technology climate in their professional environments. The student population represented students in every class year, indicating the validity in generalizing these conclusions to the entire student population.

The coordinated analysis of technology adoption and integration within teaching and learning practices is an opportunity for institutions of higher education. The shortcomings of these data are informative. Across 11 campuses, technology integration is one of many topics to consider on an institution-wide level. Nonetheless, there is a significant institutional investment involved in providing technology and staff to support it. Successful technology use and integration that is accompanied by ongoing scholarly debate and monitoring has the potential to provide more access, promote learning outcomes, measure strategic institutional goals, and protect the institutional investment in technology. Since new technologies tools are always becoming available, the key to sustainable technology integration is a community-wide commitment to its effectiveness and continuous improvement.

Technology integration is a continuous process, and its success is assured through monitoring and program evaluation. Prior to this investigation, there was no evidence that ongoing technology integration monitoring practices existed. The surveys employed here, when used semi-annually, may provide a low-cost model for the monitoring of technology integration. The surveys also have the potential to provide technology use and integration data that may inform strategic planning processes and institutional learning outcome development.

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Appendix A

Faculty Survey

1. What learning management systems (LMS) have you used? [check all that apply]
   a. Canvas
   b. Blackboard
   c. D2L/Brightspace
   d. Pearson eCollege
   e. Moodle
   f. Google classroom
   g. Other, please name here:
2. A **technology tool** is a digital resource that you use to enhance your teaching. How many technology tools do you use in a single class per semester, not including the LMS?
   a. 1
   b. 2–5
   c. 6–8
   d. 9–10
3. Do you use the LMS when you teach in the classroom?
   a. Yes
   b. No
4. If you use the LMS when you teach in the classroom, how do you use it? [check all that apply]
   a. To curate documents
   b. To run discussions
   c. To administer tests and quizzes
   d. For assignment submission
   e. To manage the gradebook
   f. Other, please describe:
5. Do you use an electronic textbook?
   a. Yes
   b. No
6. If you use a textbook (digital or paper), which of the following do you also use? These are often available on the publisher's Website. [check all that apply]
   a. I don't use a textbook
   b. Testbanks
   c. Adaptive study program
   d. Lecture outlines
   e. Slide presentations
   f. Instructional videos
   g. Virtual labs
7. Which of the following external technology tools do you use on a regular basis, or plan to use on a regular basis (even though at the time of survey you may have used it only once to try it out)? If you used a tool only once and chose not to use it again, do not check it here. [check all that apply]

   a. Instructional videos/ podcasts
   b. Slide presentations
   c. SoftChalk lessons
   d. Blogs
   e. Websites
   f. Wiki pages
   g. Twitter feeds
   h. Google communities
   i. LinkedIn groups
   j. Facebook groups
   k. Other, please name here:

8. If you stopped using a technology tool, why did you stop? [check all that apply]
   a. Too difficult to integrate into the LMS
   b. Was not an effective learning tool, in your opinion
   c. Was not an effective learning tool, as determined by your students
   d. Cost too much money
   e. Too time-consuming to set up
   f. Other, please describe:
9. What kinds of technology tools have you produced at least once? [check all that apply]
   a. Instructional videos/podcasts
   b. Slide presentations
   c. SoftChalk lessons
   d. Web conferencing
   e. Blogs
   f. Websites
   g. Wiki pages
   h. Twitter feeds
   i. Google communities
   j. LinkedIn groups
   k. Facebook groups
   l. I have never produced a technology tool
   m. Other, please name here:
10. How did you learn to use a technology tool? [check all that apply]
   a. CMC professional development
   b. Other college or university professional development
   c. Self-taught from publisher resources
   d. Internet videos or tutorials produced by a user, not the publisher
   e. A colleague
   f. Other, please describe:
11. Do you publish your media? [check all that apply]
   a. In the LMS
   b. On the Web
   c. In the LMS and on the Web

d. Other, please describe:

12. How many years have you been teaching in higher education?
    a. 0–2 years
    b. 3–5 years
    c. 6–9 years
    d. 10 or more years
13. How many years have you been teaching at Colorado Mountain College?
    a. 0–2 years
    b. 3–5 years
    c. 6–9 years
    d. 10 or more years
14. Approximately how many courses do you teach per fall and spring semesters at CMC? [check all that apply]
    a. not always teaching every semester
    b. 1 non-lab course
    c. 2–3 non-lab courses
    d. 1 lab course
    e. 2–3 lab courses
15. Approximately how many courses do you teach per fall and spring semester at CMC and any other college or university combined?
    a. Not always teaching every semester
    b. 1 course
    c. 2–4 courses
    d. 5–7 courses
    e. 8–10 courses
    f. More than 10 courses
16. How many years have you taught online courses?
    a. 0–2 years
    b. 3–5 years
    c. 6–9 years
    d. 10 or more years
17. Are you an adjunct instructor or a full-time instructor?
    a. Adjunct
    b. Full-time

Thank you for your participation.

Appendix B

Student Survey

1. A **technology tool** is a digital resource that instructors use to facilitate your learning. What technology tools are your favorites? [check all that apply]
    a. Instructional videos/podcasts
    b. Slide presentations
    c. SoftChalk lessons
    d. Blogs
    e. Websites
    f. Wiki pages
    g. Twitter feeds
    h. Google communities
    i. LinkedIn groups
    j. Facebook groups
    k. Other, please name here:
2. Do you think technology enhances your learning?
    a. Yes
    b. No
3. How does technology enhance your learning? Please describe here or explain why it does not enhance your learning.
    [open response]
4. What is your class year?
    a. Freshman
    b. Sophomore
    c. Junior
    d. Senior
5. How many semesters have you been enrolled at CMC?
    a. 1–3 semesters
    b. 4–6 semesters
    c. 7–9 semesters
    d. 10–12 semesters
    e. More than 12 semesters
6. Do you take courses online?
    a. Yes
    b. No
7. Do you take courses in the physical classroom (i.e., face-to-face courses)?
    a. Yes
    b. No
8. How many online courses have you taken?
    a. 0 courses
    b. 1–3 courses

   c. 4–6 courses
   d. 7–9 courses
   e. 10 or more courses
9. How many face-to-face courses have you taken?
   a. 0 courses
   b. 1–3 courses
   c. 4–6 courses
   d. 7–9 courses
   e. 10 or more courses
10. How many hybrid courses have you taken? Hybrid courses have either the lab or lecture component online and the other component face-to-face.
   a. 0 courses
   b. 1–3 courses
   c. 4–6 courses
   d. 7–9 courses
   e. 10 or more courses
11. How many interactive video system (IVS) courses have you taken?
   a. 0 courses
   b. 1–3 courses
   c. 4–6 courses
   d. 7–9 courses
   e. 10 or more courses
12. How many non-credit courses have you taken in total?
   a. 0 courses
   b. 1–3 courses
   c. 4–6 courses
   d. 7–9 courses
   e. 10 or more courses
13. How many credit courses have you taken?
   a. 0 courses
   b. 1–3 courses
   c. 4–6 courses
   d. 7–9 courses
   e. 10 or more courses

Thank you for your participation.

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Teachers' Use of Education Dashboards and Professional Growth

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Abstract

Education dashboards are a means to present various stakeholders with information about learners, most commonly regarding the learners' activity in online learning environments. Typically, an education dashboard for teachers will include some type of visual aids that encourage teachers to reflect upon learner behavior patterns and to act in accordance to it. In practice, this tool can assist teachers to make data-driven decisions, thus supporting their professional growth, however, so far, the use of education dashboards by teachers has been greatly understudied. In this research we report on two studies related to the associations between the use of education dashboards by elementary school teachers and the teachers' professional growth. We used the framework defined by the International Society for Technology in Education's (ISTE) Standards for Educators. In the first study, we took a quantitative approach (N=52 teachers), using an online self-report questionnaire, and found that the use of dashboards is positively associated with professional growth in the dimensions of facilitator, analyst, designer, and citizen. In the second study, we took a qualitative approach (N=9 teachers), using semi-structured interviews, to shed light on the mechanisms through which teachers benefit from the use of education dashboards.

Keywords: teachers, education dashboard, professional development, data-driven decision-making, elementary school

Introduction

The use of educational technologies has become mainstream in many teaching and learning settings. Specifically, the use of computing devices and online learning environments by students in grade schools today appear to be the norm in many countries (Allen & Seaman, 2017; Richardson et al., 2013; Wishart, 2017). Whether the online learning component is integrated as part of the school-based activities or as homework assignments (in most cases, it is a combination of both), teachers face the need to deal with hybrid learning spaces, which include the physical classroom and the online learning environment. While teachers are trained for observing (and responding to) what is happening in the physical environment, where students' actions are normally visible and communication with students is primarily spoken, they often lack the means to observe and respond to what is happening under the hood of the virtual environments. Indeed, teaching experience was found to be negatively correlated with teachers' communication self-efficacy and self-directed learning in online teaching (Hung, 2016).

Evidently, in such hybrid learning spaces, teachers face challenges referring to many facets of the teaching profession. In previous studies, we have shown that one-to-one computing programs (where each student has their own portable computer) may affect pedagogical behavior, for example in the ways in which teachers prepare themselves to teach lessons, how they choose to divide the lesson time between different teaching strategies, or how they assess students (Hershkovitz & Karni, 2018; Hershkovitz, Merceron, & Shamaly, 2019).

In that light, it may be useful to think of teachers as decision-makers. Indeed, teachers constantly make decisions – before, during, and after lessons – to better support their students and themselves. Such decisions may include: which content to focus on; how to best engage the students with content; whether to, or how to, partition the classroom into smaller learning units; or how to evaluate a students' learning. In many cases, such decisions are taken based on the teacher's experience and understanding of the situation, and not necessarily on empirical evidence (Annerstedt & Larsson, 2010; Hay & Macdonald, 2008; Vanlommel, Van Gasse, Vanhoof, & Van Petegem, 2017).

However, when teaching in hybrid spaces, teachers could use data about learners that is gathered automatically and continuously. Specifically, many online learning systems log students' activity in three dimensions: The action taker (who?), the action itself (what?), and the action time (when?). Analyzing these data, it is possible to calculate a plethora of measurements of the learning process (Lang, Siemens, Wise, & Gašević, 2017). As the use of such systems has grown world-wide, it has become clear that these data should be made accessible to teachers in a way that is easy to understand and to act upon. One of the most common ways to communicate such data to teachers is via an education dashboard, that is, a display which presents education stakeholders with data-driven information regarding teaching and learning processes. Education dashboards are considered as practical tools for teachers to meet the daily challenges they face and to promote the use of technology as an integral part of their teaching (Rienties, Herodotou, Olney, Schencks, & Boroowa, 2018; Xhakaj, Aleven, & McLaren, 2016; Yoo, Lee, Jo, & Park, 2015).

Indeed, many learning management systems and learning platforms today offer teachers with dashboards that provide them information about various aspects of their students' learning; for example, some popular platforms include: BrainPop (http://www.brainpop.com), Khan Academy (http://khanacademy.org), Google Classroom (http://classroom.google.com), and Canvas (http://www.canvas.net). However, evidence of their use and the impact on teachers' professional development is still inadequate. Recent preliminary findings demonstrate how education dashboard can affect teachers' pedagogical decision-making and improve interactions with their students (Ez-zaouia, Tabard, & Lavoué, 2020; Molenaar & Knoop-van Campen, 2018; Tissenbaum & Slotta, 2019). The current paper aims at bridging this gap. We take a broad perspective on teachers' professional development, in accordance with the understanding that professional development is an ongoing process that crosses a teacher's professional and personal circles and is not limited to institutional training (Collinson et al., 2009; Nabhani & Bahous, 2010). Therefore, we aim at understanding how teachers can benefit from technological tools, not only in their daily work but also in a broader sense of their ongoing professional development, may contribute to a more effective integration of technology into schools and to more effective professional development.

Background

Teachers' Professional Development

Current teacher professional development is a process that starts with a teacher's pre-service training and concludes at the end of the teacher's professional career or at the teacher's retirement, and includes various forms of education, both formal and non-formal (Avidov-Ungar, 2016; Collinson et al., 2009). As such, the term *professional development* refers to various aspects of teaching and to different periods in the teacher's career. Among others, these include the deepening of the teachers' understanding of pedagogies and of the students' learning; the development of responsibility and commitment to the teaching profession; and the ways technology may impact teaching and learning (Darling-Hammond & McLaughlin, 1995; Hargreaves, 2005).

Consequently, there is a plethora of models that describe teachers' professional development. They do not necessarily consider it as a linear, step-wise experience, but rather as an ongoing, dynamic, multi-contextual endeavor that involves multiple circles in which the teacher belongs (e.g., school, professional communities, and home; Ferreira, Ryan, & Tilbury, 2007; Grossi, Oliveira, Barbosa, & Oliveira, 2016; Yurtseven Avci & O'Dwyer, 2016). In recent years, it is agreed, therefore, that teachers' professional development presents a continuum of life-long learning throughout a professional teaching career (Collinson et al., 2009); moreover, it is closely linked to both their professional and personal identity and exists not only as part of institutional training (Nabhani & Bahous, 2010).

Additionally, one should note that current age, a teacher's identity comprises of more than just delivering content during lessons (no matter what pedagogical or technological tools and techniques they use). Danielson's (2011) *Framework for Teaching* details four domains based on which teaching should be assessed; these dimensions—planning and preparation, classroom environment, instruction, and professional responsibility—portray a broad view of the teaching profession. Even more prominently, the *Standards for Educators*, presented by the International Society for Technology in Education (ISTE; 2007), set a general framework that describes seven standards for today's teachers. The standards are:

1. *Learner*: Teachers continually improve their practice by learning from and with others, and explore promising practices that leverage technology to improve student learning;

2. *Leader*: Teachers seek out opportunities to take the lead in order to promote students' learning and their own teaching;

3. *Citizen*: Teachers inspire students to contribute to the digital world positively and to participate in it responsibly;

4. *Collaborator*: Teachers dedicate time to collaborate with colleagues and students, in order to improve their practice, to share ideas, and to solve problems;

5. *Designer*: Teachers design learning activities that are authentic and learner-driven, and that recognize and accommodate learner variability;

6. *Facilitator*: Teachers facilitate learning with technology to support student achievement; and

7. *Analyst*: Teachers understand and use data to drive their instruction and to promote students' learning (Trust, 2018).

We chose this framework to study teachers' professional development because of its broad view, and because it directly refers to the teachers' roles in the digital era.

Education Dashboards for Promoting Data-Driven Decision Making

Data-driven decision making refers to collecting, understanding, and analyzing educational data, and is considered an integral part of a teacher's professional conduct (Mandinach, 2012). Using data for educational decision making is not something new, as teachers have been using grades, students' work, and behavioral data since very early schooling days (Mandinach, 2012; Schifter, 2014). Overall, teachers use such data to evaluate their class and individual students, and also to reflect upon their own teaching (Light et al., 2005; Molenaar & Knoop-van Campen, 2018), and also to communicate with various stakeholders, such as their students or their students' parents, or the school's educational and management teams.

In hybrid learning spaces, the amount of data per student have dramatically increased (Mandinach, 2012), and nowadays, teachers need to handle a wide range of data gathered from various educational technologies (Schifter, 2014; Xhakaj et al., 2016). Additionally, the pressure on them to make accurate decisions keeps on growing (Faria et al., 2014). This has led to an increase in research and development of education dashboard, particularly to support teachers who teach in blended environments (Schwendimann et al., 2017; Yoo et al., 2015).

To put it simply, an education dashboard is a display that presents educational stakeholders with data-driven information (usually visual) regarding teaching and learning processes in such a way that will promote reflection on their behavior patterns and help them to adjust their actions accordingly (Schwendimann et al., 2017; Yoo et al., 2015). Education dashboards could contain various types of information, such as an overview of the course activity, time per tasks, students' skills, misconceptions, test results, social interaction, and students' current and historical progress in the course (Charleer, Klerkx, Duval, De Laet, & Verbert, 2016; Matuk et al., 2016).

Many studies have shown that education dashboards can be used as a decision-making tool that supports teachers in planning their curricula, evaluating the class knowledge level, and the tracking of individual students (Molenaar & Knoop-van Campen, 2018; Schifter, 2014; Xhakaj, Aleven, & McLaren, 2017). Furthermore, it was shown that the use of dashboards had led teachers to better tailor their teaching (in terms of both content and style) to students' needs, to collaborate more effectively with their colleagues, and to reflect upon their own professional conduct and abilities (Light, Wexler, & Heinze, 2005; Schifter, 2014; Schwendimann et al., 2017; Xhakaj et al., 2016). That is, this process may be seen as an integral part of a teacher's continuous professional development. However, evidence regarding the impact of education dashboards on the development of a teacher's skills is still limited (Gillet et al., 2017; Schwendimann et al., 2017), and as such, this will be the focus of our study. In this research, we address the following questions:

1. What are teachers' perceptions of using education dashboards for their own professional development?

2. What insights do teachers gain and what actionable steps do they take from examining the information in education dashboards?

Methodology

Study 1 (Quantitative, Self-Report Questionnaire)

This study was quantitative in nature (N=52), involving teachers' self-report, via an online questionnaire, of their experience using a specific education dashboard (to their choice), doing so through the lens of their professional development (see details under *Instrument* below). We distributed a hyperlink to the online research questionnaire via Facebook, as well as via professional and personal mailing lists. We collected the data during June 2018-January 2019.

Research variables. Background variables included Gender, Age, Teaching Seniority, and Domain of Teaching. Independent variable was Experience with the Education Dashboard; for matters of simplicity, we measured it by two categories: "Starting at the Previous School year [2017/8] for the First Time," or "Started Earlier Than the Previous School Year."

Seven dependent variables are based on the dimensions defined by the International Society for Technology in Education (ISTE) Standards for Educators (Trust, 2018), specifically: Learner, Leader, Citizen, Collaborator, Designer, Facilitator, and Analyst. Each of these variables measures to what extent participants grew on the corresponding dimensions.

Research population. Participants were teachers (N=52, 50 females and 2 males) in public elementary schools acorss Israel who met the inclusion criteria: they used at least one education dashboard as part of their teaching practice during the school year previous to data collection. Participants were aged between 25 to 66 years (M=41.5, SD=8.4), and had 2 to 42 years of teaching experience (M=15.8, SD=8.9). Of the participants, 11 (21%) started using the learning environment to which they referred in the questionnaire during the previous school year (2017/8); 13 participants (25%) started using that learning environment's education dashboard during the previous school year (2017/8). The remaining participants had used the learning environment or the education dashboard for longer. Most of the participants reported using an online learning environment for Mathematics (26, 50%), with less use reported for subjects in Science (5, 10%), Language (6, 12%), Social Sciences (2, 4%), or for multiple topics (13, 25%).

Instrument. The main part of our questionnaire was based on ISTE Standards for Educators (Trust, 2018). These standards are designed around seven themes: Learner, Leader, Citizen, Collaborator, Designer, Facilitator, and Analyst, each explicitly defining a set of actionable, measurable items. For example, under the first theme, Learner, there are three items (1a-1c), the first of which is: "Set professional learning goals to explore and apply pedagogical approaches made possible by technology and reflect on their effectiveness." Overall, there are 24 items.

Based on these Standards and items, we developed 23 self-report items (two items of the Collaborator dimension were merged into one questionnaire item) that directly connect the use of education dashboard to the various themes. For example, based on item 1a from the Standards, we phrased the following questionnaire item: "Using this dashboard assists me in setting professional goals to develop my pedagogical ability." Questionnaire items were phrased as short as possible, while keeping the meaning of the original item. Items were ranked on a 5-point Likert scale (from 1 "Not at All" to 5 "To a Large Extent"). The items were reviewed by a few education experts to make sure they correctly reflected the nature of the original standard; this process had been taken for a few rounds until full agreement was achieved between the experts. Each variable then was calculated based on the mean of its corresponding items. In order to test for reliability, and as we have only a few items for each dimension, we calculated average inter-item correlations instead of using the more common Cronbach's alpha test. We used the non-parametric Spearman's test to get the acceptable values of 0.46-0.79. The full list of items, including the inter-item correlation values, is provided in Table 1.

When filling out the questionnaire, after explaining what we meant by an "education dashboard," participants were asked to mention one online learning environment they used with the education dashboard that they had had experience with, and to refer to this dashboard while responding to the remaining items. We then made sure that the mentioned dashboards were indeed eligible, that is, that they were considered an education dashboard as defined in the literature. Overall, participants had referred to nine different educational systems, which represent most of the certified platforms in use in Israel (approved by the Israeli Ministry of Education), in various disciplines. By referring to multiple types of education dashboards and various disciplines, we allow for an increased variance in our population, which contributes to the generalization of our findings. Additionally, the online questionnaire was used to collect data about the background variables.

Table 1

Research Questionnaire, Based on ISTE Standards for Educations (Study 1)

Variable (mean inter-item Spearman's correlation)	Questionnaire item (Original item in ISTE standards)
Learner (ρ=0.46)	Using this dashboard assists me in setting professional goals to develop my teaching (1a).
	Using this dashboard allows me to take part in various communities that relate to my professional interests (1b).
	I stay current with research and updates regarding the use of dashboards to promote my students' learning (1c).
Leader (ρ=0.71)	I promote the use of dashboards through joint work with education stakeholders within and outside school (2a).
	Using this dashboard assists me address the social and cultural and interpersonal differences among my students (2b).
	For my colleagues I am a model of adopting dashboards for teaching (2c).
Citizen (ρ=0.60)	Using this dashboard contributes to the creation of social responsibility and empathic behavior in my classroom (3a).
	Using this dashboard allows me to establish a learning culture that promotes curiosity and criticism (3b).
	Using this dashboard allows me to mentor my students on how to use learning materials in a safe and effective way (3c).
	Through using this dashboard, I model my students how to manage personal data and data privacy (3d).
Collaborator (ρ=0.61)	As a result of using this dashboard, I collaborate with colleagues to create authentic learning experiences for my students (4a).
	Using this dashboard allows me to collaborate and co-learn with my students about effective uses of technology (4b).
	Using this dashboard allows me to emphasize the cultural diversity in my classroom to students, parents, and colleagues, thereby making them all partners in the learning process (4d).
Designer (ρ=0.79)	Using this dashboard allows me to personalize learning experiences for my students that encourage independent learning (5a).
	Using this dashboard allows me to design learning activities that foster active and deep learning (5b).
	Using this dashboard allows me to apply instructional design principles to promote student engagement and assist their learning (5c).
Facilitator (ρ=0.72)	Using this dashboard allows to foster a culture where students take ownership of their learning, individually and collectively (6a).
	Using this dashboard helps my student to foster learning strategies (6b).
	Using this dashboard allows me to create challenging, innovative learning opportunities for my students (6c).
	Using this dashboard allows me to foster creative discourse about ideas, knowledge, and connections (6d).
	Using this dashboard allows me to provide my students with diverse ways to demonstrate their ability (6a).

Analyst (ρ=0.64)	Using this dashboard allows me to give my students formative and summative assessments (6b).
	Using this dashboard allows me to encourage my students' self-direction by communicating with students, parents and education stakeholders (6c).

Study 2 (Qualitative, Semi-Structured Interviews)

Research tools. In this qualitative study, which was part of a broader study of technology orchestration in the mathematics classroom, we used a semi-structured interview. The design of the interview allowed to deviate from the protocol and capture the natural behavior and insights of the participants. During the interview, we presented to the participating teachers three types of data visualization of students' activity that were presumably taken from an online learning environment for mathematics; the visualizations were fabricated by the research team. These visualizations were a scatter plot, a table, and a bar chart; these types were chosen as they are among the most common information visualizations (Khan & Khan, 2011). The scatterplot presented students' activity, based on the average score (x-axis) and time on tasks (y-axis), where each student was represented as a circle (Figure 1); the table presented detailed information about the activity of each student in 6 dimensions: the number of completed tasks, the average score for a task, the average time for a task, the task with the highest score, the task with the lowest score, and last seen (Figure 2); lastly, the bar chart presented the number of students that master each topic (e.g., decimal fraction, percentage, ratio, scale etc.; Figure 3).

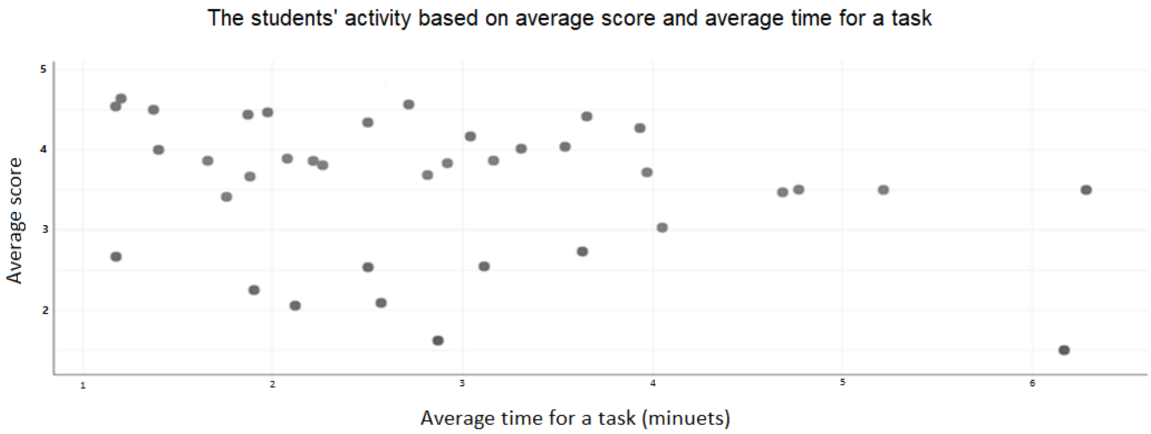

Figure 1. A report of students' activity by various measures.

Student	Completed Tasks	Avg. Score	Avg. Completion Time [min]	Highest Score Task	Lowest Score Task	Last Seen
S1	4/5	4	5:32	2	4	2 min. ago
S2	5/5	3	7:25	1	5	7 min. ago
S3	3/5	4	4:54	1	3	1 min. ago
S4	3/5	5	5:02	1,2,3	5	2 min. ago
S5	5/5	4	3:56	2	4	1 min. ago
S6	2/5	2	6:23	2	1	2 min. ago
S7	1/5	4	2:56	1	2	8 min. ago
S8	4/5	3	3:21	2	4	5 min. ago
S9	5/5	4	5:58	2	4	2 min. ago

Figure 2. Students' activity on a scatter plot of time on task (x-axis) and score (y-axis).

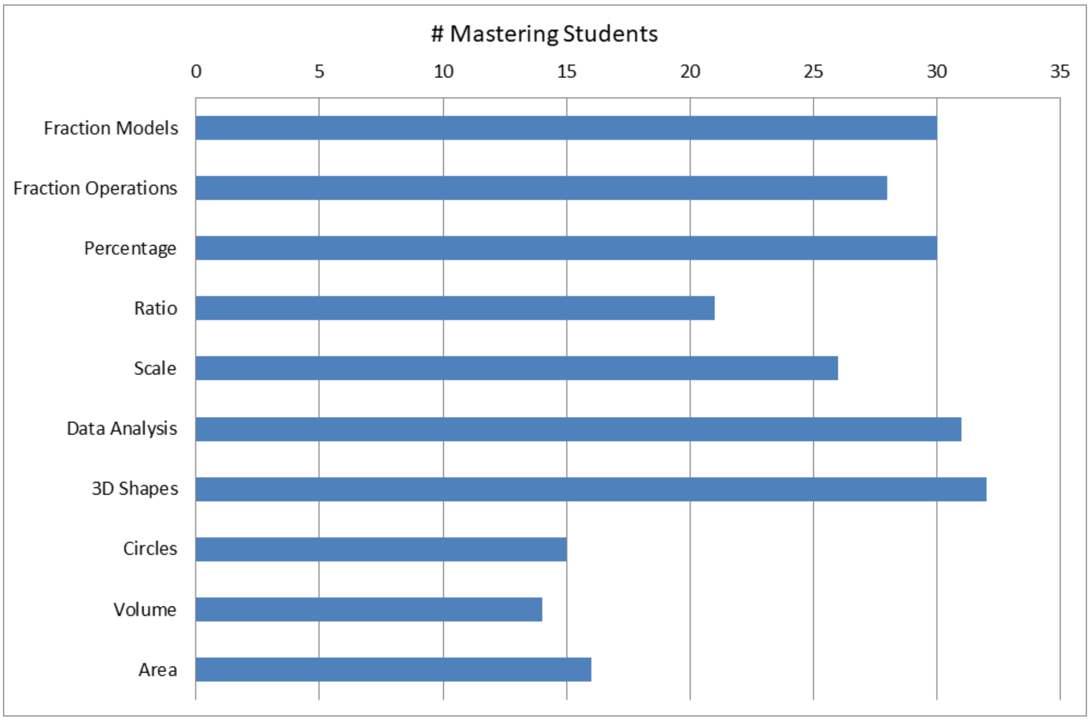

Figure 3. A bar chart of topic proficiency.

Research population. Nine mathematics teachers, all females aged between 27 to 52 years with 4 to 29 years of teaching experience, participated in the study. All participants were teaching in public elementary schools from various geographical areas in Israel at the time of the study. Some of the teachers had additional roles in or outside of school, such as a mathematics teachers' trainer or a mathematics coordinator. Participating teachers were recruited in a snowball fashion, with the inclusion criteria being that they integrated the online environment for mathematics in their teaching (either in the classroom or for homework assignments) at least once a week. A description of the research population is given in Table 2.

Table 2

Study 2 Participants

Participant code	Age	Teaching experience [years]	Grade(s) taught
T1	33	9	6
T2	52	28	4-6
T3	41	17	5
T4	47	9	3
T5	49	25	3-4
T6	52	29	3-4
T7	39	10	6
T8	29	6	5-6
T9	27	4	1

Research process. Interviews were conducted during October-December 2018. The interviews lasted about 30 minutes and were recorded. Some of the interviews were carried out via video conference (using Google Meet), and some were carried out over the phone. The data visualizations presented to the teachers via Google Drawings. All the interviews were fully transcribed before analysis.

Qualitative content analysis was conducted under our theoretical framework for assessing teachers' professional development. The unit of analysis was teachers' statements related to professional development. We used the Direct Content Analysis method (Hsieh & Shannon, 2005) with seven variables derived from ISTE's Standard for Educators; specifically, statements about professional growth were categorized into seven groups: learner, leader, citizen, collaborator, designer, facilitator, and analyst. The first author had coded one interview-transcript, and then reviewed it with the third author; these two authors discussed the coding and came to an agreement regarding conflictual coding schemes. The remaining interviews were then coded by the first author.

Findings

Study 1

We found no associations between age or teaching seniority with either of the dependent variables.

Due to the small population size and the distributions of the research variables, which are not necessarily normal, we used non-parametric tests. Specifically, we used Mann-Whitney U test for examining associations between the dependent variables and participants' experience with the education dashboard; this test is valid also in cases of unequal sample sizes and unequal variance of compared groups (Mann & Whitney, 1947). We find that, on average, the teachers with a longer experience with an education dashboard—compared with those who have a year or less experience—scored higher on Facilitator (M=3.9, SD=1.0, and M=2.9, SD=1.1, respectively, with Z=2.56, at p<0.05) and Analyst (M=3.8, SD=1.0, and M=3.0, SD=1.2, respectively, with Z=2.14, at p<0.05). (We report on Z score, which is calculated based on an approximation to the standard normal distribution and is served as the basis for the p-value calculation.) These differences denote large effect sizes of d=0.78, and d=0.7, respectively. Results are summarized in Table 3.

Table 3

Comparing Dependent Variables Based on Usage Experience (Dark Gray Background Denotes Significant Differences)

Variable	Dashboard experience [years]		Z¥
	≤1 (N=13)	>1 (N=39)	
Learner	2.8 (0.8)	3.0 (1.1)	0.16 p=0.87
Leader	3.2 (1.1)	3.4 (1.2)	0.69 p=0.49
Citizen	2.9 (1.3)	3.5 (1.0)	1.24 p=0.21
Collaborator	3.1 (1.4)	3.4 (1.1)	0.65 p=0.52
Designer	3.4 (1.3)	3.9 (1.0)	1.44 p=0.15
Facilitator	2.9 (1.1)	3.9 (1.0)	2.56* d=0.78
Analyst	3.0 (1.2)	3.8 (1.0)	2.14* d=0.70

* p<0.05, ¥ Based on Mann-Whitney U test.

Study 2

Analyzing the interviews conducted in this study, we were able to map teachers' statements to three of ISTE dimensions: designer, analyst, and facilitator. We were unsuccessful in finding statements that referred to the other four dimensions.

Designer. Recall that this dimension refers to the design of authentic, learner-driven activities, and environments that recognize and accommodate learner variability. Under this dimension, participants mostly referred to the accommodation of learner variability based on insights gained from examining the information presented to them. Commonly, teachers suggested to divide the class into groups, based on knowledge level: "I would divide the kids according to the tasks…and after that I would build the groups" (T5); "I am applying differential instruction. I am taking each group according to their knowledge, according to their presented points, and I am teaching them accordingly [...] promoting them or strengthening them according to their needs" (T4); "Here [table] I know which groups to create and give them tasks according to their success or un-success" (T8).

Some teachers referred specifically to those students who seemed to be struggling the most, differentiating them from the rest of the class, and focusing on the ways they could be assisted and supported, for example, by clarifying the tasks to them, giving them individual lessons, extra exercises, and extraordinary attention: "First, I think to explain the tasks [to the struggling students]. There seems to be some misunderstanding of the tasks [among them]" (T7); "So, it is worth one or two individual hours for those children who have difficulties with [the subject]" (T1); "Working individually [with the struggling students], or in a group during class, or as an extra practice" (T9); "[There are] children who need more support and more help, so that I will keep an eye on them, and I will notice them more, so I can see if they get along" (T3).

Some teachers referred to instructional design principles regarding the struggling students, mostly by creating a personal work plan that is based on "checking the questions that were there" (T5) in order to support "students who need reinforcement" (T6).

On the other side of the scale, and to the least extent, some teachers referred to supporting those students who seem to be excelling by supplying them with challenging tasks. Some ideas on that directions include: “Giving them extra tasks in the classroom, like riddles, more challenging tasks, higher level tasks" (T1); “There are many [students] who scored many points in a short time. It means that we can challenge them with extra tasks or raise the level of difficulty” (T9); and "[This student], scored excellent grades in 3 out of 5 tasks, maybe it required out-of-the-box thinking, so I will give him challenging tasks" (T2).

Alongside the reference to the two extremes, teachers also referred to the class' overall knowledge level and suggested instructional principles that mainly aim at the average, mostly by adding more class-time on topics with which the majority of the class struggled, and implementing instructional intervention: “If more than half of the class does not know a particular topic, I would repeat it in another way, with the entire class." (T5); “The topics with the lowest number of children [achieving proficiency]: “circle,” “calculate volume,” “calculate area” - I would teach and repeat it in the class, because most of the class does not know it, half of the class” (T4); “On less successful topics, I would re-teach or re-practice... repeating the basics with them” (T9); "I would review task number four and would try to figure out what is that task. Then I would teacher that material using questions with the same style" (T3).

Analyst. This dimension refers to teachers' use of data as a driving force of their instruction. Indeed, teachers were appreciative of the data-driven insights: “A child that does not like to work in the classroom gets [a full score] on a task. [The dashboard] reveals another aspect of the child, which we do not always see” (T6); “It adds to the understanding of what you do not see during lessons, and then, when you actually get the data at home, you can manage and process it correctly” (T9); “The table clearly presented the students' skills, and how you as a teacher can strengthen and give feedback to specific children” (T2).

Furthermore, examining the data presented to them, teachers were able to identify necessary assessment components: “If I want to build a formative assessment for a student, I must use this table” (T5).

Others suggested additional, more fine-grained student evaluation: "I would take the topics and make a summary table to see which topics are well understood, and which topics I should strengthen" (T2); "I could map out the student's' skills" (T3).

Some of the teachers explicitly mentioned how data would help them to communicate with students and parents to encourage student ownership of their learning: "I need to know in which tasks the student struggled, because when I talk to a parent or with another teacher, I need a very accurate picture of the child" (T8); "[Using the dashboard I can] ask the child: why didn't you do the task? Where did you struggle?" (T6); "I saw that [the student] did [the task] quick and that he was wrong. I would talk to him about it, and I would try to direct him so that he will do it more slowly" (T9):

> When you see data on a child [regarding the table], you can see his status and reflect that to him. You can show him—in that topic you are strong—empowering him; in that topic you are weak, how can I help you? how can I promote you? It gives you an option to a dialogue with the student (T7).

Facilitator. In line with this dimension, a few teachers were able to suggest ways of facilitating learning with technology to support students' meaningful learning. For example, they suggested using "visual [aids] and games, all sorts of things that could give the child a comfortable place" (T7), or "doing it digitally, say with [online] games or things like that, and I can do it with worksheets, and flashcards" (T8).

Discussion

In this paper, we reported on two complementary studies of the role of education dashboards by teachers in their professional development. We refer to "professional development" in a very broad sense, as a life-long endeavor that takes place throughout the teacher's career and relates to her or his professional and personal lives at large. In many ways, our two studies complement each other, as findings from our qualitative study (N=9) shed light on those from the quantitative study (N=52), and the quantitative study helps us emphasize the more prominent findings from the qualitative study.

Overall, the studies reported here suggest that teachers' experience with education dashboards may positively contribute to the extent to which they grow professionally as facilitators, analysts, and designers, as defined by ISTE Standards for Educators. While the quantitative findings emphasize the associations with the facilitator and analyst dimensions, the qualitative findings support the contribution to the designer and analyst dimensions, and to a lower extent, the facilitator dimension. From the similarities and differences between the findings from these two studies, we would like to highlight some important issues.

First, education dashboards may indeed support teachers' decision-making, hence their professional growth, regarding teaching in the traditional sense. The impact on the dimensions of designer and facilitator is well understood, as education dashboards usually present teachers with information on students' learning vis-à-vis the students' content understanding. Note that of the seven dimensions defined in the Standards for Educators, these two are the ones that directly relate to the traditional teachers' responsibilities, that is, to her or his teaching content in the classroom. So, it is of no surprise that the current findings reinforce previous studies in that sense (Molenaar & Knoop-van Campen, 2018; Schifter, 2014; Xhakaj et al., 2016). Indeed, when teachers think of their needs from the "ultimate" dashboard, they usually think of it as augmenting their traditional teaching (Holstein, McLaren, & Aleven, 2017).

Second, the positive impact on teachers' sense of being an analyst is worth highlighting. Data literacy has been mentioned as an important skill for today's educators (Mandinach & Gummer, 2013), and it was shown that data-related interventions may improve this skill (Reeves & Honig, 2015). We showed that the very use of data-intensive digital platform may improve teachers' data literacy. Of course, this finding does not underestimate or undermine such interventions, but rather emphasizes the importance of authentic, routinely, long-lasting usage of data.

Finally, that we did not observe an impact of the use of education dashboards on the other dimensions—namely, learner, leader, citizen, and collaborator—may be an evidence to the yet unfulfilled potential of education dashboards as a means for teachers' professional development on a broad level. This may be a result of either a design issue or lack of training (or both). In order to enhance the effectiveness of the use of education dashboard by teachers, it is also recommended to design them according to teachers' needs (Demmans Epp, Phirangee, & Hewitt, 2019), to train teachers on the use of data for their professional use, and to supply them with ongoing support on that topic (Rienties et al., 2018). We plan to continue studying the ways in which education dashboards could help in promoting teachers professionally, to make this decision-supporting tool as effective as possible in all aspects of teaching and learning.

This study is, of course, not without limitations. First, it was situated in a single country, characterized by a specific culture of education, technology, and implementing technology in schools; more than that, it is limited to a particular sub-population (elementary school teachers, mostly women, teaching primarily mathematics), which may have unique characteristics. Therefore, our findings should be validated by similar studies in other disciplines and in other countries. Additionally, the sampled population is not to be considered as representing the whole teacher population in the discipline/country discussed here. Despite these limitations, we feel that the contribution of the current study is of importance for promoting a more effective use of education dashboards, and to enhance teacher training and teachers' professional development on that topic.

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Zones of Agency: Understanding Online Faculty Experiences of Presence[i]

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Abstract

As instructors are forced to move their courses online, they are confronted by a sense of isolation and distance from their learners. Research has shown that feelings of loneliness are mitigated when *presence* is created in the online environment. An interpretive phenomenological analysis was conducted at a public university in the United States to answer the question: What are the determinants of presence for instructors in online teaching? Twenty-five online instructors from various disciplines, with diverse levels of experience teaching online, were recruited for the study. Interviews, analysis of course syllabi, and observations of course sites revealed five determinants of presence for online instructors: content, format, strategies, technology, and students. The crucial factor in deciding an instructor's experience of presence was the degree of agency instructors had over these determinants. This paper introduces the Zones of Agency for Online Instructors model and describes how the model can be used to enhance instructors' experiences of presence.

Keywords: presence, online education, faculty development, determinants of presence

Introduction

The online learning environment is a mediated environment that is characterized by the isolation that arises from distance (Kim, Kwon, & Cho, 2011; Lee & Choi, 2011; Moore, 1993). In this environment, *presence* plays a crucial role in creating participant enjoyment and involvement (Lombard & Ditton, 1997). Presence in a mediated environment has been variously defined as a sense of "being there" (Slater, 1999, p.2), "being connected and together" (Sung & Mayer, 2012, p. 1739), and being "accessible, available, and subject to one another" (Goffman, 1963, p. 22). The concept of presence in online education has been studied extensively. Some of the concepts and frameworks that have been developed are social presence; telepresence; the community of inquiry framework, which draws together social, cognitive, and instructor presence (Garrison, Anderson, & Archer, 1999); and the being "there" for the online learner model (Lehman & Conceição, 2010). These concepts and frameworks, in the context of online education, share a learner-centered focus. It is the learner's experience of presence that is studied, and the frameworks are designed to enhance the learner's experience of presence in the online learning environment.

What is generally overlooked is an acknowledgement that the instructor in an online environment is also a participant in the mediated environment and, therefore, equally impacted by presence or the lack thereof. Research has shown that a lack of face-to-face interaction with students negatively affects instructor satisfaction with online teaching (Lloyd, Byrne, & McCoy, 2012; Mills, Yanes, & Casebeer, 2009; Shea, 2007; Wasilik & Bolliger, 2009). Childers and Berner (2000) and Henning (2012) further note that the sense of isolation instructors experience could potentially affect their motivation to teach in the online environment. However, the instructor experience of isolation has not been widely researched, and literature in this area has been limited to personal anecdotes (Bair & Bair, 2011). Bair and Bair (2011), reflecting on their own experiences in online instruction, comment that the lack of physical interaction resulted in their experience of isolation. They felt that they were merely "looking at the computer screen rather than at human faces" (p. 6).

While *presence* has been found to mitigate learners' experiences of isolation, it has not been studied in the context of instructors. As educational institutions are forced to move their programs online, it is essential to understand what factors affect instructors' experiences of presence. To this end, a qualitative study was conducted on instructors' experiences of presence. The study findings helped identify the determinants of presence for instructors in the online environment. The research question addressed was: What are the determinants of presence for instructors in online teaching?

Conceptual Framework

Lombard and Ditton (1997) synthesized various conceptualizations of presence and holistically defined presence as a "perceptual illusion of non-mediation" (Presence Explicated section, para. 1). With presence, the mediated environment appears transparent and abstracted from the user. In essence, the mediated environment *disappears*, and participants feel that they are interacting in a face-to-face encounter.

Lehman and Conceição (2010) identify six determinants of presence in their framework for designing online courses with a sense of presence: content, format, strategies, instructor role, technology, and support. From a learner-centered perspective, they contend that the six determinants can help "guide the creation of a sense of presence in the online environment" (p. 26). These determinants of presence formed the conceptual framework of this study, as it sought to explore what factors would influence instructors' sense of presence.

Methodology

This study was conducted using an interpretive phenomenological analysis (IPA) approach, since it focused on the specific phenomenon of *presence,* and the experiences and perceptions of participants regarding this phenomenon. IPA is based on the theoretical principles of phenomenology, hermeneutics, and idiography (Smith, Flowers, & Larkin, 2009). The lived experiences of the participants are studied using a double hermeneutic and idiographic approach of focusing on one participant at a time. IPA seeks the essence of a particular experience across different participants and focuses on vertical generalizability, where findings from one context could prove useful in other situations within similar contexts (Yardley, 2008).

Participant Sample

To ensure homogeneity of the instructional context, all participants were recruited from a single 4-year public university in the United States Midwest. This guaranteed that all participants had access to the same online learning platform, support services, and administrative policies. Research has shown that instructors from different disciplines differ in their interaction styles (Smart & Umbach, 2007), dialogic behavior (Gorsky, Caspi, Antonovsky, Blau, & Mansur, 2010), and evaluation strategies (Smith, Heindel, & Torres-Ayala, 2008). Studies have also shown that instructors' perceptions of online education vary with their experience levels (Ulmer, Watson, & Derby, 2007). These factors were taken into account, and a purposive sampling process was implemented to achieve a broad representation of participants across disciplines and experience levels. Biglan's (1973) model categorizes disciplines as hard/soft, pure/applied, and life/non-life. For this study, Biglan's model was modified into four main categories of pure/hard, pure/soft, applied/hard, and applied/soft. The Appendix shows how the University's academic course offerings were classified. Instructors who had taught more than three fully-online courses were classified as *experienced*, and instructors who had taught up to three fully-online courses were classified as *novice* instructors.

A matrix (see Table 1) was created to categorize participants based on their disciplines and experience levels and to ensure that a minimum of two participants were represented in each quadrant. Instructors at the university who had taught fully-online graduate or undergraduate courses during one academic year were identified and invited via email to participate in the study. A total of 25 participants were distributed across the matrix as shown in Table 1. In order to maintain anonymity, gender-neutral identifiers of *P#* were assigned to the participants based on the order in which their interviews were conducted.

Table 1

Participant Distribution Matrix

	Experienced instructor	Novice instructor
Pure/Hard	2 participants	3 participants
Applied/Hard	4 participants	3 participants
Pure/Soft	3 participants	4 participants
Applied/Soft	4 participants	2 participants

Study Design

Data were collected from three sources in this study: course syllabi developed by the participants (2 per participant), semi-structured interviews, and observations of participants' online course sites. These three data sources provided rich detail and enabled triangulation of the data. Each participant emailed the researcher two course syllabi, which were analyzed prior to the participant's interview. The interviews were 60–90 minutes in duration and were audio-recorded. Observations were limited to online courses that were underway at the time of the interviews, and five of the participants consented to being observed. The observation spanned 12 weeks (i.e., one academic semester). During the observations, detailed notes were taken, guided by the research question. All three sources of data were treated as textual data and analyzed as prescribed by IPA. Transcripts were read, themes were identified and clustered, followed by the tabulation of the themes in an organized format.

Findings

All of the transcripts were analyzed using the six determinants of presence identified by Lehman and Conceição (2010). The findings are presented through the lens of the six determinants: content, format, strategies, technology, support, and student role.

Content

> **P12**: I love the topic matter, so it's easy to be enthusiastic. I think it makes a big difference for the dynamic with the students, so I love the response that that gets.
>
> **P6**: I like the course.
>
> **P4**: [It] probably helps that I really like the subject material, and it changes every year. I always have to update it, and it's a nice excuse to spend time doing something that I would want to do anyway, which is learning more about seeing how the science is changing year after year.

Course content emerged as a clear determinant of presence for the participants. When participants were teaching content that they were passionate about, they felt involved and engaged. Love of the subject matter ensured that participants remained motivated to teach and engaged with the course irrespective of other factors.

However, participants were not always consulted on what courses they taught. At times they were required to teach courses that they were not familiar with, which caused them anxiety. P15 reported that, "This semester I don't love either of the classes I'm teaching. It's more of a drag than I've had in a long time. So I think I do feel less inclined to get online and interact." P19 faced restrictions in her teaching, as she was required to implement strategies and assessments prescribed by her department. This led her to admit that, "some of the stuff, I don't believe in myself. But I'm a representative teacher [of the department]. So now I'm having to defend what I consider bunk in the first place and to do it with authority."

When they connected with the course content, participants experienced presence through the content of the course. When they did not believe in the content, however, it clouded their online teaching experience and affected their experiences of presence online.

Format

> **P1**: When I grade, I tend to try to put a professional or personal comment or tone to it.

Online courses are broadly taught in two main formats: self-paced or instructor-led. Self-paced courses are created by the instructor and then implemented on "auto-pilot." Students allocate their own study time and decide on the pacing of the course (Tullis & Benjamin, 2011). They independently access the materials and submit assignments. Interaction between the instructor and the students is infrequent and is usually limited to the feedback instructors provide on assignments. Instructor-led courses are more interactive, and the instructor plays a more active role in leading and facilitating the course. These online courses include both synchronous and asynchronous interactions, such as video conferences and discussion boards.

All of the participants in this study felt a greater sense of presence when they played an active role in their courses. They talked about knowing their students better and experiencing presence when they provided individual feedback. As P2 expressed it, "So then, that gave me a chance after they [wrote an essay] to then write them and say 'You did a wonderful job, but'; and then they'd think about it and write back, and then we started connecting." Instructors viewed the process of providing feedback as an opportunity to show their commitment and concern for student success. Sixteen (64%) of the participants talked about interacting with individual students through emails or discussion posts. Course formats that allowed for increased interaction between the instructor and the learners created a greater sense of presence for the instructors.

Strategies

> **P24**: When you start reading their responses and how they're thinking of dealing with a situation, you do get a feel for their personalities.

> **P22**: I'm very connected with [the students] by their projects because I'm reading about them, or chatting about them; they're talking about them, I'm giving them feedback on them.

> **P5**: Through their assignments, every week they're saying, "well here's something that happened to me at work," "here's what I'm going through," "I'm really interested in this." So, I'm getting to know them pretty well.

The pedagogical strategies that instructors incorporated in their courses played a significant role in their personal experiences of presence. Essays and open-ended writing tasks effectively connected participants to their students on a deeper and more meaningful level. In addition to essays, quizzes were included as a form of assessment. Auto-graded multiple-choice and short-answer quizzes were used in the courses. The auto-graded multiple-choice quizzes provided opportunities to check student knowledge, but their use created no sense of presence for the participants. Short answer quizzes that required manual grading, however, enabled P13 to engage with the learners.

Many participants included discussion forums in their courses. P12 taught an introductory undergraduate level class with 175–200 students and incorporated discussions in at least four of the course modules to encourage interaction. She found it rewarding for herself and her students. P1 revealed that "I'm very engaged in the discussion boards." However, not all of the participants' experiences with discussion boards were positive. P6 found discussion boards to be "an ineffective means to stimulate conversation. A bad proxy for a discussion." P19 noted that "online you [students] are required to enter the conversation because you're required to have so many posts at certain points of time; and they need to be substantive, they need to be productive." P19 considered this an artificial form of engagement. For some instructors, therefore, these discussion posts did not draw them into the online environment and did not enhance their experiences of presence in any way.

Technology

> **P3**: I watch these little video essays…and I think they're interesting and fun. And, so then I feel like [creating videos] is interesting and fun for me.
>
> **P17**: I just found new software this weekend…so I'm very excited about making digital flashcards for my…class.
>
> **P5**: [T]hat computer work over the years, I like to do that. It's kind of fun, it's a challenge, so I enjoy that part of it. So, I think I've had a positive experience.
>
> **P19**: A love of the technology itself is critical. Really wanting to have fun with Internet tools.… I think it changes the experience. I really do.

Online education is built on technology, and participants' relationship and emotional response to technology was an important factor in their perceptions and experiences of presence. Instructors who were comfortable using technology had more positive online experiences. They used technology to create new and interesting course materials, which they found to be an engaging and rewarding experience. Half (52%) of participants enjoyed working with technology and engaged with their online courses at a deeper level, thereby experiencing presence. However, this experience was not shared by all of the participants. P9 stated that, "I like technology. I don't like technology when it doesn't work, or when people change things, and I have to relearn."

The greater the challenges they experienced with technology, the more distant instructors felt in their courses. P1 spoke of how she had adopted Second Life:

> So in Second Life, it probably impacted me more than the students. The amount I got frustrated...the amount of time [I] spent on dealing with the technology issues that took away from me focusing on the students' learning and understanding and appreciating the content.

For P25 the learning management system (LMS) was "a universe unto itself, and there's somebody who understands it" but, he did not. For P25, the LMS was merely "a tool. I would never sit down and have a good time playing with the computer."

Support

> **P5**: I just thought it was very helpful.

> **P2**: If I go to the LTC [Learning Teaching Center] with a question, they're absolutely wonderful.... I don't know what I'd do without them.

> **P1**: [The] one-on-one attention I got from [my mentor], it improved my online and improved my face-to-face classes.

The participants had access to a variety of institutional-support resources, including 24-7 helpdesk access, training sessions, and technical support. Support was also provided through mentors. P1, P4, and P19 had highly valued mentor relationships. They felt that their mentor was the most significant contributor to their success in online teaching (see also Vaill & Testori, 2012). Departmental peer groups were available to P3 and P6, and discussion topics ranged from online teaching experiences to course materials and assessment strategies. Beyond the institution, P4 and P23 found support through national communities of practice, where members shared resources to enhance their teaching practice. Interestingly, while support and training enhanced the teaching practices of the participants, none of the instructors associated their training with their experiences of presence.

Student Role

> **P21**: I act, there is a reaction, and that informs what I'm doing. I can't explain something to a wall because I can't understand what's being received and whether I'm being clear or understood. And if I don't get that back, then I don't know where to go.

> **P7**: [I]t takes two people to have a conversation.

Lehman and Conceição's (2010) framework identifies the instructor role as a determinant of presence for learners. For instructors, students were identified as a strong determinant of presence. Student participation within the online learning space strongly impacted the instructors' experiences of presence. When students actively engaged with the instructor, the content, activities, and other students, the participants were drawn in and felt connected, engaged, and affirmed. For participants, it was the students' interaction with them and among themselves that heightened their experiences of presence. The most disconcerting experience for the participants was when students were non-responsive. P14 noted that an instructor had "to be very reliant on [their] students for that back and forth. So in that regard, if [the students] don't do it, you're stuck." When students chose not to respond, it left an impression that "there's a non-entity there" (P21).

P24 commented that, "I saw that they [students] were engaging in these discussions, and they really gave the impression that they really cared about the topics." Conversely, when there was no activity, P21 noted that, "I don't know whether I'm succeeding in engaging people if I'm getting nothing back. Online, if they don't respond to me, I have nothing."

While students' interaction through emails and discussion posts was important, it was the quality rather than the quantity of interactions that was important to the participants. P6 received the desired number of discussion board posts with comments, such as "good point," which left him feeling dissatisfied. P8, on the other hand, enjoyed the experience of interaction due to the motivation and high quality of student posts. The participants accepted that there was a spectrum of student engagement. On one end of the spectrum were students who were very engaged, and on the other end were students who "vanished." The instructors' sense of presence was impacted by the level of student participation. When students disappeared, the participants also disengaged.

Although the activities that the instructors included in their courses affected their experiences of presence, the best and most interactive activities could only succeed when students responded. It was students' behaviors that the participants associated most with their experiences of presence.

Discussion

Online instructors' experiences of presence were affected by five major determinants of presence: content, technology, student role, format, and strategies. The degree of agency instructors had over these determinants affected their experiences of presence in their online teaching environments. The Zones of Agency for Online Instructors model was developed to show the relationship between instructors and their level of agency over the determinants. The instructor is the focus and is placed in the center of the model. Figure 1 represents the zones of agency that surround an online instructor.

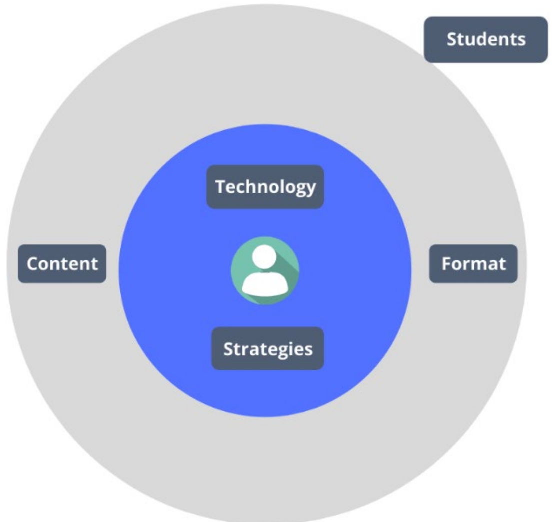

Figure 1. The Zones of Agency for Online Instructors model.

Determinants that lie close to the instructor (i.e., in the blue circle) represent elements that the instructor has the most agency over and can use to create a personal sense of presence. The further away from the instructor the determinants are (i.e., in the grey circle and in the periphery), the less agency the instructor has over them. In this study, instructors designed the pedagogical strategies they used in their online courses. They had a high degree of agency in their choice of pedagogical strategies. When an instructor designed a course, they had the discretion to decide what kind of activities to incorporate, thereby providing opportunity for enhanced experiences of presence. Technology is another determinant where the instructors could exert their agency. Familiarity with technology, gaining practice using technology, and then comfortably incorporating technology in their online courses established a sense of presence for the instructors. Instructors could also choose what technologies to incorporate in their courses, thereby adding to their agency.

Content and format are in the outer zone of agency (i.e., the grey circle). Instructors did not have a high degree of agency over these determinants, although content and format affected their experiences of presence. Course formats were decided at the institutional or departmental level, and instructors were given courses to teach in specific formats; for example, self-paced or instructor led. Within these formats, the participants could define activities that create more interaction with the learners, thereby creating a personal sense of presence. Course content, such as the topic of the course, course goals and objectives, and course materials were defined at the departmental level; and most participants did not have much of control over content. However, the choice of materials fell under the instructors' purview and contributed to their sense of presence.

Students were the most impactful determinants of presence for the instructors; yet, they are on the periphery of the instructor's zones of agency. While the instructors could create opportunities for interaction with the students, it was up to the students to engage with them. The instructors' experiences of presence were strongly affected both positively and negatively by students' interactions with them in their courses.

The Scope of the Zones of Agency for Online Instructors Model

The strength of the Zones of Agency for Online Instructors model lies in its adaptability. The model can be restructured in different ways to represent different teaching environments. The organization of the determinants of presence depicted in Figure 1 is specific to a learning environment where instructors have autonomy over their choice of pedagogical strategies and some autonomy over content selection and course format. However, if the institution were more prescriptive, and instructors were provided with fully developed courses and had no autonomy over any course choices, the model could be modified to reflect that teaching environment, as presented in Figure 2. Instructors do maintain some agency over pedagogical strategies and technology (in the grey circle), and they can shape their personal experiences with the technology they use and the ways they reach out to their learners. In this environment, content and format move to the periphery, outside the instructor's zone of agency. While depicting the instructors' zones of agency, Figure 2 also conveys the instructors' reduced experiences of presence when they have less agency over the determinants of presence.

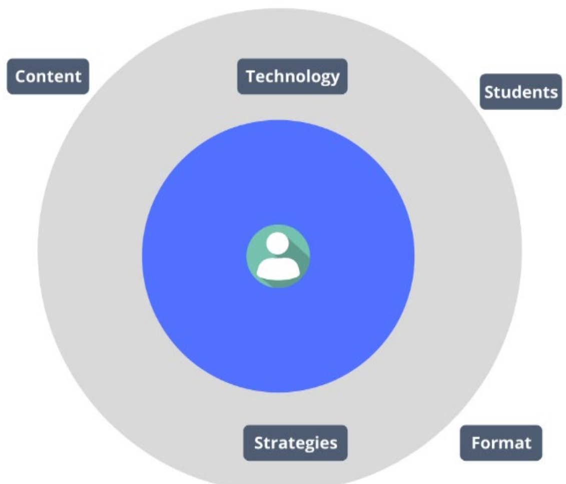

Figure 2. An adaptation of the Zones of Agency for Online Instructors model to depict a prescriptive course environment.

A program where instructors can determine the entire design of their course is represented in Figure 3. With such a high degree of agency, an instructor's experiences of presence would be elevated compared to the previous scenarios. In all situations, however, students remain on the periphery of an instructor's zones of agency, while they are the most impactful factor.

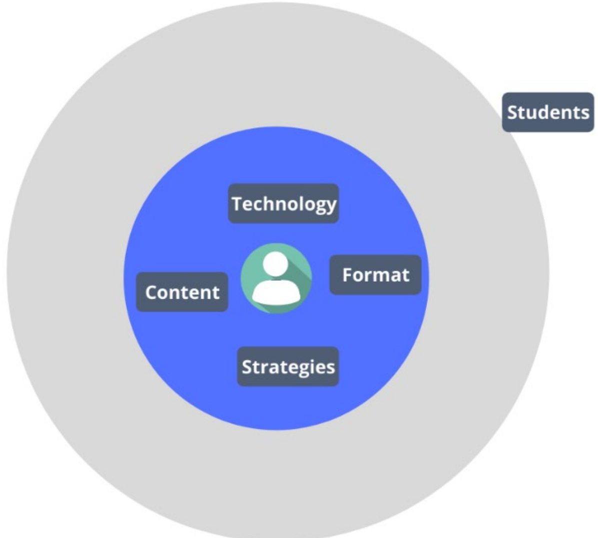

Figure 3. An adaptation of the Zones of Agency for Online Instructors model to depict a teaching environment where instructors have a high degree of agency.

Implications for Theory and Practice

The Zones of Agency for Online Instructors model is a simple but effective way to prepare instructors for transitioning to online teaching or new instructors joining an institution. As part of instructor orientation, this model can clearly express what is provided by the institution, how much autonomy instructors have, and what they should expect from online teaching.

Based on the study results, Figure 3 represents an effective combination of autonomy. The instructors were most satisfied when they had more agency over the course format, content, and strategies. Other representations of the model, such as Figure 2, can provide institutions with an opportunity to understand why their instructors may not be engaging with their online courses at an optimal level. The model provides room for critical reflection on how an institution's online teaching practices are organized and how that may affect instructors' experiences of presence. The model can also provide the basis for suggestions for improvement.

Study Limitations and Future Research

This study is limited by the participant sample. Since participation in this study was voluntary, there was an inevitable self-selection bias that must be acknowledged. Furthermore, the employment status of the instructors (e.g., tenured, adjunct and assistant professor, lecturer) was not considered as a variable in this study. Inclusion of this variable may have highlighted other determinants of presence for the instructors, such as job security or the hierarchy within the organization. Another variable that was not included was that of instructors' workload. The number of courses that an instructor teaches at one time may affect their experiences of presence. Finally, student demographics were not considered as a variable in this study. It would be interesting to explore whether differences in student demographics affect their position in the zones of agency model. The influence of employment status and workload should also be considered in future research. Future research replicating this model in different institutions should be conducted to verify its applicability and relevance beyond the study context.

Conclusion

The literature on online learning is highly focused on student experiences. However, as instructors are forced to move their courses online, they should be considered as equal participants in the online environment. In this research, instructors' experiences were at the center, and the study aimed to understand the elements that contributed to instructors' sense of presence. The findings from this study indicate that instructors' sense of presence was dependent on the levels of agency they had over five determinants of presence: content, format, technology, strategies, and students.

The Zones of Agency for Online Instructors model can be adapted to represent the degree of agency online instructors have within specific institutions. It provides a quick snapshot of how online course design and delivery functions within an institution, and it immediately conveys instructor experiences of presence within that specific representation of the model. At an institutional level, this model can be a valuable tool to understand and enhance instructor experiences of presence and engagement in online courses.

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Appendix

Table A1

Classification of the University's Academic Course Offerings

Pure disciplines		
	Hard sciences	Soft sciences
	Astronomy	Africology
	Physics	American Indian studies
	Mathematical sciences	Anthropology
	Mathematical statistics	Arabic
	Geosciences	Latino studies
	Chemistry & biochemistry	Lesbian, gay, bisexual & transgender studies
	Geography	Linguistics
		Art history
		Celtic studies
		Chinese
		Classics
		English
		Ethnic studies
		French
		German
		Spanish
		Hebrew Studies
		History
		Japanese
		Jewish Studies
		Russian
		Scandinavian Studies
		Women's studies
		Master's in language, literature, and translation
		Philosophy
		Sociology
		Communication
		Comparative literature
		Urban studies
		Political science
		Psychology
		Music
		Film, video, animation, & new genres
		Film studies
		Foreign languages & literature
		Dance
		Art & design

		Communication sciences & disorders
		Global studies
Applied disciplines		
	Hard sciences	Soft sciences
	Mechanical engineering	Business administration
	Architecture	Business management
	Atmospheric science	Theatre
	Electrical engineering	Music education
	Industrial & manufacturing engineering	Curriculum & instruction
	Biomedical sciences	Educational policy & community studies
	Conservation / Environmental sciences	Educational psychology
	Computer science	Exceptional education
	Kinesiology	Library & information sciences
	Biological sciences	Translation & interpreting
	Information studies	Economics
		Nursing
		Therapeutic recreation
		Public administration
		Social work
		Nonprofit administration
		Nursing
		Occupational therapy
		Public health
		Journalism, advertising, & media Studies
		Criminal justice
		Health care administration
		Counseling
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E-Learning Challenges in Iran: A Research Synthesis

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Abstract

This study investigates and fully identifies the challenges of the Iranian e-learning system. The approach was qualitative and the method was research synthesis. The statistical population consisted of studies from 2006 to 2019 in the field of challenges of the e-learning system of Iran collected with specific keywords from the country's databases. A total of 48 studies were identified as relevant. They were screened in stages and evaluated based on their title, abstract, and content. The final 19 articles selected underwent content analysis, revealing that Iran's e-learning system faces problems in eight dimensions: legal, human, educational, technological, sociocultural, support, economic, and managerial-organizational. The results of the analysis could serve as a model for countries with similar technology infrastructure and cultural features wishing to improve their e-learning systems.

Keywords: e-learning, challenge, Iran, research synthesis, model

Introduction

Higher education in Iran started in the middle of the 19th century and is now part of the education system, under the supervision of the Ministry of Science, Research and Technology, the Ministry of Health and Medical Education (University of Medical Sciences), and the Ministry of Education (University of Farhangian). Iranian higher education leads to degrees of associate, bachelor's, master's, and doctorate. Studies into Iranian higher education indicate that the current bureaucratic and centralized system is not capable of directing higher education centers and this has reduced the quality of education and learning.

Enhancing learning and teaching at universities has always been an important issue (Muyinda, 2007). To this end, using technology to support teaching and learning can be effective. Technology is constantly modernizing education and is now an integral part of the learning environment. Undoubtedly, the Web and all its domains have provided unprecedented opportunities and platforms for learning. One of the emerging opportunities that has changed traditional formal education in terms of quality, quantity, accessibility, cost, and delivery is e-learning (Aljamal, Cader, Chiemeke, & Speece, 2015; Liu, 2013). E-learning provides a new generation of learning that can assist institutions to achieve manifold goals (Taha, 2014) and play a key role in the learning process (Kc, 2017).

The word e-learning has been used since the third millennium AD and its meaning is still expanding. Today, the term mainly refers to the use of online technologies to enhance the teaching-learning process and the acquisition of knowledge and skills (Ostad et al., 2019; Uppal, Ali, & Gulliver, 2018). E-learning means using information and communication technology to enhance and support learning at every level of education (Cidral, Oliveira, Di Felice, & Aparicio, 2018; Dev, 2018). In fact, e-learning uses technology to facilitate the learning process, making it independent of time and place. What is more, the learner is much more active in this type of learning than in traditional methods.

Since information is central in the present era, e-learning is considered a necessity for an information-driven society. Similarly, universities cannot ignore e-learning thanks to the development of computers and the Internet in education. Proper application of an e-learning system in universities can help develop skills to use online academic content, in addition to introducing teachers and students to new teaching methods (Shahnavazi, Mehraeen, Bagheri, Miri, & Mohammadghasemi, 2017). Studies also show that e-learning, as a learner-centered teaching method, facilitates and improves higher-order cognitive skills such as analysis, synthesis, evaluation and judgment, critical thinking, and problem solving (Zarei, Javaheri, & Shikhi, 2019). In general, the goal of e-learning is to eliminate time, place, and educational resource constraints, to provide equal, free, and searchable access to courses, to create a uniform learning environment for different groups of individuals in any location, and to optimize delivery of lesson content for deeper and newer learning (Uppal, Ali, & Gulliver, 2018; Zare & Saeed, 2017).

E-learning officially started in Iran in mid-2002. Subsequently, many e-learning courses were launched in 2004 by Shiraz University, granting a degree in control and precise instrumentation engineering, followed by the University of Science and Technology, Khajeh Nasiruddin Tusi University, and Amir Kabir University which began to offer similar courses. The University of Payame Noor also started to develop curricula for semi-formal education in five disciplines at twenty-eight centers (Dosti, Madanipour, & Bideglo, 2018). Given the growing number of students, the shortage of educational venues, the fact that many students have jobs (Rafiei, Ghaffari, & Khorami, 2017), and the role of e-learning in the realization of the *5th Plan and Development Outlook of 1404* (knowledge-based development) (Zare & Saeed, 2017), e-learning could be considered the most important educational method, especially in Iranian higher education. E-learning was developed in Iran by 2010 using the policies, rules, and regulations related to face-to-face education, and since then, efforts have continued. However, since e-learning is a strategic program, the problems and issues it faces should be identified and serious action taken to solve them. Therefore, this study, taking a qualitative approach, aimed to evaluate research conducted into e-learning challenges and was guided by the following question: what are the challenges in Iran's e-learning system?

Method

This qualitative study used a research synthesis method. The aim of research synthesis is to combine empirical research to make generalizations (Hedges & Cooper, 2009). As shown in Figure 1, a seven-step method (Sandelowski & Barroso, 2006) was used to identify relevant studies for analysis.

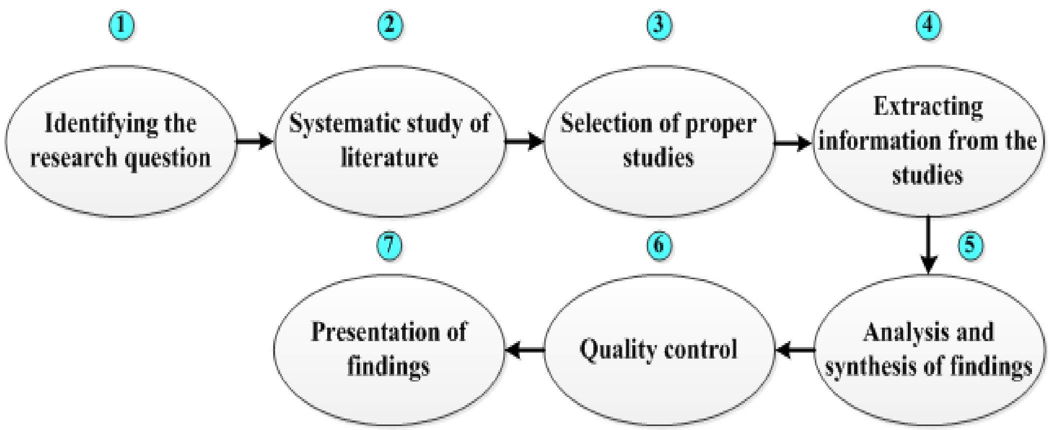

Figure 1. Research synthesis steps. Adapted from *Handbook for synthesizing qualitative research*, by M. Sandelowski and J. Barroso, 2006, Springer Publishing Company.

Step 1: Identifying the Research Question

In the first step, the main research question should be identified. We articulated our question as follows: what are the challenges in Iran's e-learning system?

Steps 2 and 3: Systematic Study of Literature and Selection of Relevant Studies

The statistical population of this research includes studies from 2006 to 2019 in the field of e-learning challenges. The largest Iranian databases, including CIVILICA, Magiran, Ganj, Noormags, and SID, were searched using these keywords:

- e-learning / distance learning pathology;
- e-learning / virtual education pathology;
- electronic learning / distance learning challenges;

- electronic learning / virtual learning challenges;
- e-learning / distance learning barriers;
- e-learning / virtual learning barriers;
- e-learning / distance learning threats; and
- e-learning / virtual learning threats.

As shown in Figure 2, 48 studies were selected from the databases and evaluated. From among these, 19 were finally selected for analysis after several screening stages based on title, abstract, and content.

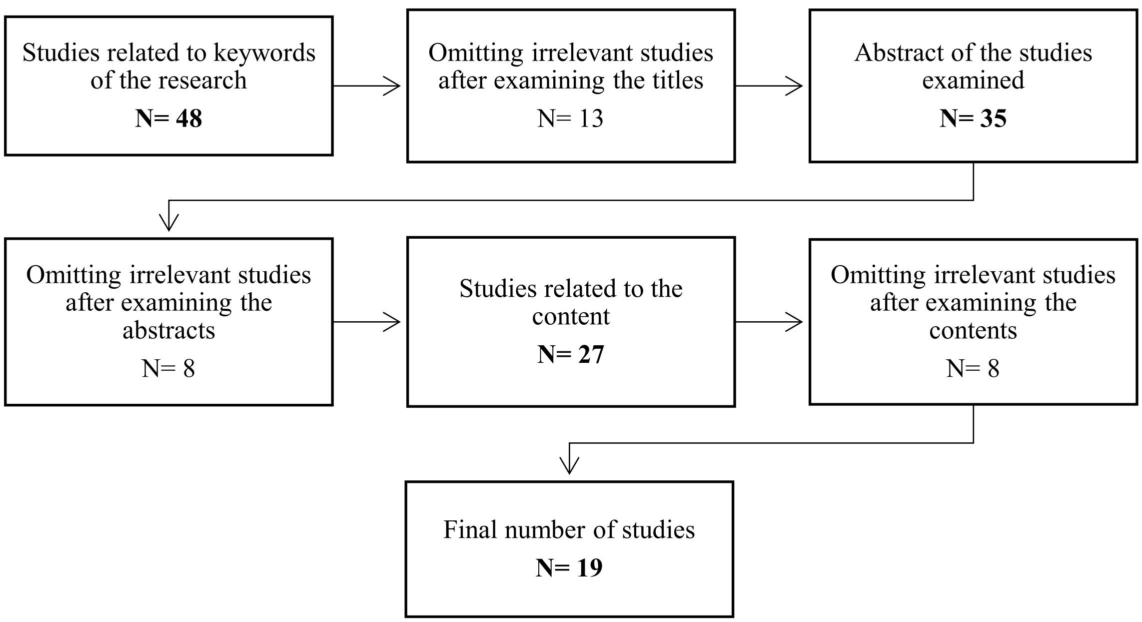

Figure 2. Stages of selecting, refining, and organizing research. Figures in bold are the number of studies remaining after completion of each step, showing how the total number of studies was reduced.

In this screening, the critical appraisal skills program (CASP) proved useful for evaluating quality. CASP offers 10 questions to determine the accuracy, validity, and importance of research studies. According to Mohamadian, Manian, and Khodadad Beromy (2015), these questions focus on: (a) research objectives; (b) methodology logic; (c) research design; (d) sampling method; (e) data collection; (f) reflectivity; (g) ethical considerations; (h) accuracy of data analysis; (i) clear expression of findings; and (j) research value. Members of the research team examined and evaluated the articles using CASP and selected those which received a good (31-40) or excellent (41-50) score on the 50-point scale.

The 19 selected studies are shown in Table 1.

Table 1

Post-Screening Studies Selected for Coding

Article code	Source	Year
1	Zarei, Javaheri, & Shikhi	2019
2	Ghasemi, Fardanesh, Hatami, & Ahmady	2018
3	Dosti, Madanipour, & Bideglo	2018
4	Vardasbi, RezaeiZadeh, Khorasani, & Alikhani	2018
5	Abbasi Kasani, Haji Zeynalgabedini, & Raisi	2018
6	Tari, Shams, & Rezaeizadeh	2017
7	Mohsenzadeh	2017
8	Mahmoudi & Purnasir	2017
9	Mahmoudi & Hashemikia	2017
10	Naderifar, Ghaljaie, Jalalodini, Rezaie, & Salalr	2016
11	Paykani	2016
12	Ghahramani	2015
13	Bagherimajd, Shahei, & Mehralizadeh	2013
14	Asghari et al.	2012
15	Khatib Zanjani, Zandi, Farajollahi, Sarmadi, & Ebrahim Zadeh	2012
16	Arabsorkhi & Yadegari	2011
17	Majidi	2009
18	Etezadi, Arefi, & Aghakasiri	2009
19	Rahimi Doost	2007

Steps 4 and 5: Extracting Information From Research and Analyzing and Synthesizing Findings

Conducting a study using the research synthesis method requires qualitative analysis of previous studies and findings in a specific field. One of the most effective methods of undertaking such a process is content analysis using coding that leads to the discovery of a framework of patterns (Hsieh & Shannon, 2005). Coding can be used when the researcher wishes to analyze the data obtained from events. Corbin and Strauss (2008) proposed three coding techniques: open, axial, and selective coding. *Open coding* is an analytical process through which concepts are identified and their features and dimensions discovered in the data. *Axial coding* is the process of linking categories to subcategories and connecting categories at the level of attributes and dimensions. *Selective coding* is also a process of integration and improvement of categories (Lee, 2001). MAXQDA 10, a software program used for analyzing qualitative data, together with the three-step encoding method of Corbin and Strauss were used for data analysis. Content related to the research question was first identified in the selected studies and, after repeated reviews, the initial open codes were extracted. Then, to create links between open codes, similar codes that had the same connotation were classified as axial codes. In the last step, the data were selectively coded and axial codes with the same connotation were placed in one category or dimension.

Step 6: Quality Control

In order to maintain quality in this study, research papers were evaluated based on indices such as objectivity, methodology logic, research design, ethical considerations, clear expression of findings, and research value, and only papers that scored high were selected for the next steps in the process. Furthermore, to ensure the coding was reliable, the intra-thematic agreement between two coders method was applied. An expert researcher re-encoded the data. To determine the reliability value, the Kappa Cohen coefficient formula was used. More specifically, three interviews were re-coded by the other coder and then the inter-coder agreement was calculated, resulting in a reliability of 0.73.

Step 7: Presentation of Findings

At this step, the results of the previous steps are presented.

Findings

Table 2 summarizes the results of the analysis of studies. Open source codes were juxtaposed, resulting in a number of *categories*. To determine each axial code, the open codes extracted in the first step were examined and those that resembled each other were grouped under the axial code that represented their meaning, i.e., *factor*. Afterward, homogeneous axial codes were categorized to form *dimensions* (selective codes).

Table 2

Classification of Thematic Categories Derived From Coding and Their Source Articles

Factor	Categories	Article code
	Legal Dimension	
Legalization	Lack of emphasis and obligation regarding the use of educational technology by higher education laws and regulations	13, 17
	Lack of necessary rules and regulations	5, 8, 17
	Lack of rubrics and weaknesses in making laws and regulations	6, 17
	Human Dimension	
Instructor	Insufficiency and lack of timely presentation of class assignments	2
	Fear of inability to acquire necessary job skills	5
	Lack of supervision and timely feedback on the part of instructors	2

	Low instructor engagement and lack of essential guidance	2
	Inability of some instructors to work with the system	2
	Poor eloquence of some instructors	2
	Professors' reluctance to teach on time	5
	Professors' resistance to using technology in classrooms	10, 14, 17
	Some professors' concern about their role becoming diminished	10
	Professors' lack of technological skills	11
	Professors' negative attitude toward e-learning	14
	Professors' lack of motivation to adopt e-learning	14
	Professors' insufficient time	14
Learner	Students' reluctance to use this type of education	5
	Anxiety to face the computer and use it in students	5
	Low level of motivation to interact	2
	Heterogeneous students in terms of computer literacy and knowledge	5
	Low level of information and computer literacy	2, 5, 9
	Large number of learners	2, 5
	Learners' lack of technological skills	11, 13, 19
	Learners' mental distraction and inattention to academic matters	12
	Learners' reluctance to strive	2, 11
	Weakness in time management skills	1, 19
	Low level of motivation to use e-learning by learners	13, 19
	Lack of individual study skills	1, 19
	Low English proficiency of learners	8, 13
Staff	Staff's lack of motivation	6
	Insufficient skilled workforce	2, 5
	Educational Dimension	
Educational needs analysis	Lack of educational needs analysis	2
	Unrealistic needs analysis	6
Educational designing and planning	Lack of teacher training in e-learning	5
	Weak access to content of discussions	4
	Failure to define e-learning goals	1, 5
	Failure to anticipate appropriate in-service courses to familiarize teachers with teaching methods and process of using e-learning	5
	Lack of established educational models	3
	Inappropriate intensivity of content	2

	Repetitive and out-of-date content	2
	Impractical content	2
	Inappropriate educational calendar	2
	Failure to change educational processes	3
	Mismatch between existing curricula and ICTs	1
	Difficulty creating content for e-learning practices	8
	Inattention to the learner and their needs in setting goals	11
	Inappropriate and insufficient content	6, 17
	Poor curriculum design	19
	Poor e-class design	19
	Poor quality of e-learning based educational packages	14
Execution	Decrease in face-to-face and non-verbal communication	5, 12
	Improper implementation of e-learning	6
	Inappropriate timing of some e-classes	7
	Using old techniques and methods	5
	Restrictions on practical and skill-based courses	6, 12
	Emphasis on teacher-centered methods	12
	Users being accustomed to traditional education systems	13
	Inefficient education	1, 16
	Poor supervision of educational processes	16
Evaluation	Lack of specific standards for evaluating educational programs	5
	Uncertainty about validity of educational evaluations	5
	Low test duration	2
	In-person evaluation	2
	Lack of procedures for designing evaluations appropriate for e-learning	5
	Impossibility of evaluating all aspects of learning	11
	Technological Dimension	
Software	Weaknesses in supporting software systems	10, 11, 18
	Weakness in software resources	5, 12, 14, 17, 18, 19
	Incompatibility of some software programs with personal computers	7, 18
	Inaccessibility of main software programs	8, 18
Hardware	Weakness in hardware resources	5, 12, 13, 17, 18, 19

	Insufficient hardware	7, 8, 11, 13, 14, 15
Internet	Low Internet speed	2, 5, 7, 12
	Lack of proper communication platforms	6, 8, 14
	Internet disconnection	7, 17, 18
	Expensive network communication platforms	6, 15, 17
	Low bandwidth	7, 13, 18
Learning management system	Lack of familiarity with Web design and systems	5, 16
	Unattractive system appearance and poor UI	2, 5, 19
	Inability of some instructors to work with the system	2
	Complexity of system	11
	Learners' lack of access to their performance evaluations	4
	Sociocultural Dimension	
Society's attitude	Low value of a university degree in the minds of entrepreneurs and the public	13
	Disbelief in virtual education	6
	Improper status of e-learning	5, 6
	Objectification of learners	1, 12
Resistance to change	Fear of presence of new technology	6
	Resistance to adoption of e-learning	6, 17
Cultural and social values	Lack of culture conducive to adoption of e-learning	1, 14
	Lack of copyright in the software community of the country	5
	Resistance due to traditional, cultural values	1, 10
	Support Dimension	
Conditions and facilities	Inadequate quality of equipment	1, 5, 11
	Weakness in online support	2
Scientific sources	Shortage of native scientific resources in the field of e-learning	5, 10
	Economic Dimension	
Investment	Inadequate investment in e-learning	5, 8, 18

Budget and financial resources	Inadequate government funding for e-learning	5, 13, 18
	Low financial resources	2, 17
Cost	High cost of e-learning	5, 13, 17, 18
	High initial costs	5, 8
	Cost of keeping technology up-to-date	14
	Hardware and software costs of e-learning	14
	Managerial-Organizational Dimension	
Organizational structure	Failure to precisely define organizational structures for implementing e-learning	5, 13
Management and leadership	Lack of experienced managers to manage the e-learning system	13, 17
	Lack of proper leadership	5, 17
	Inefficient management	16
Planning and policy-making	Failure to define precise policies regarding the use of e-learning	5, 13
	No long-term strategic plans	5
	Lack of specific mechanisms in the Ministry of Sciences' policy-making and planning units	13
	Lack of coherent policy-making	5
	Ambiguity of goals and missions	1
Establishment of e-learning system	Rejection of e-learning in some universities	10, 17
	Insufficient dissemination of e-learning capacities	6, 16
	Uncertainty about efficiency of virtual universities	13
	Multiple decision making centers	8
	Multiple administration centers	8
	Higher education authorities' reluctance to establish a virtual university	13
Managers' attitude to e-learning	Misconception that e-learning is inefficient and resistance to it	5, 17
	Fear of failure	17

Note. Dimension = selective coding; Factor = axial coding; Categories = open coding; ICT = Information and Communications Technology; UI = user interface. Article codes are assigned in Table 1.

Figure 3. Challenges of the Iranian e-learning system.

These eight dimensions of setbacks and problems are discussed next.

Discussion

Legal dimension. The findings indicated that Iran's e-learning system has a major legal issue which is related to e-learning system regulation. When implementing e-learning, communities and organizations are required by law to provide rubrics on certain issues related to instructors, learners, managers, and support services in order to identify a framework of activities and ensure compliance with the education system (Bashiruddin, Basit, & Naeem, 2010). However, Iran has so far failed to properly implement and enforce its e-learning laws and regulations (Abbasi Kasani, Haji Zeynalgabedini, & Raisi, 2018) and this has caused the e-learning system to break down. Creating incentives and educational requirements for the delivery of learning content and educational interactions through cyberspace and in academic e-learning settings can greatly reduce resistance to e-learning.

Human dimension. This dimension pertains to the human factors related to the teacher, learner, and e-learning system personnel.

The teacher plays a key role in transferring knowledge, skills, and sense of competition, as well as in determining student satisfaction (Paechter, Maier, & Macher, 2010). The e-learning teacher acts as a facilitator who identifies educational goals, quality learning resources, learning activities, and evaluation practices (Khorasani, A'lami, & Razavizadeh, 2017). Teachers are also required to have computer skills as these are at the foundation of activities in such a system. Teachers sometimes resist adopting e-learning because they feel their current status may be endangered. However, they should be familiarized with the advantages and necessity of e-learning in the present age through courses and workshops to help minimize this resistance. Additionally, a teacher's eloquence is one of the features of creative teaching from a learner's perspective. Learners believe that a teacher should be able to convey content effortlessly. A teacher's online presence is also important. Without it, learning can suffer due to the lack of thorough analysis and review by the professor and the failure to initiate student participation when discussing lesson components. Misinterpretation leads to a student's confusion and loss of motivation (Mohsenzadeh, 2017).

The learner is one of the key players in the teaching-learning process. The learner-centered approach in the e-learning system actively engages learners so they can experience more effective learning by interacting with the environment, content, teacher, and other students (Khorasani et al., 2017). Motivation also influences the perceptions and concentration of the learner. With motivation, access to information, even when scarce, becomes possible. Furthermore, learners' participation in e-learning increases their motivation for further effort and persistence (Shangeerthana & Chandrasekar, 2016; Taha, 2014). Access to computers and the Internet or Intranet is essential and requires some knowledge of computer use and troubleshooting. Gaining such knowledge, however, can be costly and time-consuming (Tarin, 2016). Information literacy is another factor related to the learner. Information literacy is a set of skills enabling one to recognize their information needs, formulate search methods by identifying available information sources, evaluate the information obtained after conducting the search, and make necessary connections between new information and previous knowledge in order to generate new information (Gholami & Gavgani, 2011). Unfortunately, there are some setbacks in the area of information literacy in the Iranian e-learning system.

One of the important factors related to the learner which determines the success of e-learning is computer skills (Mosakhani & Jamporazmey, 2010; Taha, 2014). Learners need computer skills to be able to participate in e-learning. Poor computer skills can cause anxiety and result in learners being unable to take advantage of the benefits of e-learning (Selim, 2007). The characteristics of learners and their attitudes toward e-learning can also influence their success. The more compatible learners are with e-learning, the more likely they are to have a positive attitude toward it and be engaged in it, and thus succeed and improve their e-learning experience.

The research revealed certain issues with staff as another human factor influencing the Iranian e-learning system. Some staff lack motivation and there is a shortage of skills in the workforce. In principle, motivation is the momentum for an individual to pursue an activity to achieve success, and its absence will consequently cause problems (Tari, Shams, & Rezaeizadeh, 2017). Managers should encourage employees to use e-learning to provide better quality services, and to have a high level of motivation and positive attitude toward this mode of learning. Furthermore, to address the need for a skilled workforce, managers should make an effort to use e-learning to educate experts in each field (Bagherimajd, Shahei, & Mehralizadeh, 2013). E-learning is one of the most important issues in organizations and can be a factor in solving problems related to learning and staff performance.

Educational dimension. The educational dimension refers to factors influencing all steps in the education process including needs analysis, planning and design, implementation, and evaluation. Currently, the underlying problem in the e-learning system is the almost total absence of proper educational principles. As a consequence, designers and trainers often apply principles better suited to traditional education systems. This in turn leads to forms of e-learning that are nothing more than flipping through web pages and filling in e-mail boxes or providing simple alternatives to classroom-based learning (Dosti et al., 2018). In fact, one of the fundamental issues is lack of quality in the needs analysis, design, development, and delivery of e-learning, which, when addressed, will solve the problems of this type of learning (Ghasemi, Fardanesh, Hatami, & Ahmady, 2018). Educational design in network-based learning also has a significant impact on variables such as motivation for academic achievement (Noesgaard & Ørngreen, 2015). Furthermore, one of the essential requirements is the production of e-content (Tari et al., 2017). Mazini (2009) considers content as the most important challenge and obstacle to the development of e-learning in Iran. In fact, content in Iran's e-learning system is dated and lacking coherence.

Technological dimension. The technological dimension includes hardware, software, the Internet, and e-learning system infrastructures. To be successful, e-learning needs to be reinforced in terms of hardware and software, and new technologies and related infrastructures must be employed. (Elkaseh, 2015; Shangeerthana & Chandrasekar, 2016). Another factor that has dramatically changed education and learning is the Internet, which is, in principle, at the foundation of e-learning (Romi, 2017). In a similar vein, a number of researchers have pointed to e-learning issues caused by the lack of suitable hardware and software facilities, cost of access to the Internet, bandwidth limitations, and slow Internet speed (Gulati, 2008). E-learning, based on computer communication platforms, is dependent upon these platforms, and therefore, the absence or weakness of each component affects efficiency. Low bandwidth and slow Internet speed make users reluctant to try Web-based learning (Tari et al., 2017). Iran's e-learning system has not yet advanced far enough to be able to provide the necessary software and hardware infrastructures and thus has weaknesses in this respect.

Learner activities also take place in a learning management system (LMS). This system should cover all activities and provide a good user interface (UI). As the number of Internet users has soared in recent years, close attention has been paid to UI when creating Web applications. UI is defined as the interaction between people and a Web application (Abbasi Kasani & Shams, 2018). In addition, learners expect to have access to some of the capabilities of the LMS. They also believe the results of their activity evaluations should be accessed through the LMS (Vardasbi, RezaeiZadeh, Khorasani, & Alikhani, 2018).

Sociocultural dimension. The sociocultural dimension refers to conditions related to culture and society that influence the application and use of technology in education (Paykani, 2016). In light of the expanded use of e-learning, it is essential to promote it first and foremost in the academic community and then in the community in general. By raising awareness about the features, goals, and benefits of e-learning, community members can develop a more positive attitude toward e-learning, supporting users who will become more eager and active in this environment (Ghasemi et al., 2018). Right now, there is a stigma attached to e-learning and people in the community generally do not value virtual education. They deem e-learners as individuals who are only in pursuit of a degree, not of learning. What is paramount in using technology is defining the path, speed, direction, and ultimate purpose (Tarin, 2016). Should these goals be well defined and made transparent to members of the community, it can be argued that resistance to e-learning will diminish.

Support dimension. The support dimension is concerned with online support and resources needed to foster meaningful learning environments (Abbasi Kasani et al, 2018). The research findings suggested that there are deficiencies in terms of facilities and scientific resources in the Iranian e-learning system. Within any organization involved in e-learning, it is essential that clear reasons for distance learning are provided, the extent of responsibility and independence of the learner and teacher are determined, and personal and educational support are provided. E-learning courses should also be supported in terms of scientific, technical, and guidance resources. However, in the e-learning system in Iran, there is a shortage of technological, economic, and even cultural infrastructure which has resulted in Iran suffering from lower quality equipment when compared to many other countries, impinging on online support as well. Another aspect of support pertains to native scientific resources. Native scientific resources are currently scarce and instead more foreign scientific resources are being used. While the experience and knowledge of other countries are important, national scientific development is also a necessity.

Economic dimension. The economic dimension includes all matters related to investment, budget and finance, and cost. Despite the growing importance of e-learning, there is still less investment in this sector when compared to traditional education, and there is no significant separate funding available for it. In addition, the cost structure in e-learning is quite different from that in conventional education. Large-scale e-learning programs may train more graduates at a lower cost than conventional systems. The costs depend on the use of learning materials, media, technologies, and the organization that provides support to learners (Tarin, 2016). On the other hand, establishing an e-learning approach necessitates provision and maintenance of various infrastructures and therefore costs a lot initially (Mahmoudi & Hashemikia, 2017), which in turn makes decision makers reluctant to commit to e-learning.

Managerial-Organizational dimension. The organizational dimension refers to structural and administrative factors within a body. The research findings indicated that the managerial-organizational dimension of Iran's e-learning system has been adversely affected by factors such as organizational structure, management and leadership, planning and policy making, e-learning system establishment, and managers' attitudes toward e-learning. It is important to obtain the approval of high-level managers, who need to understand how e-learning can reduce costs, improve product quality and profitability, and enhance employee performance as well as customer satisfaction (Bagherimajd et al, 2013). Managers can be a determining factor in improving and streamlining change in their organizations. When an organization wants to improve the workflow of a process, it requires formulation of an executive approach. Just as the articulation of policies and procedures for e-learning is considered essential, the lack of planning and educational strategies and support specific to e-learning can make adopting this approach challenging (Tari et al., 2017). Hadadyan (2011) demonstrated that organizations do not provide conditions conducive to e-learning, which is in line with the results of the present study.

Another major pathology of the e-learning system lies in its establishment and implementation. Currently in Iran, six governmental bodies consider themselves to be in charge of e-learning: the Ministry of Science, Research and Technology; the Ministry of Education; High Council of Information; the Ministry of Information and Communications Technology; the Islamic Republic of Iran Broadcasting; and the Management and Planning Organization. As a consequence, each adopts different policies, approaches, and guidelines, and they also use different methods of conducting e-learning courses (Mahmoudi & Hashemikia, 2017). Such a multiplicity of agents leads to poor quality and even failure of the e-learning system. What is more, in some cases there is resistance to e-learning. This resistance usually emanates from an individual with extensive experience and belief in the real classroom, who resists change in organizational structure and questions the need to change in the first place, who may have a fear of technology and is reluctant to enter a new learning cycle, and, finally, has insufficient knowledge of e-learning benefits (Aoki & Pogroszewski, 1998).

Limitations

In this study, a comprehensive identification of e-learning system challenges in Iran was investigated using only a synthesis method. However, the challenges of the Iranian e-learning system could also be addressed with the help of other data collection methods and tools such as interviews and questionnaires. Moreover, the views and opinions of professors, students, and stakeholders were not considered in this study. These limitations however suggest directions for future research.

Conclusion

Technology has a remarkable capability to modify or redefine teaching and learning activities in all institutions of higher education and provides opportunities to design scientific environments previously thought to be impossible. For this reason, many universities in Iran are keen to launch e-courses to capitalize on the merits of information technology in the form of e-learning. However, the e-learning system already launched in many universities in the country faces numerous challenges and problems. These include deficiencies in 8 areas: legal, human, educational, technological, sociocultural, support, economic, and managerial-organizational. Findings could prove beneficial for countries similar to Iran in terms of technology infrastructure and cultural features.

This study has eight recommendations to support e-learning in Iran. We suggest the adoption of these measures: (a) employment of technical experts in the field of virtual education to train teachers as well as learners and raise their awareness; (b) establishment of an e-learning culture through websites and the media; (c) justification of the values and benefits of e-learning; (d) creation of motivational and support mechanisms, such as providing facilities, enhancing knowledge and skills, and providing financial support for technology purchase and use; (e) provision of the infrastructure needed to implement e-learning effectively; (f) hiring of competent and caring managers in e-learning institutions; (g) development of laws and regulations related to the e-learning system; and (h) allocation of sufficient funding.

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Online Courses in Higher Education in Iran: A Stakeholder-Based Investigation into Preservice Teachers' Acceptance, Learning Achievements, and Satisfaction: A Mixed-Methods Study

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Abstract

This study focused on the perspectives of higher education stakeholders on teaching English as a foreign language (TEFL) in online courses in Iran, as well as preservice teachers' learning achievements in online courses. Three cohorts of participants were included in the study: preservice teachers of TEFL (n = 104), TEFL university instructors (n = 23), and heads of TEFL departments (n = 10). Data was collected using a questionnaire and semi-structured interviews. The Kruskal Wallis test was used to detect differences among participants' perspectives. Preservice teachers' mid-term and final scores in the online courses were also compared. Results show significant differences among the perspectives of the three participant groups regarding online courses. The preservice teachers appeared to have relatively positive attitudes about online learning, while the university instructors and department heads showed lower levels of satisfaction with this medium. Participants identified several challenges in online learning, including lack of rigor in online courses, lack of credibility of course certificates, lack of technological infrastructures, technical problems, lack of practical content in the lessons, lack of human interaction, students' low knowledge of the content, and employers' lack of interest in employing graduates of online courses. Participants also noted the need for pedagogical and technological training for both university instructors and preservice teachers of TEFL. The comparison of preservice teachers' mid-term and final scores in the online courses showed a significant difference and improvement in students' learning achievements with medium to large effect sizes. In the interviews, participants confirmed that online courses could improve student learning.

Keywords: acceptance, challenges, online learning, preservice teacher training, student achievement, TEFL stakeholders

Introduction

Online learning has been established as an effective and influential learning medium in many educational organizations and institutions (Ahmed Abdullah & Sultana Mirza, 2020; bin Mohd Amin, Kumar Piaralal, Rosli bin Daud, & bin Mohamed, 2020; Lee, Chang, & Bryan, 2020; Westine et al., 2019). Online courses provide a convenient and flexible approach to learning, and students have the option of studying even when they are working (Kim, Liu, & Bonk, 2005). Dashtestani (2014) argues that online learning can assist students and teachers in their educational practices. Furthermore, due to the increased need for higher education institutions to respond to the needs of students and admit new students, the justifications for including online education are plausible and pertinent (Kim et al., 2005).

Cost-effectiveness can be regarded as a significant benefit of online education, a benefit not commonly found in traditional courses. There are also considerable opportunities for students to communicate and collaborate online through social network sites, a benefit that computer-mediated communication (CMC) tools can provide for their users (Stone & Perumean-Chaney, 2011). The opportunities for learning anytime and anywhere, the focus on the learner and their needs and preferences, and the activation of students' critical thinking are also significant benefits of online education (Dashtestani, 2014). However, it can be argued that implementing online learning may be problematic due to issues, such as university instructors' incompetence in teaching online courses, students' and instructors' low digital literacy levels, insufficient and low-quality instructor feedback, and the absence of interaction in online courses (Dashtestani, 2014).

Students' Perceptions of Online Courses

A large body of research has explored the acceptability levels of online courses in different educational settings and contexts. Grimes (2002) analyzed the attitudes of dentistry students towards online learning in a course. The students' view of the online course was positive overall, and they perceived it as a valuable learning experience. Convenience was perceived as an important benefit of the course. The students were satisfied that they did not need to commute in order to attend the class. The challenges they faced were isolation and technical problems, which impeded the learning process. Furthermore, Grimes found that students with visual styles of learning had more positive perceptions of the course compared to students with auditory learning styles. Hughes and Daykin (2002) investigated students' attitudes towards online learning as well. Results of their qualitative study indicate that students were able to reduce their anxiety levels regarding the online course they attended and showed rapid socialization in the online environment. The limitation students raised was that discussions were limited, and they only shared information.

Kim et al. (2005) conducted a study on students' perceptions of the benefits and limitations of an online master's of business administration (MBA) course. Results show that students had positive attitudes towards the online MBA course, and that they believed that the online course could provide them with employment opportunities at an international level. The students' perceived benefits of online learning included flexibility, learning new online learning skills, and a high level of interaction. The perceived challenges included lack of feedback and limited communication between peers. Students also suggested that more training, support, and interaction be considered in order to enhance the effectiveness of online learning in MBA programs. Karaman (2011), similarly, investigated nurses' perceptions of online learning. He found that nurses had positive attitudes towards online learning. However, there was a significant difference between the perceptions of nurses who seldomly used computers and nurses who frequently used computers. The settings in which the nurses worked also had a significant influence on their perceptions of online courses.

Fortune, Spielman, and Pangelinan (2011) measured students' perceptions of online versus face-to-face learning. They found that there was no significant difference between the students' preferences for the two modes of learning. Both online students and face-to-face students had positive attitudes towards their learning modes. Lowenthal, Bauer, and Chen (2015), similarly, evaluated student perceptions of online and face-to-face learning. They suggested that students' attitudes towards face-to-face courses were more positive compared to their attitudes towards online courses.

Teachers' Perceptions of Online Courses

Dashtestani (2014) assessed English as a foreign language (EFL) teachers' attitudes towards teaching English online. He found that EFL teachers held positive views on online teaching. The teachers' perceived challenges of teaching EFL online included lack of digital equipment and facilities, limited interaction in online courses, instructors' low levels of knowledge about online teaching, and cultural limitations and problems. The teachers also emphasized the importance of training and their interest in receiving training on teaching EFL online.

Teaching English as a foreign language (TEFL) is a major field of study in the context of higher education in Iran. A large number of students are now studying TEFL as a major, and each year many applicants strive to be admitted to this program at Iranian universities. Considering the popularity of the program in recent years, online TEFL courses at the master's level have been introduced and included in the higher education curriculum in Iran. However, there is a paucity of research on the effectiveness and acceptability of the online TEFL courses in the context of Iran. More importantly, the majority of studies on the effectiveness of online courses have explored the perspectives of teachers or students separately. The perspectives of preservice teachers, university instructors, and department heads have been a neglected area of research. To address this gap, this study examined the perspectives of key stakeholders on online learning in higher education in Iran. The learning achievements of Iranian preservice teachers of TEFL were also identified and analyzed. Results of this study, including the differences and similarities among the stakeholders' perspectives, have implications for educational planners and policy makers.

Methodology

This study adopted a sequential mixed-methods design. Combining qualitative and quantitative approaches, both interview guides and questionnaires were developed and used. Due to the complexity of investigating the participants' perspectives, both qualitative and quantitative data were collected. According to Johnson, Onwuegbuzie, and Turner (2007),

> mixed-methods research is the type of research in which a researcher, or team of researchers, combines elements of qualitative and quantitative research approaches (e.g., use of qualitative and quantitative viewpoints, data collection, analysis, inference techniques) for the broad purposes of breadth and depth of understanding and corroboration (p. 123).

In this study, methodological and participant triangulation were conducted in order to provide supplementary and confirmatory data.

Research Questions

Based on the specific aims and objectives of the study, the following research questions were formulated:

1. What are the perspectives of Iranian online TEFL preservice teachers, university instructors, and department heads in terms of their acceptance of online TEFL courses? Are there significant differences among the perspectives of the three participant groups in terms of their acceptance of online TEFL courses?

2. What are the perspectives of Iranian online TEFL preservice teachers, university instructors, and department heads about the challenges of online TEFL courses? Are there significant differences among the perspectives of the three participant groups about the challenges of online TEFL courses?

3. What are the perspectives of Iranian online TEFL preservice teachers, university instructors, and department heads about the measures that can be used to improve the acceptability of online courses of TEFL? Are there significant differences among the perspectives of the three participant groups about the measures to improve the acceptability of online TEFL courses?

4. What are the perspectives of Iranian online TEFL preservice teachers, university instructors, and department heads about their training needs for online TEFL courses? Are there significant differences among the perspectives of the three participant groups about their training needs for online TEFL courses?

5. Are there significant differences in the learning achievements of Iranian online TEFL preservice teachers in online courses based on the comparison of their mid-term and final scores? What are the perspectives of Iranian online TEFL preservice teachers, university instructors, and department heads about the learning achievements of preservice teachers in online TEFL courses?

Participant Sample

Three participant cohorts were included in this study. The first group comprised 104 master's students (preservice teachers), who studied in online TEFL courses and were aged 25–30 years. The sample was chosen from six highly ranked Iranian universities that offer online courses for master's studies. The cluster method of sampling was employed to recruit the participants of the study. The second participant group comprised 23 university instructors, who taught TEFL lessons and subjects online and had 3–18 years of university teaching experience, and 2–5 years of experience teaching online TEFL courses at a university. Of this sample, 15 instructors were faculty members, and 8 instructors were invited to teach TEFL in online courses. The third participant group comprised 10 department heads who taught online and traditional TEFL courses, were faculty members, and had 8–23 years of teaching experience. All 127 participants completed the study questionnaire; 27 master's students (preservice teachers), 9 university instructors, and 4 department heads participated in the interviews as well. In addition, access to the mid-term and final scores of a total of 53 students from three courses was provided with the permission of the instructors of the courses.

Measures and Data Collection

Questionnaire. Four factors were taken into account in designing the survey. The first factor was the acceptance levels of preservice teachers, university instructors, and department heads. Therefore, the first section of the questionnaire focused on participants' agreement with some of the benefits of online learning. The second factor was linked to the current challenges of online learning of TEFL in Iran. The second section focused on participants' agreement with a list of items on the challenges of online learning. The third factor was associated with measures that can be used to facilitate the implementation and acceptance of online TEFL courses. The third section considered the perceived importance or priority of each measure. The fourth factor was the issue of training. The fourth section focused on whether the participants believed that training was an important factor or not and aimed to identify the training needs of the participants. To write the initial list of items, a review of previous studies was undertaken and consultations were conducted with a group of computer assisted language learning (CALL)/educational technology specialists and a few university instructors and students who are involved in online learning in Iran. In order to achieve a high response rate, the participants were provided with paper-based questionnaires. Some participants completed the questionnaires at the time of its administration and some other ones returned the questionnaires in one week's time.

In order to examine the suitability of the questionnaire for the particular goals of the study, statistical analyses were undertaken. Cronbach's alpha test was conducted for all sections of the questionnaire to explore the reliability of the instrument. Specifically, the first section of the questionnaire was designed to assess the acceptance of online TEFL courses (18 items; Cronbach's alpha = 0.894), the second section examined the challenges of online TEFL courses (18 items; Cronbach's alpha = 0.604), the third section assessed measures to improve the acceptance of online TEFL courses (13 items; Cronbach's alpha = 0.777), and the final section focused on the training needs of students and university instructors (6 items; Cronbach's alpha = 0.634). The total Cronbach's alpha index of the questionnaire (55 items; Cronbach's alpha = 0.750) demonstrated an appropriate level of item reliability. Five-point Likert Scale items were included in all the sections of the questionnaire.

The structure of the questionnaire was also validated using exploratory factor analysis. The first section of the questionnaire contained four factors ($KMO = 0.879$, Bartlett's test of sphericity = 865.692, $df = 153$, $p = 0.000$), the second section of the questionnaire comprised six factors ($KMO = 0.772$, Bartlett's test of sphericity = 527.157, $df = 153$, $p = 0.000$), the third section included four factors ($KMO = 0.772$, Bartlett's test of sphericity = 324.265, $df = 78$, $p = 0.000$), and the last section contained two factors ($KMO = 0.639$, Bartlett's test of sphericity = 92.655, $df = 15$, $p = 0.000$). As results indicate, the questionnaire had a suitable factorial structure and the items had factor loadings higher than 0.30. A group of specialists were also invited to provide feedback on the questionnaire items as well to assess and validate the content of the instrument.

Interviews. The interview questions were also designed based on the objectives of each research question. The interview questions explored participants' acceptance of online TEFL courses and their attitudes towards them, the challenges and limitations of current online TEFL courses, the measures that can be used to improve the status quo, the necessity of training and the training needs of the participants, and student achievements in online TEFL courses. The same group of specialists who were consulted in the development of the questionnaire were asked to provide feedback on the interview questions to assess and validate their content. The interviews were semi-structured. Each interview took about 30 minutes. The interviews were audio-recorded with the permission of the participants. Those participants who were not willing to take part in the interviews or provided insufficient information were excluded from the data analysis.

Preservice teachers' mid-term and final scores. In order to assess the learning achievements of the preservice teachers, three online university instructors agreed to share the mid-term and final scores of preservice teachers who attended their online courses. According to the university instructors, the criteria for the mid-term and final scores were students' engagement in online discussions, students' presentations in the online classes, students' mid-term or final exam scores, and students' completion of assignments and projects. The average of the mid-term score (out of 20) and the final score (out of 20) was considered the final score of the course, which was reported to the department. Final course scores of 14–20 qualified the students to pass the course. The improvement in preservice teachers' learning was measured by comparing the mid-term scores and final scores of the three online courses. For ethical considerations, the exact scores of each student are not presented to respect the confidentiality of the students' personal information.

Data Analysis

Several statistical methods were employed in the data analysis. SPSS 16.0 was used to analyze the data collected in the questionnaire. The descriptive results of the questionnaire are presented in terms of the mean and standard deviation for each item. The non-parametric Kruskal Wallis test was used to identify significant differences among the perspectives of the three participant groups. Cronbach's alpha test and exploratory factor analysis were conducted to determine the reliability and construct validity of the questionnaire. The data collected in the interviews was analyzed and common themes were identified. More specifically, the interview data were transcribed and coded. In order to enhance the reliability of the coding, two coders coded the interview data and the themes which were reported by the two coders were included in the study. Following a Shapiro-Wilk test of normality, the parametric paired samples *t*-test was used to estimate the differences between the preservice teachers' mid-term and final scores. To identify the effect size, Cohen's *d* was estimated for each of the three online courses.

Findings

The Acceptance of Online TEFL Courses

As Table 1 shows, the findings regarding the attitudes of TEFL preservice teachers, university instructors, and department heads towards online learning of TEFL were mixed. The preservice teachers' responses to the questionnaire items (M = 3.997, SD = 0.757) show that their attitudes were relatively positive about online TEFL courses. The university instructors' responses to the items (M = 3.58, SD =1.19) reveal that their attitudes were less positive towards online learning. The most negative attitudes were those of the department heads (*M* = 2.9, *SD* = 0.98). The results of the Kruskal Wallis test indicate that there were significant differences among the attitudes of the three participants groups towards online learning of TEFL. Specifically, the preservice teachers seemed to have positive attitudes towards all of the benefits of online learning of TEFL, while the university instructors had positive attitudes towards some of benefits, including the interactivity of online TEFL courses, compatibility with students' learning styles, exceptional access to learning materials, and the enhancement of students' digital literacy. The department heads agreed only that online learning of TEFL can reduce students' commute to university.

Table 1

Questionnaire Results on TEFL Stakeholders' Acceptance of Online TEFL Courses

Questionnaire item	Participant group	*M*	*SD*	Chi-square (Kruskal Wallis)	*p*
1. Online TEFL courses are convenient for students/instructors	Preservice teachers	4.18	0.73	14.403	0.001*
	University instructors	3.04	1.33		
	Department heads	3.60	1.64		
2. Online TEFL course are interactive	Preservice teachers	4.21	0.63	3.654	0.161
	University instructors	3.91	0.90		
	Department heads	3.50	1.43		
3. Learning in online TEFL courses is effective	Preservice teachers	4.16	0.67	53.719	0.000*
	University instructors	2.86	0.91		
	Department heads	1.7	0.94		

4. Personalized learning takes place in online TEFL courses	Preservice teachers	4.26	0.59	12.673	0.002*
	University instructors	3.34	1.33		
	Department heads	3.4	1.7		
5. Online TEFL courses are cost-effective	Preservice teachers	3.26	0.97	0.018	0.991
	University instructors	3.26	1.48		
	Department heads	3.2	1.22		
6. Adequate feedback can be received in TEFL online courses	Preservice teachers	3.96	0.93	19.381	0.000*
	University instructors	3.17	1.49		
	Department heads	2.6	0.69		
7. Online TEFL courses are time efficient	Preservice teachers	4.01	0.73	18.448	0.000*
	University instructors	3.73	1.60		
	Department heads	2.3	0.67		
8. Online TEFL courses provide students opportunities for learning anywhere	Preservice teachers	4.08	0.69	22.015	0.000*
	University instructors	2.56	1.8		

	Department heads	2.4	1.34		
9. Online TEFL courses are flexible	Preservice teachers	4.02	0.82	4.012	0.135
	University instructors	3.78	0.99		
	Department heads	3.2	1.31		
10. Online TEFL courses facilitate communication between students	Preservice teachers	3.25	1.07	5.293	0.071
	University instructors	3.82	1.11		
	Department heads	3	0		
11. Attending online TEFL courses reduces the problem of everyday commuting	Preservice teachers	4.14	0.74	6.654	0.036*
	University instructors	3.78	0.95		
	Department heads	4.3	1.05		
12. Studying in online TEFL courses can provide students with better job opportunities	Preservice teachers	4.06	0.65	16.289	0.000*
	University instructors	3.65	1.40		
	Department heads	2.70	0.82		

13. Studying in online TEFL courses can provide students with learning based on their learning styles	Preservice teachers	4.11	0.80	26.18	0.000*
	University instructors	4.60	0.83		
	Department heads	2.90	1.1		
14. Online TEFL courses provide students with exceptional access to materials	Preservice teachers	4.09	0.75	30.407	0.000*
	University instructors	4.73	0.68		
	Department heads	3.30	0.82		
15. Online TEFL courses give students control over their lifestyles	Preservice teachers	4.15	0.65	15.248	0.000*
	University instructors	3.2	1.44		
	Department heads	3.40	0.84		
16. Studying in online TEFL courses can foster students' digital literacies	Preservice teachers	4.03	0.72	10.950	0.004*
	University instructors	4.2	0.90		
	Department heads	2.5	1.35		
17. Online TEFL courses facilitate the process of sharing resources	Preservice teachers	3.93	0.74	22.193	0.000*

	University instructors	3.56	1.19		
	Department heads	2.1	0.87		
18. Online TEFL courses facilitate students' autonomy	Preservice teachers	4.05	0.76	22.437	0.000*
	University instructors	3.39	1.11		
	Department heads	2.1	1.28		

Note. 5-point Likert scale: 1 = Strongly disagree; 2 = Disagree; 3 = Neither agree nor disagree; 4 = Agree; 5 = Strongly agree.
*p ≤ 0.05

The participants of the three groups voiced different views about online TEFL courses in the interviews as well. As in the results of the questionnaires, the preservice teachers had relatively positive attitudes about online TEFL courses. They believed that online learning was convenient, it allowed them to work and study at the same time and reduced their commute to university. They also stated that online learning provided them with the opportunity for learning anywhere and distance learning. Some of the preservice teachers noted that they had easy and exceptional access to the content of the course sessions. They also regarded the session recording feature of online TEFL courses as suitable and effective. However, most university instructors and department heads regarded online learning as inferior to face-to-face courses. They believed that online TEFL courses were not as effective as face-to-face courses and were of lower quality.

The Challenges of Online TEFL Courses

As Table 2 illustrates, there were significant differences among the perspectives of the three participant groups regarding the challenges of learning TEFL online, based on the results of the Kruskal Wallis test. However, the three participants groups all agreed that online TEFL courses were less rigorous than face-to-face courses, were limited by technical and Internet connection problems, and lacked human interaction and practical content. They also agreed that employers lacked acceptance of certificates from online TEFL courses, that certificates/degrees from online courses lacked credibility, and that online TEFL students had low knowledge of the content.

Table 2

Questionnaire Results on the Challenges of Online TEFL Courses

Questionnaire item	Participant group	*M*	*SD*	Chi-square (Kruskal Wallis)	*p*
1. Tuition fees of online TEFL courses are high	Preservice teachers	4.17	0.64	35.919	0.000*
	University instructors	3.30	1.29		
	Department heads	1.90	0.56		
2. Learning in online TEFL courses causes distraction	Preservice teachers	3.38	0.95	24.095	0.000*
	University instructors	2.57	0.94		
	Department heads	1.90	0.99		
3. Online TEFL courses are less rigorous than face-to-face classes	Preservice teachers	4.13	0.72	16.517	0.000*
	University instructors	4.70	0.47		
	Department heads	4.60	0.51		
4. Online TEFL courses are limited by technical problems	Preservice teachers	4.12	0.67	0.264	0.876
	University instructors	4.09	0.99		
	Department heads	4.10	0.73		
5. Online TEFL courses are limited due to Internet connection problems	Preservice teachers	4.12	0.78	7.183	0.028*

	University instructors	4.57	0.59		
	Department heads	4.20	1.03		
6. There is not enough human interaction in online TEFL courses	Preservice teachers	4.12	0.75	0.939	0.625
	University instructors	4.04	1.22		
	Department heads	4.20	1.03		
7. Content taught in online TEFL courses is not practical enough	Preservice teachers	4.10	0.84	6.921	0.031*
	University instructors	4.39	0.89		
	Department heads	4.50	0.97		
8. Limited feedback is provided to students in online TEFL courses	Preservice teachers	3.56	1.06	30.319	0.000*
	University instructors	2.48	0.94		
	Department heads	1.80	0.91		
9. Online TEFL courses reduce communication between students and instructors	Preservice teachers	3.33	1.01	6.391	0.041*
	University instructors	3.87	1.21		
	Department heads	3.00	1.33		
10. Degrees received from online TEFL courses are	Preservice teachers	4.03	0.70	11.853	0.003*

not as credible/accepted as the ones received from face-to-face TEFL courses					
	University instructors	4.30 0.82			
	Department heads	4.70 0.48			
11. There is an under-representation of the learning content in online TEFL courses compared to face-to-face courses	Preservice teachers	3.02	1.33	11.917	0.003*
	University instructors	2.04	0.76		
	Department heads	3.10	1.19		
12. Students are not accountable enough in online TEFL courses	Preservice teachers	3.12	1.5	9.720	0.008*
	University instructors	3.87	1.29		
	Department heads	4.40	0.96		
13. Online TEFL courses lack an adequate level of professionalism	Preservice teachers	3.12	1.5	9.720	0.001*
	University instructors	3.87	1.29		
	Department heads	4.40	0.96		
14. Employers would not accept certificates of online TEFL courses	Preservice teachers	4	0.68	24.588	0.000*
	University instructors	4.52	1.12		

	Department heads	4.80	0.42		
15. Online TEFL courses are teacher-centered	Preservice teachers	4.12	0.70	43.462	0.000*
	University instructors	2.09	1.04		
	Department heads	3.70	1.33		
16. Online TEFL courses need a lot of time for planning	Preservice teachers	3.16	1.30	14.216	0.001*
	University instructors	4.26	0.86		
	Department heads	3	1.24		
17. Instructors are not always available for students in online TEFL courses	Preservice teachers	3.88	0.83	3.223	0.199
	University instructors	3.52	1.5		
	Department heads	4.30	1.16		
18. Students admitted to online TEFL courses do not have adequate competence levels	Preservice teachers	4.04	0.82	14.896	0.001*
	University instructors	4.52	0.59		
	Department heads	4.80	0.42		

Note. 5-point Likert scale: 1 = Strongly disagree; 2 = Disagree; 3 = Neither agree nor disagree; 4. Agree = 5. Strongly agree.

*$p \leq 0.05$

In the interviews, the study participants stated several challenges of online TEFL courses. The department heads and university instructors seemed to be more aware of the limitations of online learning compared to the preservice teachers. The participants believed that online TEFL courses do not have high levels of credibility and acceptance in society, and that students who graduated from online universities/courses were unable to be employed in prestigious institutions and organizations. Some of the university instructors and department heads noted that online courses were not that important for universities, and that students were recruited for financial purposes alone. The preservice teachers reported that the tuition fees they paid for these courses were very high, and that the services they received did not match the cost. The preservice teachers also noted that some of university instructors did not know how to use the technology and did not take online courses seriously. Other disadvantages mentioned by all of the participants were the lack of infrastructure and low Internet speeds. Some of the university instructors and department heads pointed out that the online TEFL courses lacked adequate human interaction. They also argued that the standards and levels of online students, who were admitted to the national university entrance examination, were unacceptable and low.

Measures to Improve the Acceptance of Online TEFL Courses

As Table 3 demonstrates, there was consensus among the participants about the importance of some of the measures to foster the acceptance of online TEFL courses. The participants emphasized the importance of fostering preservice teachers' and university instructors' digital literacy, improving teaching methods in online environments, increasing the credibility of online course certificates, blending online and face-to-face courses, enhancing technological infrastructures, raising social awareness about the credibility of online courses, providing technical support for university instructors and students, enhancing the speed of the Internet, updating the learning management system (LMS), and paying more attention to the importance of online TEFL courses.

Table 3

Questionnaire Results on Measures to Improve the Acceptance of Online TEFL Courses

Questionnaire item	Participant group	*M*	*SD*	Chi-square (Kruskal Wallis)	*p*
1. Fostering students' digital literacy	Preservice teachers	4.22	0.80	0.874	0.649
	University instructors	4.09	0.84		
	Department heads	4.40	0.51		
2. Fostering instructors' digital literacy	Preservice teachers	4.06	0.74	0.147	0.929

	University instructors	3.96	0.87		
	Department heads	4.10	0.73		
3. Improving teachers' methods/approaches of teaching in an online environment	Preservice teachers	4.35	0.69	6.562	0.038*
	University instructors	4.00	0.73		
	Department heads	4.10	0.31		
4. Increasing the credibility of online certificates/degrees	Preservice teachers	4.42	0.64	2.037	0.361
	University instructors	4.39	0.58		
	Department heads	4.70	0.48		
5. Blending online courses with face-to-face courses	Preservice teachers	4.13	0.75	0.596	0.742
	University instructors	4.04	0.76		
	Department heads	4.30	0.48		
6. Strengthening the criteria for student admittance	Preservice teachers	3.93	0.89	14.002	0.001*
	University instructors	4.57	0.50		
	Department heads	4.50	0.70		
7. Improving the level of technological infrastructures	Preservice teachers	4.23	0.76	2.124	0.346

	University instructors	4.26	0.75		
	Department heads	4.00	0.51		
8. Providing more technical support for teachers and students	Preservice teachers	3.99	0.90	3.893	0.143
	University instructors	4.30	0.97		
	Department heads	4.00	0.66		
9. Enhancing the speed of the Internet	Preservice teachers	4.31	0.65	1.164	0.559
	University instructors	4.35	0.88		
	Department heads	4.50	0.52		
10. Raising the awareness of society about the credibility of online courses	Preservice teachers	4.21	0.82	8.806	0.012*
	University instructors	4.70	0.47		
	Department heads	4.20	0.42		
11. Updating the LMS currently used	Preservice teachers	3.94	0.94	5.442	0.066
	University instructors	4.39	0.78		
	Department heads	4.10	0.56		
12. Using more interactive learning and teaching approaches	Preservice teachers	3.93	0.85	8.973	0.011*

	University instructors	4.13	0.75		
	Department heads	4.70	0.48		
13. Paying more attention to the importance of online learning	Preservice teachers	3.88	0.98	0.394	0.821
	University instructors	3.91	0.59		
	Department heads	4.10	0.31		

Note. Likert scale: 1 = Not important at all; 2 = Slightly important; 3 = Moderately important; 4 = Important; 5 = Very important.
*p ≤ 0.05

In the interviews, the majority of participants agreed that several measures should be implemented to improve the status quo. The three participants groups reported that online TEFL courses should be offered in the form of blended learning instead of fully virtual courses. They also believed that the quality of online courses should be enhanced in order to convince society that online courses have the same credibility as face-to-face TEFL courses. The university instructors and department heads shared the opinion that student admittance standards should be reviewed and revised. The need for improving the technological software and hardware infrastructures and enhancing the quality and speed of the Internet was also noted.

The Training Needs of Preservice Teachers and University Instructors

As Table 4 shows, there was consensus among the TEFL preservice teachers, university instructors, and department heads that preservice teachers and university instructors required training on the proper use of the LMS, competent use of the Internet, autonomous learning, the proper use of online learning materials and resources, and how to foster digital literacy.

Table 4

Questionnaire Results on the Training Needs of Preservice Teachers and University Instructors

Questionnaire item	Participant group	*M*	*SD*	Chi-square (Kruskal Wallis)	*p*
1. Training for the proper use of LMS	Preservice teachers	3.93	0.85	51.83	0.075

	University instructors	4.13	0.75		
	Department heads	4.10	0.31		
2. Training for competent use of the Internet	Preservice teachers	3.86	0.98	3.220	0.200
	University instructors	4.17	0.83		
	Department heads	4.30	0.48		
3. Training for autonomous learning	Preservice teachers	4.06	0.77	0.433	0.806
	University instructors	3.96	0.92		
	Department heads	4.20	0.78		
4. Training for the proper creation/use of online learning resources	Preservice teachers	4.11	0.86	2.163	0.339
	University instructors	4.35	0.88		
	Department heads	4.30	0.48		
5. Training students/teachers for use of interactive teaching/learning methods	Preservice teachers	4.54	0.55	12.851	0.002*
	University instructors	4.09	0.9		
	Department heads	3.90	0.56		
6. Training for fostering students' digital literacies	Preservice teachers	4.43	0.69	2.104	0.349

University instructors	4.26	0.61
Department heads	4.50	0.52

Note. 5-point Likert scale: 1 = Not important at all; 2 = Slightly important; 3 = Moderately important; 4 = Important; 5 = Very important.
*$p \leq 0.05$

The results of the interviews, in general, support the results of the questionnaires. All of the participants shared the opinion that training plays a central role in enhancing the quality of online TEFL courses. However, the participants stated that they had not received an adequate level of training and had learned how to work with the online system through experience and trial-and-error. Digital literacy training was identified as an important need for university instructors and preservice teachers. The preservice teachers and the university instructors wanted to learn more about the LMS and the properties of the software and the online courses. Some of the university instructors and department heads stated that there should be continuous on-the-job training for university instructors.

Preservice Teachers' Learning Achievements in TEFL Online Courses

Tables 5, 6, and 7 present the means of preservice teachers' mid-term and final scores in three online courses. The normality test showed normal distributions for the scores in the three courses (Course 1: Shapiro-Wilk = 0.958, p = 0.182; Course 2: Shapiro-Wilk = 0.969, p = 0.161; Course 3: Shapiro-Wilk = 0.942, p = 0.085). Significant differences were identified in the score means in the three courses (Course 1: t = 6.999, p = 0.000; Course 2: t = 5.673, p = 0.000; Course 3: t = 3.557, p = 0.003). The means of the final scores indicate significant learning improvements compared to the means of the mid-term scores in all three courses (Course 1: mid-term score mean = 16.9028, final score mean = 17.7083; Course 2: mid-term score mean = 17.3553, final score mean = 18.3553; Course 3: mid-term mean = 18.3125, final score mean = 18.8906). The effect size indices showed medium to large effect sizes for all three courses (Online Course 1: Cohen's d = 0.589766; Online Course 2: Cohen's d = 0.788153; Online Course 3: Cohen's d = 0.612974).

Table 5

Paired Samples t-Test Results for Preservice Teachers' Achievements in Online Course 1

	Mid-term scores (n = 18)		Final scores (n =18)	
Course 1	*M*	*SD*	*M*	*SD*
	16.9028	1.52946	17.7083	1.17964
Test of normality Shapiro-Wilk = 0.958 p = 0.182				
Paired samples test				
M	*SD*	*t*	*df*	*p*
0.80556	0.68361	6.999	17	0.000*
Effect size Cohen's d = 0.589766				

*$p \leq 0.05$

Table 6

Paired Samples t-Test Results for Preservice Teachers' Achievements in Online Course 2

	Mid-term scores (n = 19)		Final scores (n=19)	
Course 2	*M*	*SD*	*M*	*SD*
	17.3553	1.32108	18.3553	1.21425
Test of normality Shapiro-Wilk = 0.958 p = 0.161				
Paired samples test				
M	*SD*	*t*	*df*	*p*
1.0000	0.76830	5.673	18	0.000*
Effect size Cohen's d = 0.788153				

*$p \leq 0.05$

Table 7

Paired Samples t-Test Results for Preservice Teachers' Achievements in Online Course 3

	Mid-term scores (n = 16)		Final scores (n=16)	
Course 3	*M*	*SD*	*M*	*SD*
	18.3125	0.88019	18.8906	1.00208
Test of normality				
Shapiro-Wilk = 0.942 *p* = 0.085				
Paired samples test				
M	*SD*	*t*	*df*	*p*
0.57812	0.65012	3.557	15	0.003*
Effect size				
Cohen's *d* = 0.612974				

*$p \leq 0.05$

The interview results show that the three participant cohorts generally agreed that online courses were effective in promoting preservice teachers' learning achievements. The preservice teachers reported that the lessons were recorded so that they had opportunity to review lessons many times, and that this repetition was important in fostering their learning and retention of the content. The university instructors and department heads stated that online courses were somewhat effective in promoting students' learning. They noted that the motivations of online students to attend online courses differed from the motivations of face-to-face students. The department heads and university instructors believed that to achieve the most effective and the highest level of learning, face-to-face sessions should be added to online courses.

Discussion and Conclusion

The data analyses indicate mixed findings regarding the TEFL stakeholders' acceptance levels of online courses. While the preservice teachers were relatively positive about online learning of TEFL, the university instructors and department heads were not as positive. Previous research indicates similar attitudes towards online learning (e.g., Dashtestani, 2014; Karaman, 2011; Kim et al., 2005). Stakeholders' acceptance of and positive attitudes towards online learning can lead to the success of online courses. The differences in participants' attitudes may be the result of various factors, some of which can be controlled. The views of the university instructors and departments heads are thought-provoking and important to the analysis of the factors that play a role in their dissatisfaction with, and low acceptance levels of, online courses. Therefore, it is necessary to pave the way to meet the needs, preferences, and requirements of university instructors and departments heads in order to increase their interest in implementing and teaching online courses.

Although there were differences among the participants' perspectives regarding the challenges of online learning of TEFL, the participants were all aware of the presence of challenges. The issue of admitting incompetent students to online courses is a significant challenge, which can influence the attitudes of society about online courses. Participants suggested that more rigorous and stricter assessment procedures be implemented in admitting students to online courses. Another challenge is the lack of credibility of online learning certificates and degrees. While many universities emphasize that online and face-to-face course certificates have the same qualities, many employers are reluctant to employ individuals who received their degree from an online course. Addressing this problem requires both awareness-raising in society and implementing immediate plans and actions by educational planners and the Ministry of Science, Research, and Technology. The challenges of technological infrastructures and the speed of the Internet are another impeding factor, which can reduce the popularity of online TEFL courses. This issue may require the direct attention of university deans and government authorities. Similar findings regarding the challenges of online education have been reported in previous research (e.g., Grimes, 2002; Hughes & Daykin, 2002)

The participants made some suggestions to improve the status quo of online TEFL courses in Iran. Promoting the digital literacies of both university instructors and preservice teachers is an important recommendation. Students are usually admitted to online courses based on their knowledge of the field they plan to study in and not on their digital literacy. Taking into account the issue of the digital divide, many students may join online courses without adequate digital literacy skills. This can pose significant challenges for other students and university instructors in these courses. Therefore, stricter standards for digital literacy should be considered and stipulated for applicants who are admitted to online TEFL courses. Raising social awareness about the importance and credibility of online learning in higher education is another important measure to consider. All individuals involved in the process of developing and implementing online courses should undertake relevant measures to accommodate these challenges and limitations.

The majority of the participants agreed that training was needed for online learning stakeholders. Both university instructors and preservice teachers must receive training in order to enhance their teaching/learning effectiveness in online courses. This training can include different digital skills or teaching and learning methods for online learning environments. Training should be offered on a regular basis in order to enable teachers and students to address the challenges they encounter in online learning. Training is also needed for both novice and experienced online learning users. The need for training on online learning features and competencies has been discussed in previous literature as well (e.g., Dashtestani, 2014; Kim et al., 2005).

The results pertaining to preservice teachers' learning achievements in Iranian online TEFL courses show improvements in the final scores of the preservice teachers. The results of the paired samples *t*-test confirm the existence of significant differences between students' mid-term and final scores. The perspectives of the three participant groups also confirm that online courses can foster students' learning. However, while online courses can be effective in fostering students' achievements, the attitudinal and pragmatic barriers highlighted above can have significant impact on students' achievements in online courses. More importantly, many employers and proponents of face-to-face learning may question the quality of students' achievements and the assessment procedures in online courses.

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Mobile Teacher Professional Development (MTPD): Delving into English Teachers' Beliefs in Indonesia

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Abstract

In recent years, mobile phones have been used for teacher professional development (TPD). However, the potential use of smartphones, a current-generation of mobile phones, to develop teachers' pedagogical, social, personal, and professional competences remains underexplored. This mixed methods study, examining the potential use of smartphones for TPD by delving into English teachers' beliefs, employed a sequential explanatory approach. A quantitative survey was completed by 81 participants, followed by qualitative interviews with 8 selected participants. All the respondents were English teachers in elementary, junior, and senior high schools in 11 provinces in Indonesia. The survey was tested for validity and reliability, and analysed using the descriptive statistics method, while the semi-structured interview was analysed using the content analysis method. Almost all teachers had *very favourable* and *favourable* beliefs about the use of smartphones for TPD, perceiving that a smartphone could facilitate the enhancement of their pedagogical knowledge, communication skills, positive characters and English proficiency. Very few teachers had *unfavourable* beliefs, but among those who did, they believed traditional face-to-face TPD was more beneficial and that smartphones would only lead to addiction. This study recommends that smartphones be optimally applied by English teachers for TPD activities and that governments facilitate such implementation by constructing smartphone TPD models and applications.

Keywords: teacher professional development, TPD, mobile learning, smartphone, teachers' beliefs, English teachers, Indonesia

Introduction

Professionalism is imperative for teachers because it affects teaching quality (see Gore, Lloyd, Smith, Bowe, Ellis, & Lubans, 2017) and student achievement (see Sampel McMeeking, Orsi, & Cobb, 2012). The most popular approach to enhancing professionalism is traditional face-to-face teacher professional development (TPD) such as seminars, workshops, and trainings (see Irmawati, Widiati, & Cahyono, 2017; Utami & Prestridge, 2018). This approach, unfortunately, is "designed as mandatory for particular career stages (e.g., the new academic) or voluntary one-off events around a particular topic or innovation" (Dean, Herden-Thew, Delahunty, & Thomas, 2019, p. 50) which limits the freedoms of teachers to choose suitable TPD activities anytime and anywhere. Moreover, this approach presents several drawbacks in terms of practicality and financial viability. Teachers, particularly those in rural areas, find face-to-face TPD to be expensive and impractical (Russell, Carey, Kleiman, & Venable, 2009). Thus, in the field of teacher training, there has been a clarion call to provide another avenue of TPD, one which is more financially friendly, flexible, and practical.

The mobile phone offers one such avenue. The mobile phone has capability to provide myriad resources for teacher professional learning (Aubusson, Schuck, & Burden, 2009) so that teachers can improve their skills and knowledge anytime and anywhere, and so they have full freedom to choose TPD activities which best meet their needs. This capability is rooted in the ability of the mobile phone to merge mobile and ubiquitous learning (Schon, 1987) with authentic and meaningful contexts (Hsu & Ching, 2012). Furthermore, the use of mobile phones also helps teachers financially due to the fact that costs for the purchase and operation of mobile phones are comparatively low (Burns, 2015). Evidence in support of the use of mobile phones, especially traditional cell phones, for TPD is found in two related studies. Walsh, Shrestha, and Hedges (2013) showed how a cell phone with hundreds of TPD and classroom audio and video files which were stored on micro secure digital (SD) cards had the ability to enhance teachers' professional knowledge and students' communicative English language acquisition. Meanwhile, Shaheen, Walsh, Power and Burton (2013) carried out the English in Action (EIA)'s School Based Professional Development (SBPD) model and discovered that a cell phone was able to positively change the classroom practice of English teachers in Bangladesh.

However, further research is needed, particularly as it relates to the potential use of a more current mobile phone models (Tossell, Kortum, Shepard, Rahmati, & Zhong, 2014), specifically smartphones. The smartphones can facilitate the advancement of academic capabilities and progressions (Ifeanyi & Chukwuere, 2018). It can also engender social media involvement and information sharing and build social skills (Mokoena, 2012).

This study investigated teachers' beliefs, verbal propositions and judgements perceived to be true by teachers, concerning the potential use of smartphones to develop teachers' pedagogical, social, personal, and professional competence and understand the reasons for such beliefs. Building on previous research into TPD and mobile technology, this study elicited critical information on the current state of the use and usefulness as well as shortcomings of smartphones for TPD.

Indonesia was chosen as the context of this study because it is made up of 17,504 islands (Martha, 2017) and represents great diversity in terms of geographical areas (developed, less-developed, outermost, and rural regions) as well as in terms of TPD profile activities performed by teachers. Furthermore, research into the topic of mobile phone use for TPD in countries with emerging economies, such as Indonesia (Olken, 2019), is still in its infancy (Kidd & Murray, 2013).

Literature Review

Teacher Professional Development (TPD)

TPD, discussed extensively in educational literature, has evoked multiple conceptualizations. The term has been defined largely as a process of creating a change or improvement in the quality of teaching (Farias & Araujo, 2018; Kennedy, 2016) and student learning (Novozhenina & López Pinzón, 2018), mostly in the areas of a teacher's pedagogy, behaviour, and personal competence (Makovec, 2018). Moreover, existing literature has described TPD as a process of meaningful and life-long learning directed towards developing teachers' personal, professional, social, and behaviour competence (Valenčič Zuljan, 2001). The research focuses on the development of subject-matter knowledge, pedagogical expertise, self-awareness, understanding of learners, curriculum and materials, and career advancement for teachers (Richards & Farrell, 2005). Therefore, for the purpose of this study, TPD is defined as the process of engendering a positive change in the pedagogical, social, personal, and professional competence of teachers through meaningful and lifelong learning to improve teaching practices and student learning outcomes. These competences were further elaborated by Tahir (2017).

The pedagogical aspect includes (a) understanding both physical and non-physical characteristics of learners' development, (b) mastering learning theories and models, (c) developing curricula and strategies for developing curricula, (d) conducting professional instructional activities, (e) developing learners' various potentials and interests, (f) communicating effectively with learners, (g) using technology in teaching, (h) administering and using assessment of learning outcomes, and (i) conducting a reflection of learning (Tahir, 2017).

The social aspect involves (a) promoting inclusivity and non-discrimination and knowing the strategies to develop these attitudes, (b) communicating effectively, emphatically, and politely to colleagues and people in school, (c) adapting to all conditions of learning and education with diverse social cultures, and (d) communicating with the same or different teacher associations both in spoken and written forms (Tahir, 2017).

In terms of the personal competence, the indicators involve (a) performing behaviours in line with norms, (b) exhibiting the characteristics of a role model, (c) building an excellent character and work ethic, and (d) upholding ethical codes of profession (Tahir, 2017).

Finally, the professional aspect comprises (a) mastering topics, structures, concepts and conceptual frameworks in the field of expertise, (b) comprehending standard and base competence of the subject being taught, (c) developing learning materials creatively, (d) improving professionalism continuously by conducting research and reflective teaching practices, and (e) using Information and Communication Technology (ICT) for personal development (Tahir, 2017).

Smartphone

A smartphone is a technological product which is handheld and pocket-size (Lundquist, Lefebvre, & Garramone, 2014) and part of the current-generation of mobile phones which provides users with extensive access to the Web, different games, social networks, and a myriad of other applications (Tossell et al., 2014). Sarwar and Soomro (2013) described its capabilities:

> Smartphone is a mobile phone with advanced features and functionality beyond the basics like making phone calls and sending text messages. It is able to display photos, play games, play videos, navigation, built-in camera, audio/video playback and recording, send/receive e-mail, built-in apps for social web sites and surf the Web, wireless Internet and others (p. 216).

Smartphones provide ubiquitous facilities required to ease the exploration of the cyberspace as well as fulfil daily needs, such as learning (Wenyuan, 2017).

There are significant benefits to learning through the use of a smartphone. These include advancing academic capabilities and progression (Ifeanyi & Chukwuere, 2018), social media involvement, as well as sharing information and building social skills (Mokoena, 2012). Despite these advantages, there are reports of addiction which is defined as "uncontrollability of smartphone use" (Cha & Seo, 2018, p. 2), especially for entertainment purposes. This could lead to numerous social, personality, and health problems. There is a need to educate and guide users of this phone in order to promote understanding of its positive and negative impacts (Sarwar & Soomro, 2013).

Teachers' Beliefs

Pajares has completed comprehensive research into the concept of teachers' beliefs (Borg, 2015). According to Pajares (1992), the concept is related to what the teachers believe about their work, subject matter, roles, and responsibilities. Other researchers have defined teachers' beliefs as the verbal statements of proposition or judgement perceived to be true by the teachers (Saiful, 2018; Saiful & Widodo, 2019), leading to commitment (Borg, 2001).

The elements of teachers' beliefs include works, subject matters, roles, and responsibilities. Limited research has been conducted on these elements, particularly in relation to the responsibility of English teachers in developing competences (see Ahonen, Pyhältö, Pietarinen, & Soini, 2014; Subekti, 2019; Too & Saimima, 2019). This means there is a lack of knowledge about the propositions or judgements perceived to be true by English teachers concerning the strategies or tools to develop their competence.

Methodology

Research Method and Design

This study employed mixed methods with sequential explanatory approach to reveal the beliefs of English teachers on the potential use of smartphones for TPD. The study looked not only at the diverse beliefs but also at the reasons for these beliefs. The two-phase research trajectory included a quantitative approach followed by the qualitative method and concluded with interpretations as shown in Figure 1.

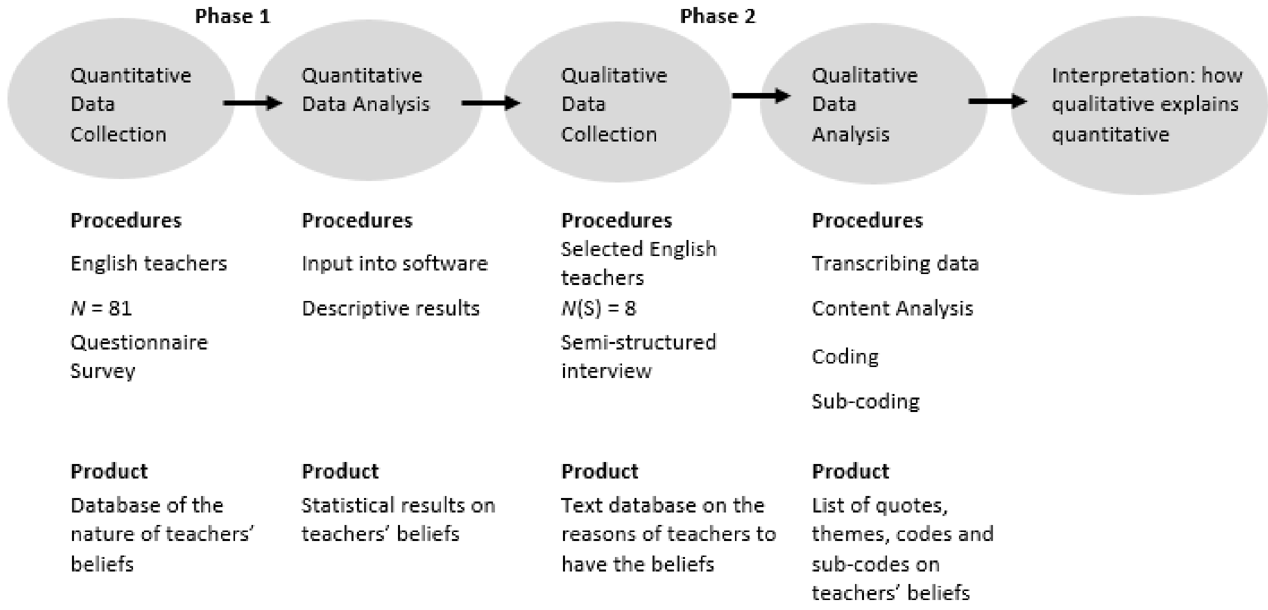

Figure 1. The trajectory of a mixed-method study. Adapted from "Turkish high school students' English demotivation and their seeking for remotivation: A mixed-method research," by C. Akay, 2017, *English Language Teaching, 10*(8), p.111. Copyright 2006-2018 by the Canadian Center of Science and Education. (http://www.ccsenet.org/journal/index.php/elt/article/download/69377/37724)

Participants

There were two categories of participants: those who completed the survey and those who took part in interviews.

Eighty-one English teachers who stated that they developed their professionalism mostly through the use of their smartphones were surveyed. They reported using WhatsApp and YouTube applications installed on their smartphones to enhance their understandings of English instructional practices and to develop English language skills. While many also took part in traditional face-to-face training, the smartphone was an important part of their professional development. This group consisted of 38 males and 43 females, teaching from elementary to senior high school level, representing 11 different provinces in Indonesia including West Java, East Java, Central Java, Jakarta, Banten, Jambi, Yogyakarta, Papua, Bangka Belitung, Central Sulawesi, and Bali.

The interviews were conducted with 8 individuals who were purposively selected based on the results of the survey. They included 3 participants who reported *very favourable beliefs*, 3 who reported *favourable beliefs*, and 2 who reported *unfavourable beliefs* in the use of smartphones for TPD.

Data Collection Techniques and Instruments

Data were collected from a questionnaire and interviews. The questionnaire was used to obtain quantitative data on the nature of teachers' beliefs in the use of smartphones to develop pedagogical, social, personal, and professional competencies. The questionnaire was divided into two parts: the first part was focused on the personal and school background of the participants, while the second part was focused on the questions related to beliefs.

This second part was constructed based on the theory of teacher competence domain proposed by Tahir (2017). It comprised 24 statements of belief in the 4 areas of competence: pedagogical (10); social (3); personal (4); and professional (7). Eight statements were classified as negative and the remaining 16 as positive (see Appendix). Participants were asked to agree or disagree with the statements, based on a four-point Likert scale in which 4 = *strongly agree*, 3 = *agree*, 2 = *disagree,* and 1 = *strongly disagree*. Furthermore, the professional competence domain of the questionnaire was constructed based on English Language Teaching (ELT) skills and components including listening, speaking, reading, writing, pronunciation, vocabulary, and grammar aspects.

This questionnaire was tested for validity and reliability before being applied as a research instrument. The construct or logic validity of the questionnaire was assessed by experts and two English teachers, after which a trial was conducted on 30 English teachers in Indonesia. The result showed all the 24 items were valid, as the score of item-total correlation was above 0.300. Meanwhile, based on the Cronbach's alpha value of 0.909, which was higher than 0.70, the questionnaire was also deemed reliable.

The interviews were conducted to understand the reasons for participants' beliefs in the potential use of smartphones to develop the pedagogical, social, personal, and professional competence. The questions were formulated based on the survey results, and were open-ended to evoke additional comments or thoughts towards the potential use of smartphones. The interviews were lasted in about 20 minutes to each of the 8 selected participants using a phone interview. The researcher installed *an automatic call recorder application* in the phone to record all conversations during interviews, and he took notes important points of the participants' responses. The sample probes of interview questions were as follows:

1. The results of the survey showed you have very favourable/favourable/unfavourable beliefs in the use of smartphones to develop pedagogical, social, personal, and professional teacher competence. Why do you have such beliefs?

2. What other comments or thoughts do you want to add on the potential use of smartphones for teacher competence development?

Data Analysis

Descriptive statistics and content analysis were the methods used with the data. Descriptive statistics involved the application of IBM's SPSS Statistics 20 software to analyse both the general nature of teachers' beliefs about the potential use of smartphones for TPD and the specific nature of beliefs in each domain of competence, i.e., pedagogical, social, personal, and professional. Furthermore, content analysis was administered to reveal both the reasons for such beliefs and additional comments. It was done after the transcriptions of the interviews were sent to the participants for validation to ensure accuracy.

The codes used with quotations in the Result section of this paper are shown in Table 1. They describe the interview participants' level of beliefs, particular competence being discussed, and additional comments. For example, a quotation with the code *T2.SB.ProC* means it belongs to teacher number 2 who demonstrated strong beliefs towards the potential use of smartphone to develop teachers' professional competence.

Table 1

Codes Used to Categorise Interview Participants' Comments

Code	Meaning
T1-T8	teacher number
B	believe
NB	not believe
SB	strongly believe
GR	general reasons
PedC	pedagogical competence
SosC	social competence
PerC	personal competence
ProC	professional competence
AC	additional comments

Results

General Nature of English Teachers' Beliefs in the Use of Smartphone for TPD

Based on mean score, teachers favoured the potential use of smartphones for TPD as shown in Table 2.

Table 2

Descriptive Statistics of a General Nature of English Teachers' Beliefs in the Use of Smartphones for TPD

	N	*M**	*SD*	*SEM*
Beliefs	81	3.1857	.29895	.03322

Note. Mean score 1.00 – 1.75 = *very unfavourable*, 1.76 – 2.5 = *unfavourable*, 1.6 – 3.25 = *favourable*, 3.26 – 4.00 = *very favourable*.

The detailed responses in Figure 2 show the majority of the participants (50) had *favourable beliefs* about the use of smartphones for TPD, while 28 had *very favourable beliefs* and only 3 reported *unfavourable beliefs*. None held *very unfavourable beliefs*.

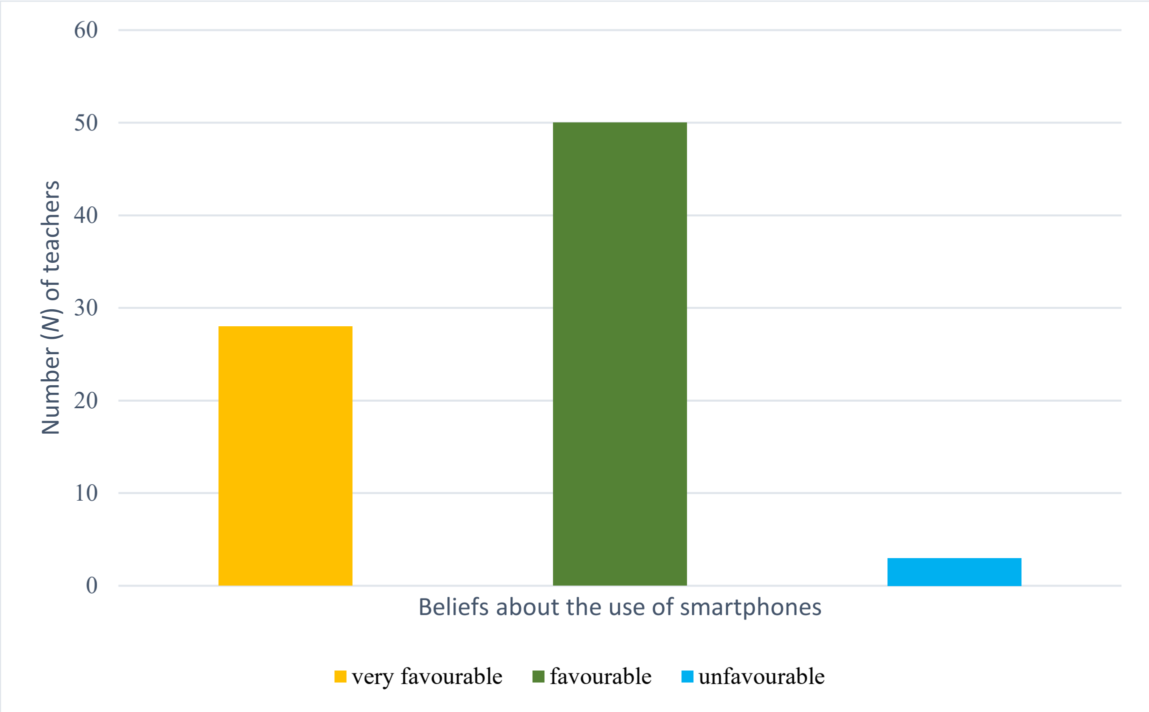

Figure 2. Distribution of beliefs of English teachers in the potential use of smartphones for TPD. No teachers reported *very unfavourable* beliefs for any item.

Specific Nature of English Teachers' Beliefs in the Use of Smartphones to Develop Competences

Table 3 shows the specific beliefs of English teachers in the use of smartphones to develop pedagogical, social, personal, and professional competences were *favourable*.

Table 3

English Teachers' Beliefs in the Use of Smartphones for Developing Various Competences

Aspects of teachers' beliefs	*N* of statements	*M**
Beliefs in the use of smartphones for developing teacher pedagogical competence	10 items	3.223457
Beliefs in the use of smartphones for developing teacher social competence	3 items	3.209877
Beliefs in the use of smartphones for developing teacher personal competence	4 items	3.000000
Beliefs in the use of smartphones for developing teacher professional competence	7 items	3.227513

Note. Mean score 1.00 – 1.75 = *very unfavourable*, 1.76 – 2.5 = *unfavourable*, 1.6 – 3.25 = *favourable*, 3.26– 4.00 = *very favourable*

Reasons for the Beliefs of English Teachers and Additional Comments

Generally, the reasons for the participants' favourable beliefs in the potential use of smartphone for TPD were due to the ability of the technology to provide significant benefits in teaching and learning, advancing knowledge, and building professional networks, particularly for those living in rural areas.

> Teachers will definitely feel the benefits of smartphone, for example, I'm teaching in a rural area and it is difficult to access the books needed to update information on decree of professions, teaching materials, and improve my knowledge on different subject matter. This device gives me the opportunity to achieve these and also to communicate with teachers from other regions or places to share knowledge and materials. (T6.B.GR)

Teachers believe the smartphone aids the development of their pedagogical competence because it is a great medium on which to learn and search for teaching materials, methods, and models, as well as to develop technological pedagogical content knowledge (TPACK) and conduct virtual classes. Related comments included: "By using a smartphone, teachers can develop TPACK" (T2.SB.PedC); "It aids the improvement of the pedagogical competence and the ability to use online virtual class such as Google classroom, WhatsApp and so on" (T5.B.PedC); and "Yes, it is possible for teachers to update teaching materials, models, and methods using the Internet on this device" (T6.B.PedC).

Smartphones were also described as having the ability to aid the development of communication skills and build positive relationships with parents and other people in the school. "Yes, for example, I can build good communication with students and parents and, most importantly, share the problems of students and know their parent's aspirations" (T1.SB.SosC). Another teacher elaborated on how using a smartphone helped improve social competences.

> Teachers can communicate easily with students using smartphone. In my case, I use my smartphone to communicate with students. They become more open, they aren't afraid to ask questions and assignment as well as material they don't understand. They usually contact me after the class or in the evening. So, I know more about my students' difficulties in learning. One important thing is that when I reply to their messages via WhatsApp, they feel appreciated and their attitude towards learning in the classroom become more positive because it seems we are now like friends. (T2.SB.SosC)

Interview participants also related one unique way in which the device helped them develop positive characteristics: by reading the biographies of reputable figures online and applying their positive attributes from the texts to their own lives. One of the teachers stated that, "If we open positive content like biography of figures, we can learn positive deeds and apply it in real life. So, I feel I have become more open and sociable by using smartphone" (T2.SB.PerC).

Smartphones were also reported to have the ability to provide ubiquitous resources for English teachers to develop their proficiency in the language. It is possible to develop skills such as listening, speaking, reading, and writing, as well as components such as grammar, vocabulary, and pronunciation by accessing websites and YouTube, as well as through the download of English learning applications or dictionaries from the Google Play Store. A few of the comments related to developing professional competence particularly in teaching English include: "Teachers have the ability to access different courses on English language using websites, YouTube, and other applications to update their reading, listening, writing, and even speaking abilities" (T2.SB.ProC); "The use of smartphones aids the learning of English expressions such as idioms using YouTube. We can also download a dictionary to look for the meaning of certain words" (T1.SB.ProC); and, "Several applications have been developed on smartphones to help teachers improve their English. You just have to download them from [Google] Play Store" (T5.B.ProC).

Additional comments related to how teachers need to be autonomous and have reliable Internet access in order to take advantage of the benefits of using smartphones for TPD. For example, one participant reported that, "There are a lot of benefits attached to the use of smartphones for teacher development, it's cheap, but teachers need to be independent to use it" (T4.B.AR). Another said that "I think we need good internet connection, or WiFi to use smartphone (T1.SB.AC).

A few participants had negative beliefs concerning the use of smartphones for TPD because they perceived that there was no relationship between the smartphone use and teacher's professionalism. Besides, they also thought face-to-face training and workshop were more useful. Their comments included: "I believe there is no correlation between developing teacher competence and smartphone" (T7.NB.GR), and "hmm… I don't think Smartphone is useful for teacher competence. I think training and workshops are more beneficial" (T8.NB.GR).

These teachers also reported that they did not believe smartphones facilitated the development of teachers' pedagogical, social, personal, and professional competences. They believed pedagogical competence could only be developed through face-to-face training and in workshops, and that the use of smartphones perceived was making teachers more individualistic and selfish. They said "…because Smartphone only makes people more individual without the willingness to socialize" (T7.NB.SosC); "It is because people become more selfish, they don't consider helping others and think about themselves only" (T7.NB.PerC); and "I think someone will neglect everything easily, the jobs for example, so, it's just distracting" (T8.NB.PerC).

Discussion

The results showed that the majority of the participants had favourable beliefs about smartphone technology and TPD, which, in the views of Saiful (2018) and Saiful & Widodo (2019), indicate that English teachers perceive the ability of smartphones as a reasonable avenue to develop their competences. This finding was corroborated by the results of the interview. The teachers reported the significant benefits of smartphones to develop knowledge, build professional networks, and support instructional activities. However, a few participants believed that the development of teacher competence could only be achieved through face-to-face workshops and training. This poses challenges for teachers in rural areas because implementing face-to-face TPD in these areas is very expensive and impractical (Russell et al., 2009), so much so that often rural teachers will have to gather in central urban areas for a couple of days at a time and thus TPD becomes more expensive and impractical. Additionally, there are times when the knowledge acquired during such activities may not be applicable to individual teacher's needs, and thus, better alternatives are being developed.

The use of smartphones by English teachers in rural areas was found to be a profound catalyst for TPD due to its characteristic low-cost (Burns, 2015), handiness, and of pocket-size (Lundquist et al., 2014). These characteristics make it possible to conduct professional development processes and activities at anytime and anywhere, without generating huge expenses. More importantly, these characteristics also make it possible to offer competence development activities which fit with the needs of many different types of teachers, due to the resources such as Web, games, social networking, and other prolific applications (Tossell et al., 2014) which are suitable for teacher professional learning (Hsu & Ching, 2012). The results of the interviews confirmed that the presence of smartphones was crucial for English teachers in particular because it allows them to review learning topics and get updated on the latest news in their professions, including teaching materials.

This study extends the findings of Walsh et al. (2013) which showed the ability of mobile phones to enhance English teachers' professional knowledge. Similarly, smartphones were believed by participants to be able to augment technological pedagogical content knowledge of English teachers, integrating subject matter and technology in instructional activities. Furthermore, the findings expounded upon the notions of Makovec (2018) and Richards and Farrell (2005) that one of the foci of TPD is to develop pedagogical competence. Likewise, during the interviews, participants reported on the ability of smartphone technology to aid in learning new teaching methods, models, and materials, as well as in exploring the possibilities of conducting online classes.

The smartphone was also believed to be able to develop teachers' social competence by enhancing communication skills and building positive relationships among teachers, students, parents, and colleagues. Participants reported that WhatsApp was one of the best ways to establish positive social skills and relationships, especially by creating groups for teachers and parents to understand the students' problems and parents' aspirations. Interestingly, in the interview, participants reported that the communication between teachers and students through a WhatsApp group had a very positive impact on the teacher-student relationship and students' learning attitudes. Furthermore, the social media platform was also reported to be a means of developing pedagogical competence for the teachers. Summarily, this study disclosed the possibilities of using WhatsApp as a tool for TPD. This result confirms the findings of Mokoena (2012) which identify building social skills as one of the significant benefits of learning using a smartphone.

Here are my findings on personal and professional competences; this adds new knowledge in the field of mobile phone for TPD. Existing works from Shaheen et al. (2013) found the cell phone could change positively the instructional practices of the teachers and from Walsh et al. (2013) found that a cell phone for TPD can positively enhance English teachers' professional knowledge. My findings, to such an extent, disclose new possibilities of the mobile phone, specifically smartphones to augment personal and professional competences of teachers. The participants reported that the use of the device to read on the biography and status of figures has extensively exposed them to examples of positive characters or deeds they can absorb and apply in real life. They also believed that they could improve their English skills (listening, speaking, reading, and writing) and components (grammar, vocabulary, and pronunciation) through the use of websites, YouTube, and other myriads of applications available on the smartphone.

My study also exhibits other novel findings which once more extend the works of Shaheen et al. (2013) and Walsh et al. (2013). When doing TPD using smartphones, a few teachers were, however, concerned about smartphone addiction. Some believed that the use of smartphones for TPD could lead teachers to be more individualistic and selfish. Nevertheless, Sarwar and Soomro (2013) believed simultaneous education and guidance could help reduce the level of addiction and promote the beneficial use of the device for TPD purposes. Furthermore, it was also reported that there was a need for autonomy and increased access to the Internet for more effective application of smartphones to TPD.

Conclusion

This study investigated the beliefs of English teachers in Indonesia about the potential use of a smartphone to develop teachers' pedagogical, social, personal, and professional competences and understand the reasons for such beliefs. The majority of the English teachers (78 of 81 participants) had *very favourable* or *favourable* beliefs concerning the use of smartphones for TPD. This indicates that most English teachers believe the smartphone can facilitate the development of their pedagogical, social, personal, and professional competences. Furthermore, the results of the interviews exhibited the reasons why the teachers have such beliefs. It was found that the teachers thought the smartphones had great potentials to: (a) facilitate the development of their technological pedagogical content knowledge, (b) develop their professional network and instructional activity, (c) serve as a medium to learn new teaching methods, models, and acquire materials, and (d) enhance communication skills and build positive relationship among students, parents, and colleagues. They also reported how smartphones could stimulate positive character development and improve their English skills and knowledge.

Beyond *very favourable* and *favourable* beliefs, the results of survey also showed that three teachers had *unfavourable* beliefs concerning the use of smartphones for TPD. The interview confirmed that it was because the teachers preferred face-to-face TPD such as workshops and trainings. These few teachers also thought that smartphones induced individualistic and selfish characteristics. However, adequate guidance and education could encourage teachers to use smartphones for beneficial purposes. Besides, this study exhibits interesting findings from interview on the possibilities of using WhatsApp as a tool for TPD, as well as on the needs for autonomy and increased access to internet for effective application of smartphones to TPD.

However, this study has limitations. This study has not yet provided empirical evidence of a causal relationship, or of the impact of the teachers' beliefs on each kind of teacher competence (personal, pedagogical, social, and professional). This study also has not examined the effect of the teachers' use of smartphones for TPD on outcomes such as instructional practices and students' achievement. Subsequent studies may, therefore, investigate these areas.

The implications of this study are two folds. First, in order to develop competence, teachers in Indonesia, particularly those in rural areas, can use low-cost smartphones to develop competence anytime and anywhere, without thinking about the financial implications. Second, as an alternative to traditional face-to-face activities, government, especially education councils, should construct smartphone TPD models and applications to support and enhance teachers' TPD.

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Appendix

A Questionnaire of Teachers' Beliefs in the Potential Use of Smartphones for TPD

Table A1

A Questionnaire of Teachers' Beliefs in the Potential Use of Smartphones for TPD

Aspects of teacher competence	No.	Statements
Beliefs in the use of smartphones to develop teacher pedagogical competence	1.	The use of a smartphone limits the chances of teachers to comprehend the development of students' physical, intellectual, social-emotional, moral, spiritual and social-cultural background.*
	2.	The use of a smartphone can help teachers master different learning theories and models.
	3.	Teachers can learn about the curriculum and its development through the use of a smartphone.
	4.	I believe teachers will not be able to provide quality instructional activities using a smartphone.*
	5.	For teachers, a smartphone can be a means of developing students' academic and non-academic potentials.
	6.	Teachers can communicate effectively with students using a smartphone.
	7.	I believe the use of smartphones aid the ability of teachers to learn about the integration of technology into English instructional activities.
	8.	I believe the use of smartphone hinders the opportunities of teachers to develop the knowledge required to assess students learning outcomes.*
	9.	The use of smartphones enables teachers to boost their knowledge of implementing reflection in learning instructions.
	10.	The use of smartphone facilitates teachers discriminating behaviours towards students.*
Beliefs in the use of smartphones to develop teacher social competence	11.	I believe the use of smartphones enables the teacher to communicate effectively, emphatically, and politely with other people in school.
	12.	Teachers can adapt to new working cultures by using a smartphone.
	13.	By using a smartphone, teachers can communicate with their associations easily through both written and spoken words.
Beliefs in the use of smartphones to develop teacher personal competence	14.	I believe teachers will not develop positive attitudes and behaviours by using a smartphone.*
	15.	A smartphone is one of the media helping teachers to behave based on norms in the workplace and society.
	16.	By using a smartphone, teachers can develop their characters and work ethics.
	17.	I believe teachers can learn to uphold and apply the code of ethics of the profession using a smartphone.
Beliefs in the use of smartphones to develop teacher professional competence	18.	I am sure English teachers can develop their English-speaking skill using a smartphone.
	19.	English listening skill of English teachers will not be developed using a smartphone.*
	20.	A smartphone is a means of enhancing the English reading skill of English teachers.
	21.	English teachers cannot improve their English writing skill using a smartphone.*
	22.	The use of a smartphone helps English teachers improve their English pronunciation.
	23.	English teachers will not be able to enrich their English vocabularies using a smartphone.*
	24.	I am sure English teachers can improve their English grammar using a smartphone.

Note. (*) negative statement

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Mobile Technology Acceptance Scale for Learning Mathematics: Development, Validity, and Reliability Studies[i]

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Abstract

The purpose of this study is to develop a valid, reliable, and useful scale to measure high school students' levels of acceptance of mobile technologies in learning mathematics based on the second version of the unified theory of acceptance and use of technology (UTAUT2) model. The study was designed based on a sequential exploratory mixed-method research design. To this end, both qualitative (interviews with students, review of literature, and expert panel evaluation) and quantitative procedures (Lawshe content validity technique, exploratory and confirmatory factor analysis, convergent validity, discriminant validity, nomological validity, criterion validity, internal consistency reliability, and temporal reliability) were used to develop and validate the Mobile Technology Acceptance Scale for Learning Mathematics (m-TASLM). As a result, a 5-point Likert scale with 36 items grouped under 8 factors was developed and confirmed. Both validity and reliability studies yielded favorable results.

Keywords: mobile technology, technology acceptance, learning mathematics, UTAUT2

Introduction

Fast and continuous developments in mobile and wireless technologies have made mobile devices more useful, affordable, and widely available, which, in turn, has led to an increase in their use and the popularity of mobile learning (m-learning; Park, Nam, & Cha, 2012; Wu et al., 2012). Since its inception, m-learning has attracted the attention of both researchers and practitioners (Al-Hujran, Al-Lozi, & Al-Debei, 2014; Wu et al., 2012). Reviews on the contribution of m-learning in education have pointed to its potential for improving learning achievement, motivation, and interest in the condition that it is accompanied by proper strategies during the learning process (Hwang & Wu, 2014). M-learning needs to be investigated more specifically in teaching and learning different subjects including mathematics, science, and social studies to discover more fully its effect (Chung, Hwang, & Lai, 2019). Crompton, Burke, and Gregory (2017) reported that mathematics is a popular subject of m-learning researchers. Mobile devices' unprecedented capabilities and wide acceptance among young people can expand the boundaries of mathematics teaching and offer new ways to extend mathematical thinking beyond the classroom into the real world (McMullen, Hannula-Sormunen, Kainulainen, Kiili, & Lehtinen, 2017). Previous researches on the use of m-learning in mathematics have yielded favorable results regarding its impact on learners' knowledge (Riconscente, 2013), problem-solving skills (Al-Khateeb, 2018), self-competencies (Hung, Huang, & Hwang, 2014), motivations (Hung et al., 2014), and attitudes (Riconscente, 2013).

While m-learning has many advantages as demonstrated in the literature, its success is not guaranteed unless it is adopted and applied properly. However, proper adaptation and application depends on learners' acceptance of mobile technologies (Awadhiya & Miglani, 2016; Wang, Wu, & Wang, 2009). Therefore, students' acceptance of mobile technology needs to be investigated. With a protocol between the Ministry of National Education and Türk Telecom (a local communication company), schools in Turkey have been provided with Internet infrastructure since 2003. With the launch of the FATIH Project (The Movement to Enhance Opportunities and Improve Technology) in 2010, most teachers and students in high schools were provided with tablet computers, which means high school students in Turkey have experienced m-learning for about a decade. Thus, there is now enough background to investigate high school students' level of acceptance of mobile technologies specifically in learning mathematics.

This study was developed to design and test a valid, reliable, and useful scale, i.e. the m-TASLM, to measure high school students' levels of acceptance of mobile technologies in learning mathematics.

Theoretical Framework

M-Learning

Mobile technologies have invaded our everyday life with their unprecedented and widely affordable capabilities including small size and portability, computing power and modular platform, wireless communication ability, multipurpose applications, ability to synchronize and back up with other computers, and stylus-driven interface (Pea & Maldonado, 2006). These unique characteristics coupled with the increased use of mobile devices have made these technologies convenient for education, giving rise to new terms such as e-learning and m-learning. M-learning refers to the use of mobile technologies in the learning process (Al-Hujran et al., 2014; Crompton & Burke, 2018; Park et al., 2012). More specifically, Al-Hujran et al. (2014, p. 14) defined m-learning as "integrating mobile technologies with learning and education processes." To Crompton and Burke (2018, p. 53), m-learning denoted "learning involving the use of a mobile device." Barati and Zolhavarieh (2012, p. 298) defined m-learning as "any form of learning and teaching process that occurs by mobile device or in [a] mobile environment."

Benefits and Barriers

There is a good amount of literature on the benefits of m-learning. M-learning removes the boundaries of the classroom (Reychav, Dunaway, & Kobayashi, 2015), enabling students to learn anytime anywhere (Chung et al., 2019). In general, m-learning is best characterized by its ability to enrich learning experiences with enhanced mobility and connectivity (Cheon, Lee, Crooks, & Song, 2012). Thanks to this mobility and connectivity, students are able to learn more easily, practically, and productively (Choon-Keong, Ing, & Kean-Wah, 2013; Gikas & Grant, 2013). When accompanied with proper learning strategies, m-learning is also praised for its positive impact on students' learning achievement (Hwang & Chang, 2011; Hwang & Wu, 2014), attitudes towards the lesson (Hwang & Chang, 2011), interest and motivation (Hwang & Chang, 2011; Hwang & Wu, 2014), as well as on problem-solving skills (Al-Khateeb, 2018; Lai & Hwang, 2014), creativity, and communication skills (Lai & Hwang, 2014).

There are however some disadvantages and barriers to using mobile learning. Among these are issues of connectivity, small screen size, limited processing power, low input capacity, security and abuse, distracting factors, reluctance to adopt, and difficulty in using technology (Awadhiya & Miglani, 2016; Wang et al., 2009). Gikas and Grant (2013) mentioned that distracting factors such as social networks and small mobile keyboards are among the difficulties experienced by students using mobile devices. Gökdaş, Torun, and Bağrıaçık (2014) attributed the pre-service teachers' negative attitudes towards mobile learning to low Internet speed, and the poor quality or lack of digital content. Şad, Özer, Yakar, and Öztürk (2020) argued that using smartphones for learning may prevent students from achieving the degree of cognitive depth necessary for long-term retention.

M-learning in teaching mathematics. The unprecedented capacities of mobile devices (e.g., portability and availability) and their wide acceptance among young people have also influenced learning and teaching mathematics (Attard & Northcote, 2012). Since learning mathematics through mobile means helps students gain new mathematical knowledge, skills, and experiences, mobile mathematics learning has become a new area with a growing interest among educational researchers and practitioners (Kyriakides, Meletiou-Mavrotheris, & Prodromou, 2016). Several mobile and online applications have been developed to support teaching algebra, geometry, analysis, statistics, probability, and other areas of mathematics (Cayton-Hodges, Feng, & Pan, 2015; Fabian, Topping, & Barron, 2016).

The pedagogical potential of mobile applications especially in the fields of mathematics, science, and engineering stems from their advantages in helping students grasp the abstract concepts in these disciplines (Subramanya & Farahani, 2012). Using mobile devices also allows learners to become aware of their mathematical skills including measurement, prediction, and problem-solving (Fabian et al., 2016; Tangney & Bray, 2013). Allowing direct interaction with mathematical phenomena through visual and dynamic affordances on touchscreens, mobile mathematics learning provides students with opportunities for the easy transference between home and outdoor learning situations and more flexible ways to work collaboratively (Larkin & Calder, 2016). Mobile mathematics learning applications also provide opportunities to discover mathematics independently or cooperatively in real-life situations through visualization and contextualization (Baya'a & Daher, 2009).

Technology Acceptance and Unified Theory of Acceptance and Use of Technology

Despite the documented advantages of m-learning, its success is not guaranteed unless it is adopted and applied properly. Proper adaptation and application depends on learners' acceptance of mobile technologies (Awadhiya & Miglani, 2016; Wang et al., 2009). Wang et al. (2009) stated that "the success of m-learning may depend on whether or not users are willing to adopt the new technology that is different from what they have used in the past" (p. 93). Likewise, Awadhiya and Miglani (2016) have warned that learners' reluctance to adopt specific technologies is an important challenge to m-learning.

Many theoretical models were developed with regard to technology acceptance research, each with different acceptance determinants (Venkatesh, Morris, Davis, & Davis, 2003; Venkatesh, Thong, & Xu, 2012). Researchers had a multitude of models from which to choose, though picking one meant ignoring the contributions of alternative models (Venkatesh et al., 2003). This necessitated the need to review and synthesize these models, and eventually Venkatesh et al. (2003) integrated the most specific and well-known eight models and proposed a compact model called the unified theory of acceptance and use of technology (UTAUT; Venkatesh et al., 2012; Wang et al., 2009).

Since UTAUT was originally developed to evaluate the acceptance and use of information technologies by employees, especially in the organizational context, use of the model with different technologies, users, or cultures was limited. Recognition of the need to expand and update the model emerged (Venkatesh et al., 2012; Wang et al., 2009; Yang, 2013). As a result, Venkatesh et al. (2012) extended the UTAUT model to include the consumer context and proposed UTAUT2. UTAUT2 included three additional determinant variables (hedonic motivation, price value, and habit) as important factors affecting consumers' acceptance and use of technology. Furthermore, UTAUT2 preserved three moderator variables (gender, age, and experience) though excluded the voluntariness of use variable. As a result, the final UTAUT2 model included seven independent variables and three moderator variables representing the determinants of consumers' behavioral intention to use a technological device. Behavioral intention and the determinants of behavioral intention in the UTAUT2 model can be defined as follows:

- *Behavioral intention (BI)*: "The strength of one's intention to perform a specified behavior" (Fishbein & Ajzen, 1975, p. 288).
- *Performance expectancy (PE)*: "The degree to which an individual believes that using the system will help him or her to attain gains in job performance" (Venkatesh et al., 2003, p. 447).
- *Effort expectancy (EE):* The degree of ease associated with consumers' use of the system/technology (Venkatesh et al., 2003; Venkatesh et al., 2012).
- *Social influence (SI)*: The degree to which a consumer or individual perceives that important others (e.g., family and friends) believe he or she should use the new system or a particular technology (Venkatesh et al., 2003; Venkatesh et al., 2012).
- *Facilitating conditions (FC):* Consumers'/individuals' perception of resources or support available to perform a behavior (Venkatesh et al., 2003; Venkatesh et al., 2012).
- *Hedonic motivation (HM):* "The fun or pleasure derived from using a technology" (Venkatesh et al., 2012, p. 161).

- *Habit (H)*: "The extent to which people tend to perform behaviors … automatically because of learning" (Limayem, Hirt, & Cheung, 2007, p. 709).
- *Price value (PV)*: "Consumers' cognitive trade-off between the perceived benefits of the applications and the monetary cost for using them" (Venkatesh et al., 2012, p. 161).

Although there are many studies using the UTAUT framework, a limited number of studies (Bharati & Srikanth, 2018; Kumar & Bervell, 2019; Moorthy, Yee, T'ing, & Kumaran, 2019; Ramírez-Correa, Rondán-Cataluña, Arenas-Gaitán, & Martín-Velicia, 2019; Yang, 2013) have used the UTAUT2 framework. Among these, Ramírez-Correa et al. (2019) analyzed the acceptance of online games using components of the UTAUT2 framework with 373 individuals, aged 18 to 27. Moorthy et al. (2019) attempted to determine the factors affecting university students' behavioral intention to accept mobile learning using structured questionnaires based on components of the UTAUT2. Bharati and Srikanth (2018) modelled university students' acceptance of mobile learning using the UTAUT2 framework, introducing two additional components: *quality of service* and *interactive visual information*. Yang (2013) also tested the factors affecting the intention of university students to adopt mobile learning, using the dimensions of UTAUT2 plus *self-management of learning* as a new dimension. In a recent study, Kumar and Bervell (2019), using components of the UTAUT2 model, investigated factors affecting university students' behavioral intention to use Google Classroom as a mobile learning platform.

All these studies, whether they used the UTAUT or UTAUT2 framework, entailed the development of questionnaires to examine participants' levels of mobile learning acceptance. The factors affecting individuals' behavioral intentions and technology use regarding mobile learning were tested through structural equation modeling. However, most questionnaires were adapted from those developed by Venkatesh et al. (UTAUT; 2003) and Venkatesh et al. (UTAUT2; 2012), applying therelevant mobile technologies and contexts. Moreover, most of these studies failed to provide detailed information about the validity and reliability criteria of their questionnaires. The psychometric properties such as construct validity, convergent validity, divergent validity, and reliability were evaluated based on the statistics (e.g., factor loadings, composite reliability, average variance extracted, etc.) obtained as a result of structural equation modeling. Thus, Venkatesh et al. (2003) suggested that measures for the UTAUT should be viewed as preliminary, and research should be done to fully develop and validate scales to obtain favorable psychometric properties.

Methodology

Design

This research aimed to develop a m-TASLM using a sequential exploratory mixed-method research design. Sequential exploratory mixed-methods research involves a two-stage and sequential process in which the researcher begins by exploring the subject matter qualitatively, and then follows up using a quantitative strand (Creswell & Plano Clark, 2011). In the preliminary qualitative strand of the study, 25 high school students in grades 9 to 12 with experience using tablet computers in their math classes were interviewed to develop draft items for the m-TASLM. Content validity of the scale was tested by an expert panel of five people, including three measurement and evaluation experts and two mathematics education experts. In the quantitative strand, validity and reliability studies of the m-TASLM were conducted on data obtained from four independent study groups during the spring semester of the 2018-2019 school year.

Study Groups

First study group. Our first independent group was comprised of students representing various grade levels and types of high schools in the central districts of Malatya province in Turkey (Table 1). The data obtained from this group were used to perform an initial exploratory factor analysis (EFA).

Table 1

Individual and School Characteristics of First Study Group

	n	%
Gender		
Male	234	44.7
Female	289	55.3
Type of high school*		
Anatolian	413	79.0
Science	70	13.4
Private	40	7.6
Grade level		
Grade 9	174	33.3
Grade 10	172	32.9
Grade 11	125	23.9
Grade 12	52	9.9

Note. $N = 523$.
* Anatolian high school is a common type of state school applying a general curriculum, while Science high school is more competitive providing a curriculum with more science and math courses.

Second study group. Our second independent group was comprised of 815 students representing various grade levels and types of high schools in the central districts of Malatya province in Turkey (Table 2). The data obtained from this group were used to perform confirmatory factor analysis and to estimate Cronbach's alpha internal consistency coefficients, composite reliability (CR), average variance extracted (AVE), maximum shared variance (MSV), and average shared variance (ASV).

Table 2

Individual and School Characteristics of Second Study Group

	n	%
Gender		
Male	370	45.4
Female	445	54.6
Type of high school		
Anatolian	609	74.7
Science	136	16.7
Private	70	8.6
Grade level		
Grade 9	269	33
Grade 10	263	32.3
Grade 11	204	25
Grade 12	79	9.7

Note. *N* = 815.

Third study group. Our third independent group was comprised of 83 students representing various grade levels from a private high school in the central district of Malatya province in Turkey (Table 3). The data obtained from this group were used to estimate the temporal reliability of the m-TASLM. The re-test was administered to the students one month after the first test during the spring semester of 2018-2019.

Table 3

Individual and School Characteristics of Third Study Group

	n	%
Gender		
Male	36	43.4
Female	47	56.6
Grade level		
Grade 9	24	28.9
Grade 10	18	21.7
Grade 11	26	31.3
Grade 12	15	18.1

Note. *N* = 83.

Fourth study group. A fourth independent group was comprised of 64 students representing various grade levels from an Anatolian high school in the central district of Malatya province in Turkey (Table 4). The data obtained from this group were used to test the criterion validity of m-TASLM.

Table 4

Individual and School Characteristics of Fourth Study Group

	n	%
Gender		
Male	23	35.9
Female	41	64.1
Grade level		
Grade 9	18	28.1
Grade 10	14	21.9
Grade 11	16	25
Grade 12	16	25

Note. N = 64.

Scale Development Procedure: Item Development, Data Collection, and Analysis Processes

The m-TASLM was intended to include the original components of UTAUT2 developed by Venkatesh et al. (2012): PE, EE, SI, FC, HM, H, PV, and BI. In order to develop an item pool, similar scales were examined first (Cheon et al., 2012; Venkatesh et al., 2003; Venkatesh et al., 2012; Wang et al., 2009). Next, 25 high school students were interviewed about their views and experiences using mobile technologies while learning mathematics. As a result, a collection of 69 items was developed and grouped as follows:

- 10 items about PE (e.g., Using mobile technologies while learning mathematics improves my mathematics performance).
- 14 items about EE (e.g., Learning to use mobile technologies for studying mathematics is easy for me).
- 10 items about SI (e.g., Educators in my immediate environment support me to use mobile technologies while learning mathematics).
- 6 items about FC (e.g., I have the necessary knowledge to use mobile technologies while learning mathematics).
- 6 items about HM (e.g., Mobile technologies make learning mathematics enjoyable).
- 7 items about H (e.g., It is a habit for me to use mobile technologies while learning mathematics).
- 5 items about PV (e.g., The mobile technologies I can use to learn mathematics are cost-effective).
- 11 items about BI (e.g., I intend to start using mobile technologies while learning mathematics).

Scale items were arranged in the form of a 5-point Likert questionnaire. Responses ranged from 1 (*strongly disagree*) to 5 (*strongly agree*). The items were submitted to an expert panel to check content validity. Expert opinions were evaluated using the Lawshe technique (Lawshe, 1975). The content validity ratio (CVR) was calculated for each item, and the critical CVR value for the five experts was set to .99 at α = 0.05 significance level according to the following formula (Lawshe, 1975):

$CVR = \frac{n_e - N/2}{N/2}$ (where n_e = number of experts rating the item as *essential*, and N = total number of experts).

Based on the feedback from experts, necessary corrections were made to the scale. The content validity index (CVI) was estimated for the entire scale, calculating the mean of CVRs for all remaining items (Lawshe, 1975). Next, the draft scale was examined by a Turkish linguist for issues of language and expression. Finally, five high school students were asked to check the scale for clarity and understanding, and four items with minor problems were rearranged.

Following the preliminary qualitative item development procedures, the m-TASLM was administered on the first (N=523) and second (N=815) study groups successively to test exploratory and confirmatory factor analyses. Moreover, convergent, discriminant, and nomological validity of the scale were examined using the results of the confirmatory factor analysis.

The temporal reliability of the m-TASLM was determined through test-retest analysis using two data sets obtained from 83 high school students over a one-month interval. To test the criterion validity of the scale, the correlation was estimated between the final form of the m-TASLM and the Tablet Computer Acceptance Scale, originally developed by Güngören, Bektaş, Öztürk, and Horzum (2014) to measure high school students' acceptance of tablet computers. Finally, Cronbach's alpha, CR, and AVE coefficients were calculated and reported.

Results

Content Validity

Based on the ratings of five subject-matter experts, the content validity ratio (CVR) for each of the 69 items was calculated. The CVRs for 47 items were equal to 1, indicating perfect agreement. On the other hand, the CVRs for 5 items were equal to -0.2, for 10 items equal to 0.2, and for 7 items equal to 0.6. Thus, these 22 items (5+10+7) with CVRs less than .99 were excluded from the scale.

That left 47 items remaining, which included: 6 in the PE subscale; 8 in the EE subscale; 6 in the SI subscale; 6 in the FC subscale; 4 in the HM subscale; 6 in the H subscale; 5 in the PV subscale; and 6 in the BI subscale. Since all components of the UTAUT2 model were represented in these remaining 47 items, content validity was not impaired by the removal. In addition, the content validity index (CVI) value was equal to 1 for each subscale and overall scale. Thus, it can be said that the content validity of the m-TASLM was statistically established (Lawshe, 1975).

Construct Validity

Exploratory factor analysis (EFA). The construct validity of the m-TASLM was initially tested using EFA in the SPSS Statistics 20 program (Hair, Black, Babin, Anderson, & Tatham, 2014; Tabachnick & Fidell, 2013). Before the analysis, the data set was checked to meet the assumptions of EFA. To this end, first, both univariate and multivariate normality assumptions for the data set for 523 cases were tested. To test univariate normality, cases with z scores exceeding ± 3.29 (p <.001) were considered outliers (Tabachnick & Fidell, 2013). Also, skewness and kurtosis values for all items were calculated and found to be between ±1 (skewness = -.800 to .693; kurtosis = -.882 to .293). To test multivariate normality, Mahalanobis distances were calculated, and a total of 60 outliers were detected for $p < .001$ significance level (Tabachnick & Fidell, 2013). After deleting these outliers, the data set was reduced to $n = 463$. Next, the missing values, not exceeding 1.1% for any item, were replaced using the series mean technique.

The correlation matrix for all items was examined and coefficients were found above .30 for all variable pairs. Also, all correlation coefficients were lower than .90, indicating no multicollinearity problem between variables. Results of the Bartlett Sphericity test ($\chi^2 = 15290.534$; $df = 1081$; $p = .000 <.05$) and KMO statistics (KMO = .961) indicated the sampling adequacy of the whole data set, while anti-image correlation coefficients for each item (r =.657 to.983) were adequate for sampling adequacy of individual items.

As a result of the EFA, item 34 in the draft scale was removed because it had close loadings (<.10) in two factors (H and FC factors); and items 10, 11, 12, 13, 14, 18, 26, 31, 37, and 41 were removed because they had loadings less than .50. The analysis results are shown in Table 5.

Table 5

Results of Exploratory Factor Analysis Using Oblimin Rotation With Kaiser Normalization

Item	Communalities	Factor								Item-Total Cor.
		PE	H	PV	SI	HM	FC	BI	EE	
PE1	.696	.722								.706
PE2	.752	.715								.732
PE5	.658	.674								.683
PE3	.718	.637								.735
PE6	.663	.604								.714
PE4	.610	.575								.690
H33	.645		.747							.438
H35	.553		.685							.487
H36	.564		.549							.558
H32	.536		.529							.611
PV39	.738			.843						.472
PV38	.681			.817						.451
PV40	.516			.605						.509
SI16	.677				-.831					.573
SI15	.708				-.797					.629
SI17	.669				-.785					.617
SI19	.596				-.693					.604
SI20	.539				-.691					.562
HM29	.833					.830				.720

HM28	.790					.809				.693
HM27	.758					.740				.700
HM30	.661					.674				.674
FC24	.738						.812			.626
FC25	.690						.731			.650
FC21	.665						.694			.630
FC23	.709						.689			.635
FC22	.641						.643			.639
BI44	.744							-.799		.676
BI46	.687							-.745		.659
BI45	.601							-.719		.609
BI43	.617							-.651		.679
BI47	.585							-.601		.590
BI42	.501							-.542		.600
EE8	.766								.821	.615
EE9	.662								.605	.627
EE7	.613								.524	.644
Total Variance Explained (%) = 66.068		41.83	6.90	4.34	4.30	2.88	2.36	2.10	1.37	

Note. Factor loadings below .500 are not shown in the table. The extraction method was principal axis factoring. PE = performance expectancy; H = habit; PV = price value; SI = social influence; HM = hedonic motivation; FC = facilitating conditions; BI = behavioral intention; EE = effort expectancy.

As it is seen in Table 5, the factor analysis yielded an 8-factor construct with 36 items explaining 66.068% of the total variance. The factor loadings, communalities, and corrected item total correlations were also favorable, proving the construct validity of the scale.

Confirmatory factor analysis (CFA). In order to further test the 36-item and 8-factor construct obtained from the EFA, a CFA was conducted using the data collected from the second study group (n = 815) in the LISREL 8.8 statistics program. Table 6 shows the goodness of fit values produced in the first CFA.

Table 6

Results of Confirmatory Factor Analysis for the 8-Factor Construct of m-TASLM

Goodness of fit value	p	X^2/df	RMSEA	RMR	SRMR	GFI	AGFI	CFI	NFI	NNFI
Pre-modification	.0000*	3.09	.054	.056	.040	.88	.86	.99	.98	.99
Post-modification	.0000*	2.44	.044	.058	.041	.90	.89	.99	.99	.99

Note. *p<.01; RMSEA = root-mean-square error of approximation; RMR = root mean square residual; SRMR = standardized root mean square residual; GFI = goodness of fit index; AGFI = adjusted goodness of fit index; CFI = comparative fit index; NFI = normed fit index; NNFI = non-normed fit index.

The first analysis yielded a significant p-value for the 8-factor model (χ^2 = 1749.15, df = 566, p = .0000 <.01). Therefore, other goodness of fit values were examined to confirm the model. The goodness of fit values were found to be either excellent or acceptable in general, since benchmark values indicate acceptable model fit when: (a) χ^2/df is less than 5; (b) RMSEA, RMR, and SRMR values are less than .08; and (c) CFI, GFI, AGFI, NFI, and NNFI values are greater than .90. They indicate excellent model fit when: (a) χ^2/df is less than 2; (b) RMSEA, RMR, and SRMR values are less than .05; and (c) CFI, GFI, AGFI, NFI, and NNFI values are greater than .95 (Brown, 2006; Hair et al., 2014; Hu & Bentler, 1999; Tabachnick & Fidell, 2013) (see pre-modification model values in Table 6). However, the values for GFI = .88 and AGFI = .86 were slightly under what is normally deemed acceptable. At this stage, the modification suggestions offered by the LISREL program were applied, by correlating residuals of items 19 and 20 in the SI factor; and items 24 and 25 in the FC factor, which statistically significantly improved the model ($p < .01$). As a result, the goodness of fit values of the 8-factor model became acceptable or excellent except for the AGFI value (see post-modification values in Table 6). Since AGFI = .89 was also found to be very close to the acceptable limit, it can be said that the 8-factor construct of the measurement model is confirmed adequately. The standardized factor loadings, squared standardized factor loads (R^2), and t values for the model after modification are presented in Table 7.

Table 7

Standardized Factor Loadings, Squared Standardized Factor Loads (R^2), and t Distribution for the Modified 8-Factor Construct of m-TASLM

Item	Standardized loading	R^2	t
PE1	.86	.74	29.00
PE2	.89	.79	30.67
PE3	.88	.77	29.75
PE4	.81	.66	26.31
PE5	.83	.69	27.41
PE6	.85	.72	28.29
EE7	.83	.69	26.55
EE8	.85	.72	27.91
EE9	.87	.76	28.59
SI15	.87	.76	28.73
SI16	.87	.76	28.61
SI17	.86	.72	28.12
SI19	.72	.52	21.90
SI20	.70	.49	20.96
FC21	.88	.77	29.95
FC22	.85	.72	27.83
FC23	.89	.79	30.32
FC24	.81	.66	25.82
FC25	.79	.62	25.01
HM27	.90	.81	30.98
HM28	.91	.83	31.67
HM29	.92	.85	32.15
HM30	.84	.71	27.58
H32	.80	.64	24.73
H33	.75	.56	22.83
H35	.78	.61	24.18
H36	.81	.66	25.57
PV38	.85	.72	26.78
PV39	.89	.79	28.98
PV40	.75	.56	22.83
BI42	.78	.61	24.79
BI43	.82	.67	26.47

BI45	.87	.76	29.13
BI45	.78	.61	24.87
BI46	.86	.74	28.76
BI47	.80	.64	25.57

Note. PE = performance expectancy; EE = effort expectancy; SI = social influence; FC = facilitating conditions; HM = hedonic motivation; H = habit; PV = price value; BI = behavioral intention.

As is seen in Table 7, the standardized factor loadings, R^2 estimates, and the *t* values suggest favorable results.

Convergent, Discriminant, and Nomological Validity

In order to test the convergent, discriminant and nomological validity of m-TASLM, CR, AVE, MSV, and ASV values, inter-factor correlations, and the square root of AVE values were calculated. The results are presented in Table 8.

Table 8

Results of Convergent, Discriminant, and Nomological Validity Analysis

Factor	1	2	3	4	5	6	7	8	CR	AVE	MSV	ASV
1. PE	.85**								.94	.73	.59	.41
2. EE	.77*	.85**							.89	.72	.61	.34
3. SI	.70*	.56*	.81**						.90	.65	.49	.31
4. FC	.68*	.78*	.56*	.85**					.93	.71	.61	.33
5. HM	.77*	.69*	.65*	.71*	.89**				.94	.80	.59	.38
6. H	.64*	.48*	.61*	.45*	.60*	.79**			.87	.69	.56	.30
7. PV	.46*	.43*	.43*	.48*	.42*	.48*	.83**		.87	.62	.27	.19
8. BI	.73*	.59*	.64*	.56*	.71*	.75*	.52*	.82**	.92	.67	.56	.37

Note. PE = performance expectancy; EE = effort expectancy; SI = social influence; FC = facilitating conditions; HM = hedonic motivation; H = habit; PV = price value; BI = behavioral intention; CR = composite reliability; AVE = average variance extracted; MSV = maximum shared variance; ASV = average shared variance.
*p < .05
** Square root of AVE

As seen in Table 8, CR values for all factors are > .70 and AVE values are > .50. Thus, it can be said that m-TASLM has convergent validity, which suggests that measures of the same concept are adequately correlated (Hair et al., 2014). Furthermore, the square root AVE values calculated for each factor are higher than the correlations between one factor and others. In addition, the criteria of AVE> MSV and AVE> ASV were satisfied. Thus, it can be said that m-TASLM also has divergent validity, which suggests that though measuring conceptually similar concepts, the measures are sufficiently different from one another (Hair et al., 2014). Finally, the values in Table 8 indicate that the correlations between factors are positive and statistically significant (p <.05), indicating the nomological validity of the m-TASLM, which suggests that each construct accurately relates with the others in a theoretically consistent way (Hair et al., 2014).

Criterion Validity

Since the normality assumptions for the data sets obtained from the Tablet Computer Acceptance Scale (skewness = -.015, kurtosis = -.607) and m-TASLM (skewness = -.633, kurtosis = -.714) were adequately satisfied, the criterion validity of the m-TASLM was tested using the Pearson correlations coefficients test. Test results revealed a positive, high, and statistically significant correlation between the two scales (r = .726, p <.05). Therefore, it can be said that m-TASLM can adequately measure a construct similar to the one measured by the Tablet Computer Acceptance Scale.

Reliability Analysis

To test the reliability of scores obtained from the m-TASLM, Cronbach's alpha internal consistency and test-retest temporal reliability coefficients were estimated. The results are shown in Table 9.

Table 9

Results of Reliability Analysis

Factors	Cronbach's alpha	Test-retest (r**)
PE	.94	.751*
EE	.88	.571*
SI	.91	.772*
FC	.93	.639*
HM	.94	.739*
H	.86	.529*
PV	.87	.463*
BI	.92	.738*

Note. PE = performance expectancy; EE = effort expectancy; SI = social influence; FC = facilitating conditions; HM = hedonic motivation; PV = price value; H = habit; BI = behavioral intention.
*p < .05
**r = pearson correlations coefficient

Estimated Cronbach's alpha coefficients for all factors were .86 and above, which indicates very good or perfect reliability (Kline, 2011, p. 70). In order to test the consistency of the responses for individuals at two points in time (with a one-month interval in between), a test-retest method was used (Hair et al., 2014). Since the normality assumptions for pre- and post-test results obtained from 83 students were adequately satisfied (skewness and kurtosis <±1), scores were tested with the Pearson correlation analysis. The analysis yielded significant positive moderate-to-high correlation coefficients for factors (r = .463 to .772). For the entire scale, the consistency was high (r = .932, p = .000<.05). Accordingly, it can be said that the scale is reliable enough against random errors depending on time. Also, the CR coefficients over .70 and AVE values over .50 for all factors (see Table 8) support evidence for the reliability of the scale (Hair et al., 2014).

Conclusion and Discussion

In this study, a scale, called m-TASLM, to measure high school students' level of mobile technology acceptance in learning mathematics was developed. The m-TASLM was designed to include the components of UTAUT2 developed by Venkatesh et al. (2012), specifically PE, EE, SI, FC, HM, H, PV, and BI.

Composed as a synthesis of eight technology acceptance models, UTAUT2 is an extended version of the UTAUT model for consumers (Venkatesh et al, 2012). In addition, the UTAUT2 model has a better predictive validity than other models as it can explain higher percentages of variance in behavioral intention (74%) and technology use (52%) scores (Venkatesh et al., 2012). In contrast, the UTAUT2 model was used in a limited number of studies which investigate mobile technology acceptance (Bharati & Srikanth, 2018; Kumar & Bervell, 2019; Ramírez-Correa et al., 2019; Venkatesh et al., 2012; Yang, 2013). Thus, the present is believed to contribute to both the relevant literature and practice, especially for researchers who would like to investigate learners' tendency to use mobile technologies in learning mathematics or other subjects, after due adaptations are made.

In this comprehensive and meticulous scale development study, designed according to a sequential exploratory mixed method approach, both qualitative and quantitative research methods were used, and a 5-point Likert scale with 36 items under 8 factors, explaining 66.068% of the total variance, was developed and confirmed. Results of the validity and reliability studies showed that the m-TASLM sufficiently meets the benchmark criteria regarding validity and reliability.

Based on these results, the m-TASLM is a valid and reliable instrument to measure high school students' acceptance levels of mobile technologies in learning mathematics. Researchers could examine the psychometric properties of the scale for different educational levels (e.g., grades 5 to 8) or for mobile technology users of any age. Furthermore, though the m-TASLM has been developed to measure mobile technology acceptance in learning mathematics, its psychometric properties could be adapted to different subjects (e.g., science, social sciences, etc.).

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Implementing Mobile Learning Within Personal Learning Environments: A Study of Two Online Courses

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Abstract

This article presents a case-study of two distance learning courses, in order to address the question of universal adoption of mobile devices and applications by students, and the impact of these devices in personal learning environments (PLEs). First, a critical discussion of the value of these concepts in the current technological context was carried out, followed by an analysis of their impact on educational use, based on data collected in online courses on physics and statistics at Universidade Aberta, the Portuguese Open University. The results indicated that all students have adopted mobile learning, and the make-up of an individual's PLE depends more on the learning resources available rather than on gender or age. These findings can help provide more efficient ways to implement learning by connecting current social needs to learners' mobile PLEs, particularly when flexibility of time and space are of utmost importance. Further studies at the Portuguese Open University will address a larger and more balanced sample of students across more course units.

Keywords: mobile learning, personal learning environment, social media, open university

Introduction

The current context of open and distance learning is fertile ground for the re-conception of education as a mobile and flexible interaction with many stakeholders. It has changed the traditional view of classroom instruction often replicated in online teaching, and that of education as the transmission of knowledge bound by the restrictions set by a fixed curriculum. Within this context, education has become an on-going process of learning through continued inquiry, sharing, and cooperation—in the various circumstances, roles, and settings in which an individual plays a part (e.g., school, work, leisure, family/private contexts). Social media can be a useful tool in facilitating offline relationships and maintaining ties (Thomas, Orme, & Kerrigan, 2020). Using social media to support distance education augments the power of learning communities with the benefits of using technology to support student engagement. However, this is a difficult process to scrutinize because it involves many variables; it is challenging to acquire an accurate sense of the different aspects of learning that are being evaluated (Lai & Bower, 2019). Concerns have been raised regarding academic distraction within personal learning environments (PLEs), more specifically the overuse of social media and the Internet for entertainment, with a negative effect on students' academic success (Feng, Wong, Wong, & Hossain, 2019).

Nevertheless, there is a perception that students of the so-called PlayStation generation tend to react better to learning based on interactive and dynamic features, with the possibility of consulting not only textbooks but also other media with links to online databases (Kearney, 2016). On the other hand, many students use mobile technologies for both personal use and for studying in a collaborative way. Most learners consider them as key components of the world in which they live and are more willing to engage in educational processes when the results they are to attain are presented as networked multimedia activities (Kukulska-Hulme, 2007). In fact, these users have created their own communications environment and are already telling their own stories on YouTube, on Facebook, on Instagram, and on many other social media, based on their perceived usefulness (Gómez-Ramirez, Valencia-Arias, & Duque, 2019).

Teachers and colleges can also use these new emerging technologies to foster learning, creativity, and students' enthusiasm. New technologies are relevant in areas related to the school curriculum, but also in other areas of knowledge, particularly in open and distance education courses where student isolation can be an obstacle (Bidarra, Figueiredo, & Natálio, 2015). Thus, the main motivation for this research was to ascertain the universal use of mobile learning in open and distance learning, and how it shapes students' PLEs. Therefore, this study posed the following research questions:

1. To what degree is mobile learning currently being adopted by the students at Universidade Aberta? Are there individual factors that significantly determine its adoption by these students?

2. How do mobile learning tools influence students' PLEs? Do the individual factors have an impact on this influence?

This article starts with a review of the relevant literature concerning the use of mobile devices and applications by students, following up on evidence that shows a change in paradigm where the control of learning shifts from the institution towards the student. Although the terms mobile learning and personal learning environment are often used in the context of online learning, institutions do not usually see a clear benefit in the association of students' mobile and PLE factors at the course level. Some authors have stated that mobile learning has actually been implemented more in the spirit of a virtual learning environment (VLE) than a PLE, and that there remains a great deal of unexplored ground in the area of mobile PLE systems (Chen, Millard, & Wills, 2008). This has not changed much in the last decade; perhaps a very promising institutional aim would be to provide an online learning environment that combines structured learning with the flexibility and personalization that a mobile PLE offers. Our goal was to fill that gap by investigating students' actual use of mobile devices and PLEs in the current technological context, based on data collected in two online courses (physics and statistics) at Universidade Aberta, the Portuguese Open University.

Integrating Mobile Learning into PLEs

Research on mobile learning has covered a variety of themes, but the most common has typically concentrated on enabling applications and systems (Krull & Duart, 2017). An increasing number of studies have focused on the use and affordances of smartphones and tablets (e.g., the use of specific apps) rather than the instructional design of educational content. Another relevant factor, perhaps the most significant change so far, has been the emergence of social media, generating huge amounts of data and connecting users across the world. This has implications for students' mobile PLEs as open and distance teaching universities need to encourage socialization by means of digital media. Often these integrate mobile learning with social networking, gamification, and augmented reality. But a more in-depth research is needed to show how to reconcile mobile hardware and software, lesson content, teaching methods, and educational goals (Sung, Chang, & Liu, 2016).

In the area of open and distance learning, the development of PLEs has been identified with a specific field of research (Johnson & Liber, 2008) covering several perspectives that may include technological and social aspects (e.g., open software, social networks, virtual environments). Essentially, a PLE is a mix of learning resources that may be used by students in the context of learning a specific subject (van Harmelen, 2008). The body of research on PLE started around 2005 with research disseminated by authors such as S. Wilson, M. van Harmelen, G. Atwell, S. Downes, and G. Siemens (Fiedler & Väljataga, 2013). According to Attwell, Bimrose, and Brown (2008) "a PLE should be based on a set of tools to allow personal access to resources from multiple sources and to support knowledge creation and communication" (p. 82). One typical aspect, but also a problem for researchers, is that PLEs integrate people, tools, communities, and resources in a very loose kind of way (Wilson, 2008).

Despite the potential benefits contained in a PLE, Dabbagh and Kitsantas (2012) recognized that not all students possess knowledge management abilities and the necessary self-regulatory skills to effectively make the most of it. This is why the demographic variables of gender and age were used as statistical factors in this study. There is also a relevant learning curve associated with the development of a learning environment that works for the student. So, from an educational perspective, there is a need to support online learners and help them model their learning environments in the context of the courses they are studying (Fiedler & Väljataga, 2013). This opens the door to mobile learning solutions, which are often described as supporting informal learning (Sharples, Corlett, & Westmancott, 2002).

If the popularity of mobile devices (e.g., smartphones and tablets) is considered, one realizes that informal learning has been a valid paradigm for educational technology since the beginning of this century. Traxel (2009) defined learning with mobile devices simply as the kind of learning that is supported by a portable or mobile device, encouraging learning through the ease of access to information and the ability to transport and manage very diverse content (e.g., text, image, audio, video, animation). Integrating mobile devices into the pedagogical models used in open and distance learning is a most desirable goal, and follows an active learning perspective (Prince, 2004). This is of utmost importance to open universities, such as Universidade Aberta, who must rely on digital technology to support global reach, social acceptance, and assure high standards of quality in online teaching and learning (Cross, Sharples, Healing, & Ellis, 2019).

Towards Seamless and Ubiquitous Learning

In the last decade, developments in the sophistication of mobile devices which, integrated with seamless networked media applications, have provided novel approaches to online learning that have enhanced the everyday use of learning management systems (García-Peñalvo & Conde, 2015). Mobile devices and PLEs give students the power to access, aggregate, configure, and manipulate digital artifacts in the context of their learning experiences. The advantages of mobile learning tools comprise the ability to connect anytime and anywhere to online resources, such as electronic books (e-books) and apps, bringing this possibility to the realm of learning environments. But while mobile devices can improve educational effects, the actual impact of mobile learning programs needs to be enhanced by longer intervention durations, closer integration of technology and the curriculum, and further assessment of higher-level skills (Sung et al., 2016).

A comprehensive study on mobile seamless learning by Wong and Looi (2011) suggested that

> learners need to be engaged in an enculturation process to transform their existing epistemological beliefs, attitudes, and methods of learning. Therefore, at the early stage of learners' engagement with mobile devices, teachers need to model the seamless learning process by gradually and systematically incorporating mobile learning activities into the formal curriculum. (p. 5).

Another study (Park, 2011) also supported the advantages of ubiquitous learning and discussed the features and pedagogical potential of mobile learning, anytime, anywhere. More recently, other research has emerged, and correlated the ICT skills of today's students and their choice of PLE, including mobile learning (Schmid & Petko, 2019). This new perspective considers the connection among PLE, social media, and self-regulated learning as a multilayered approach to the use of digital technologies for personalized learning. Furthermore, the cross-cultural design of technology can help to identify culturally relevant areas such as attitudes towards informal and collaborative learning, while recognizing the local context for content delivery. It may also support the development of a sound user experience of mobile learning in different learning contexts (Vainio & Walsh, 2017).

However, even if learning with mobile technology empowers learner-centered educational decisions towards the construction of PLEs, there are issues of gender, age, and access that may be an obstacle to the acceptance of mobile learning. The ways in which different students integrate these instruments into their PLEs has been the focus of more specific research (Labach, 2011). Of course, there are also myths and misperceptions related to mobile learning (Brown & Mbati, 2015), but in this article the focus is on empirical knowledge from specific distance learning courses.

This present study sought to ascertain how universal (i.e., how widespread) were the previous literature findings, by looking at current empirical data. In a sense, it tried to answer the question of whether those findings apply to all distance learning students. Also, it sought out individual factors which may influence, and to what degree, the conclusions highlighted in this literature review, namely, how mobile learning has shaped students' PLEs. To our best knowledge, this was the first attempt to do so in a quantitative manner.

Empirical Evidence From Two Courses

More than 10 years have passed since Universidade Aberta's virtual pedagogical model for distance education was laid out in detail (Pereira, Quintas-Mendes, Morgado, Amante, & Bidarra, 2008). This essential teaching framework, which still guides the institution today, has put an almost exclusive emphasis on the deployment of e-learning resources based on a VLE. At the time of its inception, emerging concepts such as mobile learning or ubiquitous learning were not considered. Today, in an ever-expanding networked context, an online pedagogical strategy is still key, but there is no point in restricting the options for students, the faculty or the institution.

A pedagogical framework for mobile learning has been proposed by Park (2011), to enable instructional designers and individual learners to incorporate mobile technologies into their teaching and learning effectively. This could be easily merged with the virtual pedagogical model for distance education used by Universidade Aberta, thus adopting a transactional distance view, and adding a new dimension to reflect the characteristics of mobile technologies that support both individual and social aspects of learning. This approach followed up on Cochrane (2010), who highlighted that the critical success factors are still

> the pedagogical integration of the technology into the course assessment, lecturer modelling of the pedagogical use of the tools, the need for regular formative feedback from lecturers to students, and the appropriate choice of mobile devices and software to support the pedagogical model underlying the course. (p. 133)

Currently, the pedagogical situation has changed little, but the mobile devices and software have improved, and a new global integration with social media and digital tools has emerged. This has made it possible to create effective personal learning environments suitable for mobility.

Bearing in mind that it is desirable to enhance the seamless experience of students by integrating mobile devices into teaching methods, this research was designed to ascertain the actual situation concerning the integration of mobile PLEs in two online courses at Universidade Aberta, one on introductory physics and the other on basic statistics. The aim of the empirical study was to find out how students in those courses used mobile devices during their learning processes, including online interaction, social communications, and learning activities. The two courses were selected because they were part of the core curriculum and science-oriented, and so they made use of a wider range of the learning resources available, both within and outside the institution. Also, the courses encompassed two major areas of knowledge; the physics course was part of the syllabus of two science degrees (computer science and environmental science) and the statistics course was part of the syllabus of a social science degree.

Ultimately, we wanted to probe the status of student use of mobile devices integrated within PLEs and find ways in which the learning tools could be adopted and integrated within activities. Data was gathered through an online survey, over the course of three academic years (2015–2018), aimed at students in each course unit (CU), and collected the following quantitative data:

1. Students were profiled according to three individual factors, namely, gender, age, and course unit type, to ascertain whether the degree of mobile technology adoption depended on these factors;

2. To establish a PLE structure, the different apps and tools used in the learning context were surveyed for adoption and type of use (e.g., activities, communication, collaboration, sharing). The influence of individual factors was also tested for;

3. The amount of time students spent with the courses was established, in order to discriminate different kinds of learning interaction, and how this time compared with the time spent in social networking and personal messaging, in an academic context.

Sample and Methods

A researcher-designed online questionnaire was used to collect data from the students in the two courses. Because the eligible population was small, the questionnaire was made short and straightforward, in order to maximize the response rate while achieving the study objectives. Face validation was carried out by the authors and, where deemed relevant, a clarification text was inserted next to the questions. A total of 164 responses was obtained from students who volunteered to participate, and a search for eventual outliers was carried out, though none were found. Table 1 summarizes sample data, discriminated by individual factors.

Table 1

Characteristics of the Sample

	Physics (n = 101)		Statistics (n = 63)		
	Gender		Gender		
Age	Male	Female	Male	Female	Total
Less than 35 years	15	5	2	11	33
35 to 44 years	37	13	7	13	70
45 to 54 years	14	11	5	18	48
More than 55 years	2	4	2	5	13
Total	68	33	16	47	164

The individual factors, known as predictors in statistical language, were tested for statistical significance using binomial and ordinal logistic regressions, depending on the nature of the dependent variable. Spearman correlations were also obtained where relevant. All calculations were carried out using the R statistical software and logistic regression packages.

Logistic regression was chosen because it is the adequate statistical method to model situations where the dependent variable is discrete in nature (e.g., yes or no). Logistic regression can be used with multiple categorical predictors, which was the case in this research. See Niu (2020) for a review of applying this method to educational research, and refer to Alzen, Langdon and Otero (2018) for a recent example.

Both courses included Moodle discussion forums, short videos, e-book exercises, and solutions as pedagogical resources, and all were accessible from mobile devices. Other interactive resources were under development but were not yet available for students at the time of the survey.

Results

Analysis number one. Concerning the analysis to evaluate mobile technology adoption by students and what factors influenced it, data showed a clear adoption of mobile learning tools, with 126 students out of 164 (77%) stating they used some kind of mobile device in their study. Thus, the answer to this first part of research question 1 was that the degree of adoption was very high.

As for trends in mobile learning adoption, Table 2 summarizes the statistical findings with respect to the influence of individual factors.

Table 2

Significance of the Use of Mobile Devices in Course Study

	Analysis of deviance table				
Variable	*Df*	Deviance	Residual Df	Resid. deviance	*Pr (> chi)*
NULL			163	177.56	
Gender	1	0.0395	162	177.52	0.8425
Age	3	4.0117	159	173.50	0.2602
CU type	1	0.0389	158	173.47	0.8436
		Coefficients			
		Estimate	Std. error	*Z* value	*Pr (> |z|)*
Intercept		1.35018	0.50466	2.675	0.00746 ***
Gender: male		-0.16956	0.41781	-0.406	0.68487
Age 35 to 44 years		-0.08541	0.51498	-0.166	0.86828
Age 45 to 54 years		0.14161	0.56639	0.250	0.80257
Age 55 plus years		-1.18224	0.70698	-1.672	0.09448 *
CU type physics		0.08372	0.42392	0.198	0.84343

Note. Dependent variable output use_of_mobile: No (n = 38), Yes (n = 126).
***$p < 0.01$, *$p < 0.1$.

Table 2 reads as follows. In a binary logistic regression, a base scenario is characterized by a particular level of the factors, in this case, gender, age, and CU type. In Table 2, the scenario, defined by default by the software, was of a female, statistics student, under 35 years old with a log-odds of responding "yes" to the question "Do you use mobile devices in your physics/statistics study?" of 1.35018 (probability: 1 / [1 + exp(-1.35018)] = 79%). Changes to the base scenario yield changes in the log-odds. For instance, if the student were female, statistics course, but over 55 years old, the log-odds would drop to 1.35018 – 1.18224 = 0.16794 (54%). The analysis of deviance p-values [Pr (> Chi)] indicate whether a factor was, or not, statistically significant in the output of the dependent variable. Low p-values (< 0.01 or 1%) indicate that the factor clearly influenced the output variable (Yes or No), whereas high p-values (> 0.10 or 10%) indicate it did not (i.e., different levels of that factor did not significantly influence the odds of replying Yes or No). P-values between these figures are in a grey area and mean that there was some statistical evidence that the factor influenced the output, but that evidence was not clear-cut. The coefficients p-values [Pr (> |z|)] indicate whether a particular level of the factor was, or not, statistically significant. The estimate column indicates by how much the log-odds shift towards (away if negative) a Yes in the output variable. Usually, if a factor is not significant (i.e., if it has high p-values) its associated coefficients show high p-values as well. In Table 2, the dots and asterisks help identify p-value range without having to look at the explicit figures (see note to Table 2). Other columns show intermediate data from the R software.

In the particular case of use of mobile devices, the deviance table shows that the tendency for using these devices was spread evenly across the field, regardless of age, gender, or CU type. In fact, the intercept (i.e., base log-odds of having Yes as survey answer) was a good enough predictor and the only one with clear statistical significance. There was an extremely slight tendency for students above the age of 55 to reject this kind of learning (p = 9.4%), but this was too weak a hint to have called it clear-cut.

An analysis of whether students prefer only mobile learning was also carried out, yielding a rate of about 50% (No, n = 83; Yes, n = 81); the corresponding binomial regression found no influence by the factors (all p-values > 10%, including intercept).

Given the growing market trend of mobile device sales and their technological possibilities—ownership of mobile phones in Portugal was near 100% in 2018 (ANACOM, 2019)—the authors expect the already high degree of adoption of mobile learning to rise even further, possibly to a rate very near 100%.

Analysis number two. The second line of analysis required determining what specific apps and tools had been adopted in the learning context and whether this depended on the gender, age, and CU type factors. Various output variables were considered; the full list is shown in Table 3, together with the observed degree of penetration of the various apps and tools as well as theoretical estimates from the binary logistic regression models (i.e., intercept log-odds, transformed into probabilities).

Table 3

Use of Apps and Tools in an Academic Context

App or tool	Empirical Yes	Logistic regression odds for Yes
Use of Facebook	70%	77%
Use of social media (any type)	77%	76%
Messaging on Facebook*	52%	80%
Messaging (any type)	70%	85%
Files, video or image sharing	79%	76%
Use of academic apps	67%	64%
Use of e-books*	82%	82%
Use of Wikipedia*	72%	55%
Use of productivity suites	95%	82%
Average	74%	75%

Note. Asterisk (*) indicates that individual factors had significant influence on the output variable.

Both the empirical and model-estimated percentages indicated a high acceptance rate for all apps and tools tested, reinforcing evidence of a shift from institution-based resources towards student-based resources. This clearly showed a trend of learners looking for study apps and tools on their own, thus moving beyond teacher-prescribed resources.

The binary logistic regression results yielded significant influence of individual factors for only three of the output variables, namely use of Facebook messaging, e-books, and Wikipedia. For the remaining variables, only the intercepts were statistically significant, and all pointed in the Yes direction. Absence of significant coefficients for the factors indicated, just as it did for the first analysis, that students' PLE are relatively uniform across the student population. The discrepancies between observed and logistic odds are of technical origin (i.e., variance-minimization procedures) and appeared to be due to small sample size. These are expected to decrease if a larger sample is considered.

As for the output variables with significant coefficients, deviance and coefficient tables are shown in Tables 4, 5, and 6. Table 4 presents the results for Facebook messaging.

Table 4

Significance of Using Facebook Messaging

		Analysis of deviance table			
Variable	*Df*	Deviance	Residual Df	Residual deviance	*Pr (> chi)*
NULL			163	227.13	
Gender	1	13.1938	162	213.95	0.0002809 ****
Age	3	1.8359	159	212.10	0.6071586
CU type	1	3.1422	158	208.96	0.0762918
		Coefficients			
		Estimate	Std. error	*Z* value	*Pr (> |z|)*
Intercept		1.3834	0.4665	2.965	0.00302 ***
Gender: male		-0.9630	0.3598	-2.676	0.00744 ***
Age 35 to 44 years		-0.4238	0.4533	-0.935	0.34988
Age 45 to 54 years		-0.6669	0.4910	-1.358	0.17444
Age 55 plus years		-0.2850	0.7081	-0.402	0.68735
CU type physics		-0.6547	0.3698	-1.770	0.07665 *

Note. Dependent variable output facebook_messaging: No (n = 79), Yes (n = 85).
****$p < 0.001$, ***$p < 0.01$, *$p < 0.1$.

The analysis showed that gender was a relevant factor, with a decrease of 0.9630 in the log-odds for male students. Female students were thus statistically more likely to use Facebook messaging in their academic activities (actual figures are females, 66%; males 38%).

Table 5 summarizes the analysis of e-books.

Table 5

Significance of Using e-Books

Variable	*Df*	Deviance	Residual Df	Resid. Deviance	*Pr (> chi)*
	Analysis of deviance table				
NULL			163	153.03	
Gender	1	2.5062	162	150.52	0.1134
Age	3	3.1033	159	147.42	0.3760
CU type	1	18.9147	158	128.50	1.367e-05 ****
		Coefficients			
		Estimate	Std. error	*Z* value	*Pr (> |z|)*
Intercept		1.48381	0.64661	2.295	0.0217 *
Gender male		-0.08186	0.50103	-0.163	0.8702
Age 35 to 44 years		-1.18013	0.72549	-1.627	0.1038
Age 45 to 54 years		-0.75063	0.74212	-1.011	0.3118
Age 55 plus years		-1.39364	0.91106	-1.530	0.1261
CU type physics		2.10422	0.52707	3.992	6.54e-05 ****

Note. Dependent variable output e-book_use: No (n = 29), Yes (n = 135).
****$p < 0.001$.

The use of e-books (including PDF) was one situation that stood out in the analysis, as these were more likely to be used in the physics course (log-odds increase of 2.10422). The reason for this was most probably circumstantial, because e-books formed the majority of resources recommended to physics students. In the statistics course, students relied more on videos and printed books.

Finally, Table 6 shows results for the use of Wikipedia.

Table 6

Significance of Using Wikipedia

Variable	*Df*	*Deviance*	*Residual Df*	*Resid. Deviance*	*Pr (> chi)*
	Analysis of deviance table				
NULL			161	191.43	
Gender	1	0.9511	160	190.48	0.32945
Age	3	1.1034	157	189.38	0.77625
CU type	1	3.1652	156	186.21	0.07522 *
		Coefficients			
		Estimate	Std. error	*Z* value	*Pr (> |z|)*
Intercept		0.1900	0.4391	0.433	0.6652
Gender male		0.1219	0.3981	0.306	0.7594
Age 35 to 44 years		0.2440	0.4694	0.520	0.6032
Age 45 to 54 years		0.5295	0.5097	1.039	0.2989
Age 55 plus years		0.6152	0.7783	0.790	0.4293
CU type physics		0.7033	0.3970	1.772	0.0765 *

Note. Dependent variable output wiki_use: No (n = 45), Yes (n = 117).
*$p < 0.1$.

Again, the CU type was statistically relevant; physics students used this resource more (log-odds increase of 0.7033) than those in statistics. While the reason for this could not be ascertained from the present data set, it was another hint that the PLE may be shaped by the resources provided by the teacher for the CU.

To summarize, the results for analysis number two showed a tendency for course materials to influence students' PLE. Age and gender were not found to be relevant, except in the case of Facebook messaging, which was more likely to be used in academic context by females.

Analysis number three. The third analysis investigated the amount of time spent with courses per week, in the context of time spent in social networking and personal messaging with colleagues. This was done to deepen our understanding of how mobile devices may affect the PLE structure.

Time data was represented as intervals in the questionnaire. This was transformed into interval mean values, and the non-parametric Spearman correlation between mean study time and mean interaction time was evaluated, yielding a value of +35%. This indicated a mild connection between study time and interaction time. Facebook was considered the most relevant social media, and this is why it was studied separately.

In order to know whether this mild positive correlation was triggered by social media, an ordinal logistic regression was carried out, with study time and interaction time as dependent variables, and use of social media as the independent variable (i.e., Facebook, and all social media). Tables 7 and 8 summarize the results. In these tables, variables are as follows:

- network_facebook: use of Facebook. Yes means use.
- network_all: use of a social network, of any kind. Yes means use.
- Study time, level (hours/week, self-explanatory):
    - Level 2: 1 to 5 hours
    - Level 3: 6 to 10 hours
    - Level 4: 11 to 15 hours
    - Level 5: more than 15 hours
- Interaction time, level (hours/week, self-explanatory):
    - Level 1: less than 1 hour
    - Level 2: 1 to 5 hours
    - Level 3: 6 to 10 hours
    - Level 4: more than 11 hours

Note that for both study time and interaction time, five levels were defined in the questionnaire, but one level in each set was left empty in the survey, with no responses.

Table 7

Significance of Study Time, With Social Media as Independent Variables

Dependent variable ordering and output				
1 to 5 hours	6 to 10 hours	11 to 15 hours	more than 15 hours	
62	59	21	22	
	Coefficients			
Independent variable	Estimate	Std. error	*Z* value	*Pr* (> |z|)
network_facebook Yes	0.3492	0.3181	1.098	0.272
network_all Yes	0.2891	0.3459	0.836	0.403

Note. Independent variable values network_facebook: No (n = 50), Yes (n = 114). Independent variable values network_all: No (n = 38), Yes (n = 126).

The high p-values indicate that the use of Facebook or other social media did not significantly determine study time. In other words, the fact that a student used Facebook or any social media in an academic context did not influence her or his study time.

Table 8

Significance of Interaction Time, With Social Media as Independent Variables

Dependent variable ordering and output				
less than 1 hour	1 to 5 hours	6 to 10 hours	more than 11 hours	
94	49	18	3	
	Coefficients			
Independent variable	Estimate	Std. error	*Z* value	*Pr* (> |z|)
network_facebook Yes	1.2319	0.3861	3.19	0.00142 ***
network_all Yes	1.9061	0.5108	3.732	0.00019 ****

Note. Independent variable values network_facebook: No (n = 50), Yes (n = 114). Independent variable values network_all: No (n = 38), Yes (n = 126).
****$p < 0.001$, ***$p < 0.01$.

Table 8 shows how the case was different for interaction time, with positive and highly significant (p < 0.1%) coefficients for both Facebook and all social media. Positive coefficients for Yes mean the Yes answer increased the log-odds of belonging to a higher interval of interaction time (+1.2319 [77%] for Facebook use; +1.9061 [87%] for all social media). There was thus clear evidence that using social media increased student interaction time, even though it did not necessarily translate into more study time.

Discussion

Considering all the results, the research questions can now be addressed. With respect to question one, it was evident that students had adopted mobile learning to a high degree (77%). Concerning what individual factors were significant in the use of mobile learning, clearly there were none. Indeed, statistical evidence showed that all students had embraced mobile learning in a very similar manner, regardless of gender, age, or CU type. Results did not support the view that those students in the older generations may be less likely to use these technologies.

Concerning question two, to a certain extent, the same conclusion holds for PLEs: students seemed to have created similar learning environments, regardless of gender and age. This somehow contradicts Liaw and Huang (2015) that male learners have less interest in social interaction with other learners and get more involved with apps and technology issues. These authors also stated that female learners showed less interest in technology and a higher intention to share their learning experience and ideas. In our study, no evidence was found of gender difference toward mobile distance learning acceptance, namely in regards to mobile tools and social media. The exception was the use of Facebook Messenger, where females showed a preference. Also, in relation to age, there seemed to be no significant difference, thus contradicting previous claims by Prensky (2001) about digital natives and digital immigrants.

From a decision-making point of view, these results seemed to vindicate a one size fits all teaching approach. This leaves the onus on the institution to understand the value and structure of a student PLE and work towards exploring its potential to the fullest, taking advantage of the anybody, anywhere, anytime possibilities mobile devices provide. It is only the course unit subject, a circumstantial factor, that may dictate some distinction as to the nature of a PLE. For instance, the case of e-books stood out in the analysis, as they were more likely to be used in the physics course. In the statistics course, students relied on videos and printed books. In this context, it would be thought-provoking to test this in a different domain. For example, it would be interesting to know whether the low use of image-sharing tools (empirical value 6.7%, not shown disaggregated in Table 3) would actually change if a course in fine arts was analyzed instead.

The study also showed that undergraduate students generally perceived mobile technology and digital media as useful, and readily embraced these technologies, with roughly 75% acceptance. However, there seemed to be a pragmatic approach by students, and while the use of social media did not directly translate to a longer and better study effort, it did lead to more interaction time with colleagues.

Globally, it can be argued that the implementation of PLEs in open and distance education has clear advantages: (a) a student-centric approach, (b) the development of personal knowledge management strategies, and (c) the formation of a self-regulated learning model (Vazquez-Cano, Martín-Monje, & Castrillo de Larreta-Azelain, 2016). Practical examples include searching for online information, sharing content, selecting resources, developing personal information strategies, and creating content through the use of authoring tools. Nevertheless, there are important issues with respect to the competencies and skills needed to create effective PLEs and the affordances of digital technologies needed to support PLE development (Dabbagh & Fake, 2017). Accordingly, this study focused on the choice of digital tools that may support self-regulated learning, information management, peer communication, and content aggregation.

The implications for understanding the relationship between students' PLEs and online learning are clear. The former need not be defined as an essential instrument or a crucial model but as contemporary human innovations whose forms and meanings are strategic for education, because these new technologies and resources are part of our society and students have already adopted them.

Conclusion and Future Work

This article started with a review of the principles underpinning mobile learning and new digital media in the current educational context. Focus was put on how these are enacted in social practices supported by contemporary digital habits, and how they may be present in open and distance education.

The study showed that the use of mobile learning and personal learning environments in the physics and statistics courses at Universidade Aberta is transversal to all students, regardless of demographic factors, in part vindicating industrialist approaches to distance learning. Course resources appear to be the most relevant factor which can shape students' personal learning environments, and it was also found that, while social media potentiates online interaction, it does not necessarily increase study time. Evidence also points in the direction of an "always connected" pattern that has taken over the (digital) life of students.

The benefits of the research beyond the two cases can be clearly foreseen; for instance, the ongoing COVID-19 pandemic has shown there is a constant need to implement efficient and cost-effective training to prepare health professionals. Mobile learning is a potential solution to increase the delivery of up-to-date information to health professions, as it offers the prospect of wide access at low cost and flexibility with the portability of mobile devices (Dunleavy, et al., 2019). The pandemic has also highlighted, in a striking and unexpected way, the importance of online learning for educational systems all around the world. In this context, the findings of this article can help provide more efficient ways to implement learning by connecting current social needs to learners' mobile PLEs, particularly when flexibility of time and space are of utmost importance.

Further studies at the Portuguese Open University will address a larger and more balanced sample of students across more course units. We will reach for a wider range of fields and subjects, overcoming small sample sizes, and further test the hypothesis of whether a PLE may be sensitive to resources made available in specific domains, including arts, humanities, and life sciences.

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Internationalizing Professional Development: Using Educational Data Mining to Analyze Learners' Performance and Dropouts in a French MOOC

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Abstract

This paper uses data mining from a French project management MOOC to study learners' performance (i.e., grades and persistence) based on a series of variables: age, educational background, socio-professional status, geographical area, gender, self- versus mandatory-enrollment, and learning intentions. Unlike most studies in this area, we focus on learners from the French-speaking world: France and French-speaking European countries, the Caribbean, North Africa, and Central and West Africa. Results show that the largest gaps in MOOC achievements occur between 1) learners from partner institutions versus self-enrolled learners 2) learners from European countries versus low- and middle-income countries, and 3) learners who are professionally active versus inactive learners (i.e., with available time). Finally, we used the CHAID data-mining method to analyze the main characteristics and discriminant factors of MOOC learner performance and dropout.

Keywords: MOOCs, learner grades, learner dropout, learner performance, academic cohorts, educational data mining, CHAID, low- and middle-income countries, developing countries

Introduction

Numerous studies have sought to understand who benefits most from MOOCs (Emanuel, 2013; Kizilcec, Pérez-Sanagustín, & Maldonado, 2017; Liyanagunawardena, Williams, & Adams, 2013; Selingo, 2014; Stump, Hilpert, Husman, Chung, & Kim, 2011), since their original promise was education everywhere and for everyone (Lane, 2013; Laurillard, 2014). MOOCs are mainly provided in the English language (Brouns et al., 2017; Colas, Sloep, & Garreta-Domingo, 2016), and their principal audience is from Western cultural regions (e.g., Europe, North America, Australia; Altbach, 2014; Bozkurt, Akgün-Özbek, & Zawacki-Richter, 2017; Jansen, Schuwer, Teixeira, & Aydin, 2015). In 2016, MOOCs in French were the second-most taught courses; and their principal audience, after France and Western French-speaking countries, was based in Africa (i.e., North Africa and French-speaking African countries; Noukakis, Escher, & Aebischer, 2016) and in the Caribbean (largely Haiti).

Despite their expansion, MOOCs have not met initial expectations. The open and online format has, for the most part, benefited educated young learners, people based in high-income countries, and male learners (Christensen et al., 2013; Emanuel, 2013; Zhenghao et al., 2015). The MOOC audience is not as diverse as expected (Albelbisi, Yusop, & Salleh, 2018). Hansen and Reich (2015) found that, even within the United States, MOOCs accentuate the digital divide between social classes rather than reduce it. This reality is more acute in Africa (Noukakis et al., 2016). There is also an imbalance between the use of MOOCs and their added value. Garrido and colleagues (2016) suggest that MOOCs in developing geographical areas are used to gain specific job skills, education, and professional certification; but people are less likely to complete the courses than Western participants. Zhenghao et al. (2015) found that learners from emerging countries report gaining more career and educational benefits from MOOCs than learners from high-income countries. However, these learners sometimes complete modules to gain specific job skills with no reason to complete the entire MOOC. This is often the case with African participants (Noukakis et al., 2016).

Overall, research on MOOCs in developing (i.e., low- or middle-income) countries—and on learner engagement and interaction within culturally and linguistically diverse learner cohorts—is limited (Launois et al., 2019), especially in French-speaking areas. This study compares the benefits of a French professional development MOOC for learners from high-income countries and learners from low- and middle-income countries (LMIC). Our goal was to determine whether the results in this specific context (a professional development MOOC designed for the French-speaking geographical area) would differ from the results of studies on MOOCs conducted in English- or Spanish-speaking regions (Garrido et al., 2016). The use of educational data mining (EDM) allowed us to investigate the details of learners' performance in the MOOC, including the number of learners who passed, failed, or dropped out. We measured the differences in learner performance based on geographical area, gender, age, prior education, and socio-professional status to identify the most powerful predictor(s) of MOOC success.

We studied the 12th session of a French project management (PM) MOOC (Bachelet & Chaker, 2017), which ran from September to November, 2018. Unlike most MOOC studies, we focused on French-speaking cultural regions: Europe (France and French-speaking European countries), North Africa, Central and West Africa, and the French-speaking Caribbean. Two data sets were used to establish our analyses: results of a questionnaire, which participants completed at the beginning of the session; as well as their scores from weekly evaluations and the final exam, which were used to calculate their final grade.

MOOCs and Professional Development

MOOCs are widely used for professional development (Dodson, Kitburi, & Berge, 2015; Domingo, Paran, Révész, & Palange, 2019; Garrido et al., 2016; Hrdličková & Dooley, 2017); for example, two-thirds of those who took one or more of 24 MOOCs offered through the University of Pennsylvania were employees (Christensen et al., 2013). Online learning programs have been expanding within the continuing education and professional development market (Mori & Ractliffe, 2016), and 2014 was dubbed "The Year of the Corporate MOOC" (Nielson, 2014). For Radford et al. (2014), corporate MOOCs hold an immediate promise of professional development for employers and employees. MOOCs are indeed often "aligned with popular professional development courses in leadership, management, communications, and desktop applications" (Radford, Coningham, & Horn 2015, p. 13).

The MOOC format, which is by definition *open* and *online*, can be useful to professional learning, since it enables the transferability of skills between professional practice and learning (Milligan & Littlejohn, 2014). The successful use of MOOCs for professional development depends on "how professionals align their personal learning goals with learning in the MOOC" (Milligan & Littlejohn, 2014, p. 199), as MOOCs attract a broad range of learners with diverse learning dispositions (Milligan, Littlejohn, & Margaryan 2013). Indeed, research emphasizes the importance of environment in professional engagement and participation (Launois et al., 2019; Milligan & Littlejohn, 2014; Mori & Ractliffe, 2016; Murugesan, Nobes, & Wild, 2017).

Many issues have been raised regarding occupational online training, including the need for professionals to self-regulate their online training, as personal dispositions are influenced by their environment (Milligan & Littlejohn, 2014); the importance of allocating time for online training within personal and work schedules, which may interfere with learner commitment (Mori & Ractliffe, 2016); the need to address excess workloads during professional development (Hossain, 2010); and the importance of emphasizing the interrelationship between knowledge and professional skills in context (Milligan & Littlejohn, 2014; Mori & Ractliffe, 2016). International professional development courses online must, therefore, consider participants' environment in the learning process, especially in LMIC where access to technology and the gap in its use could be a problem (Liyanagunawardena et al., 2013; Zillien & Hargittai, 2009).

Attrition and Dropout

When completion rates are the benchmark for student success, evaluating the efficacy of MOOCs proves difficult (Jones, Stephens, Branch-Mueller, & de Groot, 2016). It is now widely known that MOOCs are associated with high attrition rates (Allione & Stein, 2016). This is a complex issue that goes beyond counting the number of students who quit. For example, Koller et al. (2013) show that "the ease of non-completion in MOOCs can be viewed as an opportunity for risk-free exploration" (para. 27). Beyond numbers, the reasons for registering and participating in and *dropping out* of a MOOC must be considered.

Perspectives on attrition in open online courses depend on how the courses are viewed, as Kizilcec and Halawa (2015) emphasize: MOOCs can be viewed as an open learning environment, where anyone can obtain whatever learning material they want. Indeed, as MOOCs are often free and display low commitment requirements, students tend to set their own participation requirements (Stewart, 2013). MOOCs can also be viewed through a traditional, school-norm lens, where the primary objective is to achieve the goals set by the instructors and course designers, which Tyack and Cuban (1995) refer to as the "grammar of schooling." For example, people who register for a MOOC may quit after a few weeks because they have acquired the skills or knowledge they wanted and were thus satisfied. Such cases can be considered a learning success from the participant's point of view, as they benefitted from an informal type of learning. However, the participant can also be considered a dropout from the "grammar of schooling" standpoint. Perhaps herein lies the difference between attrition and dropout.

Since the reasons for attrition are a complex issue in MOOCs, in this study we decided to measure persistence in course assessments; this variable is easy to measure empirically and can be considered a type of attrition. This approach was possible because the format of instruction and assessment in the PM MOOC includes weekly evaluations, as well as a final exam, and follows a schedule with weekly deliverables as opposed to self-paced learning. Students can, certainly, audit the course without completing the evaluations, or shift from active to passive participation; but, missing the weekly evaluations, especially after completing the first ones, can indicate a process of attrition in certain cases, especially in light of the learning goals that the participants initially set.

The Context of the Study: The French PM MOOC

The French PM MOOC launched its first edition in September 2013 and has been hosted on the Open edX Learning Management System (LMS) since 2018. The common core curriculum of the MOOC consists of four units within the first 4 weeks and an evaluation at the end of each weekly unit. Learners' global grade is calculated as follows,

- Pre-MOOC mind-mapping module: 1%
- First four weekly evaluations: 19%
- Final exam: 80%

Another distinguishing characteristic of this MOOC is the salience of academic cohorts (AC) among its learners. Half of the 6,400 active learners in the September 2018 session were students from partner institutions and had enrolled in the MOOC through their professor. AC students come from French higher-education institutions, and the weight of the MOOC in their curriculum is a powerful incentive for their success. The participation of this "captive" audience is one of the reasons for the high learner completion (success/active learner) rate (56%) in the 12th PM MOOC. According to Jordan (2013), the completion rate in the first edition of the PM MOOC was 50.7%.

Research Questions

Our research questions focus on the relationship between MOOC learners' demographic backgrounds—in terms of age, gender, geographical area (region), education, and socio-professional status (SPS)—as independent variables; and student performance—in terms of MOOC final grades and dropout rates—as dependent variables (Table 1).

Table 1

Research Questions (RQ) and Variables

RQ	Dependent variables	Independent variables
RQ1	Grades	Age
RQ2		Gender
RQ3		Region
RQ4		Education
RQ5		SPS
RQ6	Dropout rates	Age
RQ7		Gender
RQ8		Region
RQ9		Education
RQ10		SPS

The final question, RQ11, aimed to investigate the characteristics of the best MOOC performers and achievers.

Methods

Study Sample

Participants in our study were registered in the 12th edition of the French PM MOOC. MOOC registration characteristics were as follows,

- 18,302 learners were enrolled in the MOOC.
- 6,449 were active learners (i.e., completed at least one weekly evaluation).
- 3,602 of the learners achieved a passing grade.
- Learner entry (i.e., active/enrolled learners) rate was 35%, and learner completion (success/active learner) rate was 56%.

The study questionnaire was posted on the MOOC platform one week before the beginning of the course. It was then made available to all enrolled registrants. Of the 18,302 learners enrolled in the MOOC, 1,792 responded to the questionnaire; 42.2% of the respondents were female, and 155 respondents were AC students (Table 2).

Table 2

Study Participant Demographics (N = 1,792; AC: n = 155)

Independent variables	*n*	%
Gender		
Female	756	42.2
Male	1036	57.8
SPS		
Business owner	29	1.5
HMPO	449	25.1
Employee	367	20.4
Intermediate professions	90	5.00
Student	398	22.2
Jobseeker	425	23.7
Non-active	34	1.9
Education		
No degree	9	0.40
High school graduate	67	3.70
2-year technical or university degree	207	11.60
Second year engineering school	116	6.50
Bachelor's degree	394	22.00
Master's degree	890	49.70
PhD	109	6.10
Region		
Europe	1019	56.90
North Africa	127	7.10
Central & Western Africa	592	33.00
Caribbean	29	1.60

Procedure

The questionnaire was created using Google Form, and a link for its online completion was posted during Week 0 of the MOOC (i.e., the introductory week). The second source of data was learners' performance, which was obtained from file extractions through the edX platform.

Measures

Questionnaire

Demographic background. We asked demographic and sociological questions regarding participants' age (measured in years), gender, country of residence (the countries were merged into regions), SPS, and prior education.

MOOC certificate as a goal. The question on achievement goal, or intention, was measured using a Likert scale from 1 to 4 for the item: "I want to achieve the course certificate."

Learner Performance Data

Final grade. We determined the final grade by adding the final exam score (80%), the average score obtained in the four weekly evaluations (19%), and the score obtained in the pre-MOOC test (1%).

Dropout rate. Some researchers have attempted to calculate a context-based dropout rate or to take the participants' perspective into account (Liyanagunawardena, Parslow, & Williams, 2014). For example, Henderikx, Kreijns, and Kalz (2017), measured the gap between intention to complete a MOOC and actual behavior (i.e., intention–behavior gap). Using a small sample, they measured this gap to study dropout rates based on intention but they did not provide a single indicator for dropout. This paper builds on this approach to calculate a context- and intention-based dropout rate. We first calculated persistence rather than the number of participant dropouts, since the term *dropout*, in the context of a MOOC, can have multiple definitions. It is indeed difficult to assess why certain participants quit after a few days or a few weeks, since their reasons for registering are often disparate. We calculated the assessment persistence index, based on the scoring system of the PM MOOC, and the number of assessments completed as presented in Table 3 below.

Table 3

Assessment Persistence Scoring System

Persistence score	Week 1 assessment	Week 2 assessment	Week 3 assessment	Week 4 assessment	Final exam
0					
1	●				
2	●	●			
3	●	●	●		
4	●	●	●	●	
5	●	●	●	●	●

This detailed scoring system measures not the gross dropout rate (i.e., the number of learners who dropped out before the final exam), but the number of weeks validated by the participants. Scoring student persistence by considering their completed assessments constitutes a bias, since it excludes auditing participants who may be active, but they are not interested in passing exams or obtaining a certificate. Nevertheless, we sought to define a dropout variable that is as close as possible to the academic definition of *dropout* (as mentioned earlier in the *Attrition and Dropout* section) by including the course certificate as a goal. As mentioned above, student dropout rates should be measured in context, which requires considering participants' initial achievement goals or intentions. Hence, we calculated the difference between learners' achievement intention scores (i.e., the drive to obtain the course certificate) and their assessment persistence scores.

The dropout rate was defined as the distance between the students' formal learning goals, set at the beginning of the course, and students' actual achievements. The analysis was achieved by weighing each participant's achievement intention score out of 5 minus their assessment persistence score, which was measured out of 5 (4 weeks + final exam, Table 3). The resulting variable, which ranges from -5 to +5, is a new continuous variable for measuring student dropout based on 1) the achievement intention set at the beginning of the course (i.e., course certification), and 2) assessment persistence up to and including the final exam. Using our model, we can relate the minimum dropout score (-5) to an underestimated forecast of achievement, the 0 score to an accurate forecast of achievement, and the maximum score (5) to an overestimated forecast of achievement.

Results

Participants' Final Grades and Demographic Backgrounds

The assumption of normality in participants' final grade scores was not met ($D_{K\text{-}S}$ = .239; p < .001). Hence, non-parametric tests were used. Examining the final grade distribution, we observed a U shape, displaying high concentrations on both ends (Figure 1).

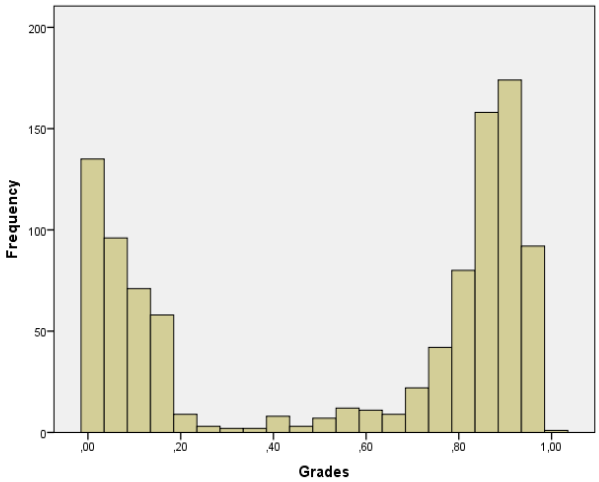

Figure 1. Distribution of PM MOOC participants' final grades.

RQ1: Final Grades and Age

Analysis shows a negative Spearman rank correlation between final grade and age (r_s = -.250; p < .001). Controlling for AC bias, partial correlation shows a lower index but with the same orientation and significance (r_s = -.137; p < .001).

RQ2: Final Grades and Gender

Testing the effect of gender on the final grade with the Mann-Whitney U-test did not reveal any significant differences based on gender.

RQ3: Final Grades and Region

We grouped the countries participants were from by region: Europe (n = 1019, 56.9%), Central and West Africa (n = 592, 33%), North Africa (n = 127, 7.1%), and the Caribbean (n = 29, 1.6%, largely Haiti). As Emanuel (2013), Selingo (2014), and Waldrop (2013) note, in the early 2010s, people from developing countries, from Africa in particular, constituted only a fraction of MOOC registrants (Liyanagunawardena et al., 2013); but these studies focused on English language MOOCs. It is interesting to observe that the French PM MOOC reached a relatively large African audience (40.1%) compared to most Western English-language MOOCs.

Learners from Europe achieved the highest final grade mean among participants (M = 62.58), followed by learners from North Africa (M = 51.02), Central and Eastern Africa (M = 39.80), and the Caribbean (M = 31.50). This is a typical situation where MOOC success is related to the level of economic development of a country or region: From Haiti in the Caribbean (the poorest country in the sample) to Central and West Africa, to North Africa, to Europe. The grade differences between regions are significant, as results of the Kruskal-Wallis H test show: $H(3) = 97.50$; $p < .001$ (Figure 2).

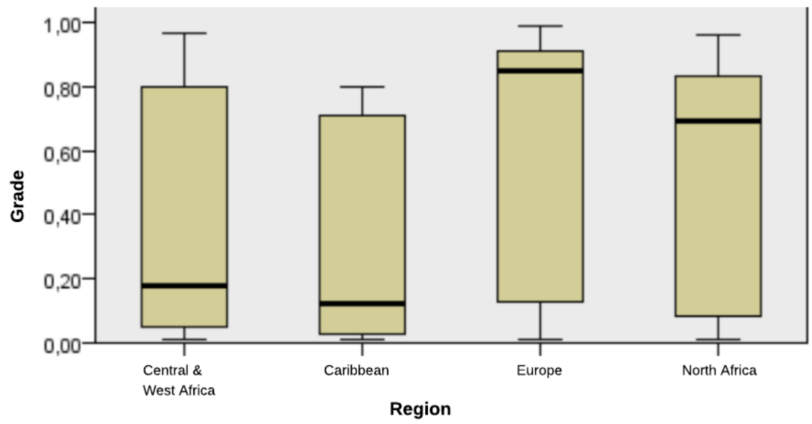

Figure 2. Box-plot of final grades by region.

RQ4: Final Grades and Education

We observed a significant relationship between participants final grade and education ($H(6) = 75.46$; $p < .001$). Second year students in engineering school had the highest final grades (M = 81.89; SD = 24.25), while Master's and PhD degree holders had the lowest grades (M = 49; SD = 40). These findings contradict Morris, Hotchkiss, and Swinnerton's (2015) finding that "the higher the prior educational attainment, the greater the completion" (p. 7). As such, the enrollment system and participants' demographic backgrounds must be considered when analyzing the relationship between education and performance in a MOOC.

RQ5: Final Grades and Socio-Professional Status (SPS)

Significant differences were found between participants' final grades and socio-professional status (SPS; $H(8) = 100.92$, $p < .001$). Participants who were students performed best (M = 72, SD = 30), followed by job seekers (M = 54, SD = 39), and participants in higher managerial and professional occupations (HMPO; M = 52, SD = 39). Time availability appeared to be an important factor in MOOC success. HMPO participants, students, and jobseekers were better able to manage their schedules, compared to employees, intermediate professionals, and workers.

Participant Dropout Rates and Demographic Backgrounds

Dropout score distribution violated normality ($D_{K\text{-}S} = .151$; $p < .001$). As a result, the statistical analyses were non-parametric.

RQ6: Dropout Rates and Age

Age was marginally correlated with dropout rate ($r_s = .172$; $p < .001$). Excluding AC participants (who were forced to enroll and were less prone to attrition) from the analysis suppressed the significant relationship between the two variables, and results reveal that age had no effect on dropout rates. This finding contradicts Guo and Reinecke's (2014) and Morris et al.'s (2015) finding that older learners are less prone to attrition.

RQ7: Dropout Rates and Gender

Male participants (M = 1.56; SD = 2.70) had higher dropout rates than female participants (M = 1.21; SD = 2.54): U = 346,018; p = .001. The result was similar when controlling for AC bias ($p < .001$).

RQ8: Dropout Rates and Region

France and French-speaking European participants (FFSE; M = 0.64; SD = 2.57) persisted significantly more than participants from French-speaking developing countries (FSDC; M = 2.47; SD = 2.34): U = 540,402, $p < .001$. When controlling for AC bias, similar results were found ($p < .001$). These findings contradict Garrido et al.'s (2016) study on MOOC completion among participants from English- and Spanish-speaking developing countries, but they confirm Kizilcec et al.'s (2017) finding that MOOC completion is higher on average in more- versus less-developed countries. Could the nature of the course and the use of the French language, which is a second language in FSDC countries (Ngalasso, 1992), explain this difference? The dropout rate of FFSE participants is close to 0, which indicates a good forecast of achievement, whereas FSDC participants display a relatively high score of overestimated forecast of achievement.

Since, as results show, the geographical variable influences MOOC performance, we examined whether gender differences in dropout rates could be observed and better explained by dividing gender groups into FFSE and FSDC subsamples (Table 4). We noticed a significant difference between genders only among FFSE participants: Female participants displayed higher dropout rates (M = 0.81; SD = 2.82) than male participants (M = 0.43; SD = 2.68): U = 138,959; p = .032. However, no gender differences where observed among FSDC participants (p = .185). Controlling for AC bias, we expected to observe a difference only within the FFSE subsample, since the learners who were forced to enroll were based in France. We found no significant gender differences in dropout rates in both FFSE and FSDC subsamples. We could argue that the only gender imbalance in dropout rates was caused by AC participants. Indeed, when considering the entire sample, male participant dropout rates were significantly higher than female participants, but when analyzing the geographical subsamples, the gender effect on dropout rates was no longer significant.

Table 4

Dropout Score by Gender and Region (Without AC)

	FFSE		FSDC	
Gender	*M*	*SD*	*M*	*SD*
Male	0.43 *(1.10)*	2.68 *(1.10)*	2.50 *(2.50)*	2.35 *(2.35)*
Female	0.81 *(1.05)*	2.42 *(2.40)*	2.40 *(2.40)*	2.34 *(2.34)*
Total	0.64 *(1.07)*	2.57 *(1.75)*	2.47 *(2.47)*	2.34 *(2.34)*

RQ9: Dropout Rates and Education

Controlling for AC bias, no significant relationships were found between dropout rates and prior education. Previous research found different relationships between prior education and MOOC completion. For example, Breslow et al. (2013) found only a marginal association between them, but

Morris et al. (2015) found a significant link between higher degrees and MOOC completion. Our results are in line with the overall mixed results regarding education attainment and MOOC dropout rates.

RQ10: Dropout Rates and Socio-Professional Status (SPS)

Jobseekers (*M* = 1.73; *SD* = 2.62), students (*M* = 0.25; *SD* = 2.77), and HMPO (*M* = 1.26; *SD* = 2.50) persisted significantly longer than employees (*M* = 2.09; *SD* = 2.40) and intermediate professionals (*M* = 2.32; *SD* = 2.22; $H(7) = 141.24$, $p < .001$). These findings are in line with Morris et al. (2015), who state that "those not working [are] more likely to complete more of their course" (p. 8). These results are also in line with our findings on MOOC grades and SPS (RQ5) and could indicate that availability is a key factor in MOOC achievement: Jobseekers, HMPO, and students display the highest performance rates and the lowest dropout rates.

RQ11: Characteristics of the Best MOOC Performers

Overall, the geographical factor was found to be a determinant of MOOC achievement and dropout in separate analyses. To answer the question on the most discriminant characteristics of the best performers, we conducted a tree analysis, with CHAID (Chi-square Automatic Interaction Detection) as an educational data mining method to examine the predictive variables of MOOC success using SPSS. We used this method to determine whether the previous results, which were obtained separately by subsampling, could be verified through an automatic data mining method, such as CHAID analysis. As previously demonstrated, the demographic variables were strong indicators of MOOC performance.

Our predictive variables were region, gender, age, education, and professional status. We excluded the AC participants from our analyses as their presence in the sample would constitute a bias, since they were forced to enroll in the MOOC. If we had included them, the results would have been overly unbalanced between learners from FSDC and FFSE countries for MOOC performance and dropout rates as our previous results demonstrate. Results show that the main discriminant factor (the first node) of final grades and dropout rates is the region variable (Figures 3 and 4): FFSE participants had higher achievement scores than FSDC participants.

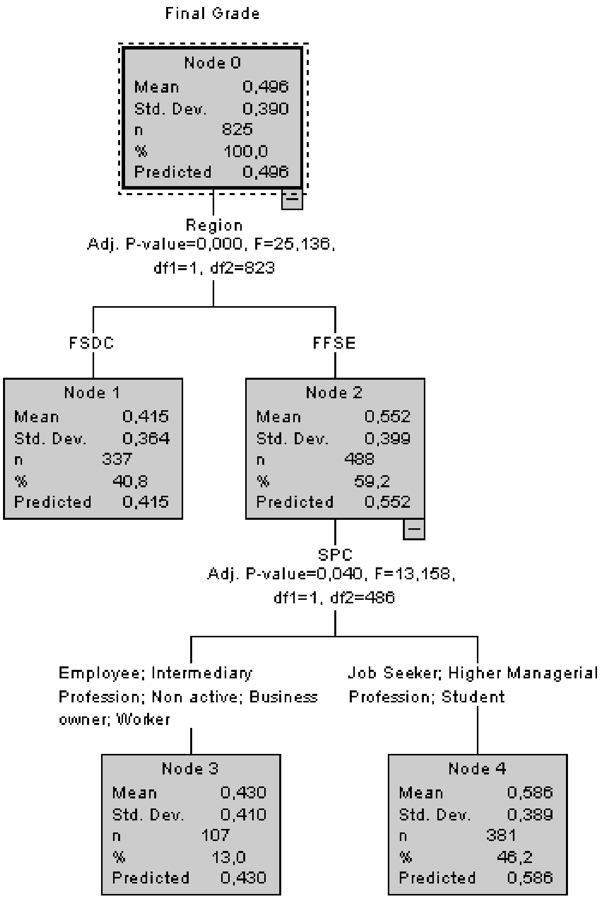

Figure 3. CHAID analysis with final grade as dependent variable (without Academic Cohorts). *FSDC: French-speaking developing countries; FFSE: France & French-speaking Europe; SPC: socio-professional categories.

Figure 3 shows that FFSE participants had higher final grades than FSDC participants, region being the first node (F = 25.13; p < .01). The second node was within the FFSE subsample, where job seekers, HMPO, and students (other than AC) had a higher average grade (M = 58.60; SD = 38.90) than employees, intermediate professionals, non-active people, business owners, and workers (M = 43.00; SD = 41.00; F = 13.15; p = .04). There were no node subdivisions among FSDC participants, and the gender variable did not appear to be a significant discriminant subgroup factor. The estimated risk for this model is 14.3%.

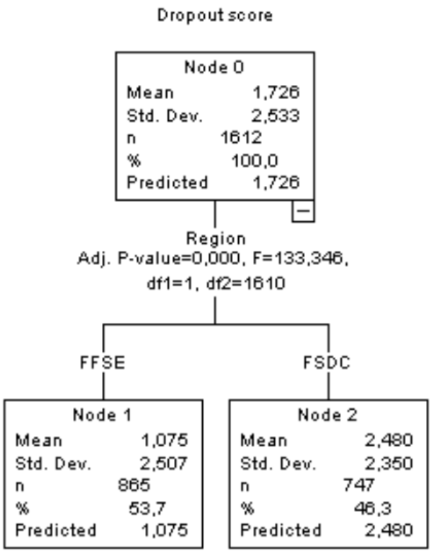

Figure 4. CHAID analysis with dropout score as dependent variable (without Academic Cohorts). *FSDC: French-speaking developing countries; FFSE: France & French-speaking Europe.

Figure 4 displays the CHAID analysis with dropout rate as a dependent variable. For this test, we removed the "course certificate as the learning intention," since it was used to calculate the dropout variable. The result shows that region is the only discriminant factor of dropout: $F = 133.34$; $p < .001$ ($M_{FFSE} = 1.07$; $SD = 2.50$; $M_{FSDC} = 2.48$; $SD = 2.35$), and the estimated model risk is 5.22%.

Finally, we verified learner performance based on the MOOC scoring system and instructional design (i.e., pass or fail). Our goal was to analyze only the achievement or non-achievement factor, without considering grade means. The final grades were mathematically divided into three categories (Figure 5).

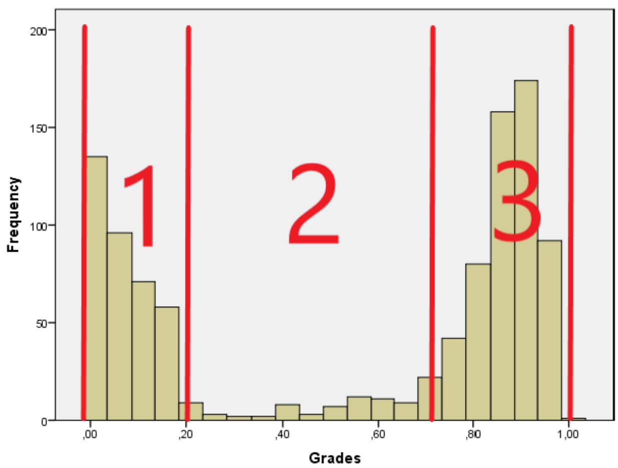

Figure 5. Categorization of the MOOC final grades in three groups.

- Group 1 (final grade between 0 and 19.99) is the dropout category: Less than four weekly evaluations were completed.

- Group 2 (final grade between 20 and 69.99) is the middle category: Weekly evaluations were completed and participants failed the final exam.

- Group 3 (final grade between 70 and 100) is the passing group: Weekly evaluations were completed and final exam was passed.

We transformed the final grade data into three discrete grade groups respecting this grading structure (Table 5).

Table 5

Number of MOOC Registrants by Grade Group and Region

Grade group	Europe without AC students *n* (%)	AC students only *n* (%)	Africa + Caribbean *n* (%)	Total *n* (%)
1	192 (39.34)	7 (4.51)	166 (49.11)	365 (34.88)
2	13 (2.66)	5 (3.22)	51 (15.08)	69 (5.40)
3	283 (57.99)	143 (86.45)	120 (37.79)	546 (59.72)
Total	488 (100)	155 (100)	337 (100)	980 (100)

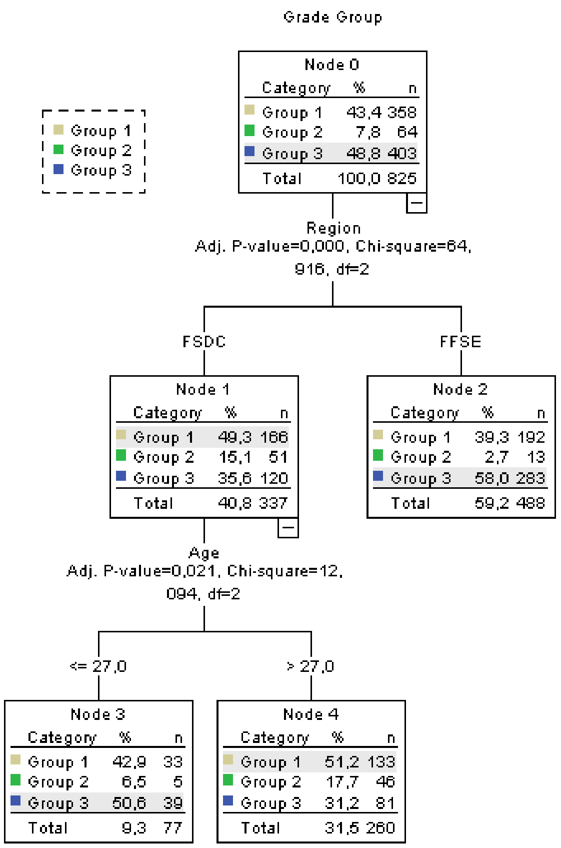

Figure 6. CHAID analysis with grade group membership as dependent variable (without Academic Cohorts). *FSDC: French-speaking developing countries; FFSE: France & French-speaking Europe.

Figure 6 presents the CHAID analysis for grade group membership. The analysis shows that region is the most discriminant factor of average grade and final exam score group membership ($\chi^2 = 64.91$; $p < .001$): FFSE participants are more present in Group 3 than FSDC participants (58.00% and 35.60%, respectively), and FFSE participants are less present in Group 1 than FSDC participants (39.30% and 49.30%, respectively). Fewer FFSE participants also completed the weekly evaluations but failed in the final exam (Group 2, 2.70% and 15.10%, respectively).

Unlike the results obtained through data mining, where the average grade is the dependent variables, in this analysis age appears as a discriminant factor within the FSDC subgroup. The FSDC subgroup is divided into two nodes: Learners below the age of 27 years had higher achievement scores than learners above the age of 27 years ($\chi^2 = 12.09$; $p = .021$). FSDC participants above the age of 27 years are less present in Group 3 and more present in Group 1 and Group 2 than the rest of the overall sample. Overall, FFSE participants and FSDC participants below the age of 27 years old completed the weekly evaluations and passed the final exam. Conversely, FSDC participants above the age of 27 years tended to underachieve. The overall correct model percentage between observed and expected group membership is 60.60%, with a 39.40% estimated risk.

Discussion and Conclusion

Main Results

We found that the biggest gap in MOOC achievement, if we omit students who were forced to enroll in an institutional context, occurred between learners from European and low- and middle-income countries. A U-shaped grade curve was observed in all of our samples. Moreover, the better performance of students and job seekers among FFSE participants highlights the importance of time availability. The results regarding MOOC completion and performance and AC students show that formal for-credit learning is a key driver of MOOC success among participants from FFSE countries. These learners had higher achievement levels than learners who enrolled for professional development reasons, whether they were European or from LMIC.

The definition of dropout must also be considered in context. We chose to consider dropout rates in the context of achieving the learning goal to obtain a certificate, set at the beginning of the course. For other purposes, we could have chosen to weigh dropout rates against other learning intentions. This perspective underscores the multifactorial aspect of online course achievement: Motivation and time availability are necessary but non-sufficient factors in success. The lower grades and higher dropout rates of learners from LMIC emphasize the significance of social and economic determinants of achievement (e.g., learning environment and technology access). The CHAID analyses led us to predict that a specific subsample will underachieve compared to the global sample: Participants above the age of 27 years from LMIC. Based on results from this EDM method, we propose that instructional design for international professional development MOOCs should address the issues that this specific group encounters.

The Importance of Context for MOOC Design

Elias (2011) highlights the challenges inherent to mobile learning in Africa. It is important to consider the access and connectivity problems African learners face (Kaliisa & Picard, 2017) when designing

MOOCs. The key to the success of MOOCs in LMIC, thus, necessarily involves investigating the availability of learners as well as technology use and access issues. This could be addressed, for example, by analyzing the mobile data. Indeed, learning data from the 11th edition of the French PM MOOC (March–April, 2018), which was processed by Google Analytics, show that 1) mobile phones represent 35% of African connections and 22.6% of European connections; 2) African connections from mobile phones display a higher attrition rate (-28%) than European mobile connections (-23%) between the first and fourth week of class (Figure 7). One way to intervene effectively would be, for example, to plan lighter and more mobile-responsive online courses.

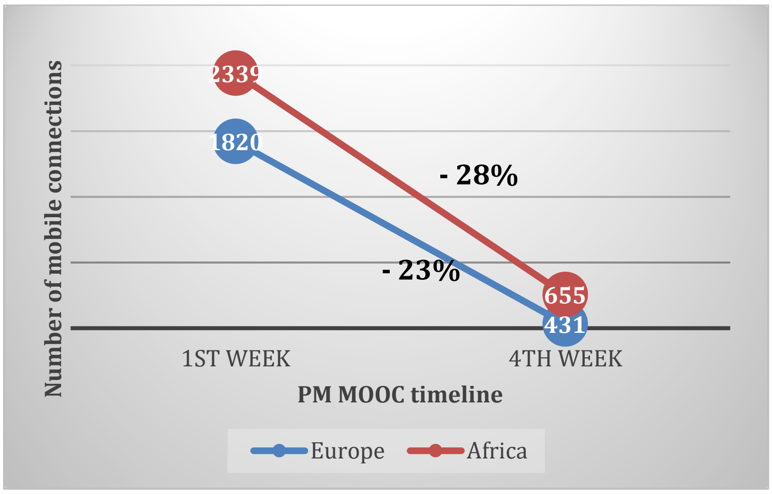

Figure 7. Number of mobile connections between the first and fourth week of the 11th edition of the French PM MOOC (March–April, 2018).

Another aspect of interest is the content delivered. There is a lack of local and contextualized content in MOOCs and in online education in general, as many studies point out (Czerniewicz, Deacon, Small, & Walji, 2014; King, Luan, & Lopes, 2018; King, Pegrum, & Forsey, 2018; Nkuyubwatsi, 2014; Nti, 2015, as cited in Launois et al., 2019). The digital divide concerns not only access but also use (Zillien & Hargittai, 2009). Liyanagunawardena, Williams and Adams (2013) note that even when there is access to good Internet connectivity, poor digital literacy skills pose a barrier. As Richter and McPherson (2012) assert regarding open educational resources, MOOCs are "produced in Western industrialized countries [and] may not necessarily fit the needs of learners in developing countries" (p. 203). MOOCs are "primarily organized by universities and address topics on an academic level" (Rohs & Ganz, 2015, p. 9).

Study Limitations

Our conclusions draw upon student results in one session of the French PM MOOC. This is the main limitation of this research, although we included a relatively large and heterogeneous sample. Nevertheless, this study can pave the way to broader studies involving comparative analyses among different geographical areas within the French-speaking world, since, as noted in the introduction, such studies are limited. Furthermore, we analyzed MOOC success through the prism of formal success (i.e., learners' final grade). It would be relevant to include among learning benefits participation itself, taking into consideration the cultural and economic context of the participants and their points of view (e.g., on their reasons for participating and self-assessed learning), as some researchers propose (Gamage, Perera, & Fernando, 2016; Guàrdia, Maina, & Sangrà, 2013; Liyanagunawardena et al., 2014).

Implications for Practice and Research

Many studies (Castillo, Lee, Zahra, & Wagner, 2015; Daniel, Vázquez Cano, & Gisbert, 2015; Nkuyubwatsi, 2014) suggest adapting online learning content to the local contexts of developing countries (Murugesan et al., 2017) and providing guidance and support to the learners (Patru & Balaji, 2016). In order to adapt the French PM MOOC to local contexts, we have implemented a set of interventions, including

- Sharing project management tools on dedicated social network groups (e.g., Facebook; Figure 8), where African learners can share contextualized productions on a familiar platform.
- Setting up a discussion forum related to each course video, in which African participants can discuss local issues.
- Establishing a dedicated team track for each session. The GdP-Lab hosts five to 10 team projects, mostly from Africa.
- Encouraging student-to-student feedback (e.g., peer review of deliverables from a case study on the advanced track).

Finally, one third of the MOOC tutoring team is based in Africa. These methods could contribute to the high completion rate of African participants in this MOOC compared to most others.

Figure 8. Contextualizing learning: Screenshot of the Facebook deliverable-sharing group.

In conclusion, further research is needed to address the technology learners use to access MOOCs, learners' geographical and cultural context, and learners' demographic backgrounds in order to enhance the achievement rate of specific audiences, such as "older" participants from LMIC, as our empirical results show.

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Heterogeneity of Learners' Behavioral Patterns of Watching Videos and Completing Assessments in Massive Open Online Courses (MOOCs): A Latent Class Analysis

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Abstract

Massive open online courses (MOOCs) have been touted as an effective way to make higher education accessible for free or for only a small fee, thus addressing the problem of unequal access and providing new opportunities to young people in middle and low income groups. However, many critiques of MOOCs have indicated that low completion rates are a major concern. Using a latent class analysis (LCA), a more advanced methodology to identify latent subgroups, this study examined the heterogeneity of learners' behavioral patterns in a MOOC, categorized them into distinctive subgroups, and ultimately determined the optimal number of latent subgroups in a MOOC. The five subgroups identified in this study were: *completing* (6.6%); *disengaging* (4.8%); *auditing* (4.6%); *sampling* (21.1%); and *enrolling* (62.8%). Results indicated this was the optimal number of subgroups. Given the characteristics of the three at-risk subgroups (disengaging, sampling, and enrolling), tailored instructional strategies and interventions to improve behavioral engagement are discussed.

Keywords: MOOC, learner behavioral engagement, tailored intervention, latent class analysis

Introduction

Increases in tuition and fees have reduced opportunities and accessibility to higher education especially for young people in middle- and low-income groups in the United States (College Board, 2016). To overcome this barrier, many universities and institutions offer massive open online courses (MOOCs), which are publicly available for free or for a small fee to anyone who wants to learn. Despite these efforts, critiques of MOOCs have pointed out that low completion rates have been a major concern (Kizilcec, Piech, & Schneider, 2013; Wang & Baker, 2015).

Some scholars claim that success of learners in MOOCs should be distinguished from success of students in traditional learning environments (Henderikx, Kreijns, & Kalz, 2017; Koller, Ng, Do, & Chen, 2013; Reich, 2014). Many educators tend to think of success of learners in MOOCs as official completion, meeting certain requirements, or earning credentials (Henderikx et al., 2017). However, many researchers assert that determining success in MOOCs needs to account for student intentions (Reich, 2014). It is known that approximately 5% of learners who enroll in MOOCs earn a credential indicating completion of the course (Jordan, 2014; Koller et al., 2013). However, if success is defined from the perspectives and intentions of learners, success rates range from 59% to 70% (Henderikx et al., 2017). Despite this argument, low completion rates have been of great concern to MOOC instructors and designers. To better understand student learning and success, instructors need to take a new approach, developing instructional strategies for MOOC learners by taking into account heterogeneity and the distributed nature of learners in MOOCs (Kizilcec et al., 2013; Koller et al., 2013).

Although research on MOOCs has rapidly grown, there is not yet an extensive body of literature on the advanced learning analytics of MOOCs. Given the very low completion rate, it is important to understand the patterns of learners' engagement in MOOCs in order to develop adaptive and specific learning mechanisms (Henderikx et al., 2017; Kizilcec et al., 2013). MOOCs are intended to include diverse populations in a single online learning environment. Learners often span wide ranges of age, location, educational background, and native language. Given the diverse profiles of MOOC learners, MOOC instructors and designers should select instructional strategies and intervention plans that match learner characteristics so that individual learners can be successful in MOOCs. This study examined the heterogeneity of learners' behavioral patterns, categorized learners into different behavior pattern groups, and ultimately developed tailored interventions for at-risk subgroups.

Literature Review

Learners' Behavioral Engagement in MOOCs

Most of the previous studies that investigated learners' engagement in academic activities were focused primarily on behavioral engagement (Jung & Lee, 2018). The most commonly used indicators of behavioral engagement were watching lecture videos, taking quizzes, completing tasks, and posting to forums (Jung & Lee, 2018; Li & Baker, 2016). It is important to identify patterns of learners' behavioral engagement since this allows MOOC instructors to understand how learners interact with content in MOOCs, detect at-risk learner groups, and tailor interventions for improving engagement and learning outcomes (Bote-Lorenzo & Gómez-Sánchez, 2017; Ramesh, Goldwasser, Huang, Daume, & Getoor, 2014). Recently, Phan, McNeil, and Robin (2016) researched the relationship between learners' behavioral engagement (e.g., assignment submission and participation in discussions) and their performance in MOOCs and found that actively engaged learners showed better performance than those who were less engaged. Thus, among the multidimensional aspects of engagement, learners' behavioral engagement is a strong indicator of success in MOOCs.

Classification of Subgroups in MOOCs

Recent literature on MOOCs is increasingly moving beyond basic analytics to explore deeper level constructs such as intent, persistence, and behavior, as well as to make attempts at developing prediction models from findings. Kizilcec et al. (2013) investigated the pattern of learners' engagement, resulting in the creation of learner subpopulations identified as the trajectory of engagement using a *k*-means clustering algorithm. They found that while survival statistics counting *completing learners* are the most common measure of success in MOOCs, other types of learners such as *auditing*, *disengaging*, and *sampling* learners are subgroups found in MOOCs. Table 1 shows brief descriptions of the four subgroups identified by Kizilcec et al. (2013).

Table 1

The Trajectory of Engagement by Subgroups in MOOCs

Subgroups	Description
Completing learners	• Completed the majority of the assessments • At least attempted the assignments • Were most similar to a student in a traditional class
Disengaging learners	• Did assessments at the beginning of the course but then had a marked decrease in engagement • Disengaged at different points in the course, but generally in the first third of class
Auditing learners	• Did assessments infrequently, if at all • Engaged by watching video lectures • Followed course for the majority of its duration • Did not obtain course credit
Sampling learners	• Watched video lectures for only one or two assessment periods • "Sampled" at the beginning of the course or briefly explored the material when the class was already fully under way

Ferguson and Clow (2015) examined the generalizability of the subgroup categories found in the research of Kizilcec et al. (2013). They replicated the research procedures and tested whether the same patterns of learner engagement were found in MOOCs where instructors used social constructivist pedagogy. Results showed seven subgroups: *samplers*, *strong starters*, *returners*, *midway dropouts*, *nearly there*, *late completers*, and *keen completers*. Table 2 shows brief descriptions of the seven subgroups described by Ferguson and Clow (2015).

Table 2

The Subgroups Found in MOOCs

Subgroups	Description
Cluster I: Samplers	• Visited the course, but only briefly • Accounted for 37%-39% of learners and made up the largest cluster in all four MOOCs
Cluster II: Strong starters	• Submitted the first assignment, but then their engagement dropped off sharply, with very little activity after that • Made up 8%-14% of learners
Cluster III: Returners	• Completed the assessment in the first two weeks, returned to do so again in the second week, and then dropped out • Made up 6%-8% of learners in the three of the four MOOCs
Cluster IV: Midway dropouts	• Completed three or four assessments, but then dropped out about halfway through the course • Visited about half of the course (47%, 59%), and roughly half posted comments (38%, 49%), posting 6.3-6.5 comments on average
Cluster V: Nearly there	• Consistently completed assessments, but then dropped out just before the end of the course • Accounted for 5%-6% of learners in all four MOOCs
Cluster VI: Late completers	• Completed the final assessment, and submitted most of the other assessments, but were either late or missed some • Accounted for 6%-8% of learners in the three of the four MOOCs
Cluster VII: Keen completers	• Completed all the assessments, including the final one, and almost all of them on time (>80%). • Accounted for 7% to 13% of learners in the three of the four MOOCs.

In advancing the research, Ferguson and her colleagues wondered if these patterns of learner engagement could be applied by MOOC instructors or designers. In order to determine the applicability to other MOOCs, they examined five MOOCs with a variety of course duration (e.g., 3 weeks, 6 weeks, 7 weeks, and 8 weeks; Ferguson et al., 2015). Results showed that those same seven subgroups were found in seven- or eight-week courses. On the other hand, the seven subgroups did not show up in relatively short MOOC courses, such as three-week courses (Ferguson et al., 2015). Rather, there were variations and new emerging patterns of learner engagement such as *saggers*, *improvers*, *surgers*, and *weak starters*.

Taken together, there have been many attempts to identify subgroups in MOOCs based on learners' behavioral patterns. However, the categorizations across the previous studies were not matched accurately and still remain questionable. This study investigated profiles of subgroups in a MOOC by analyzing behavioral engagement patterns. To optimize the number of subgroups, it was necessary to use a more advanced and rigorous methodological approach to clustering subgroups in MOOCs.

Research Question

From the literature review, it was evident that there were inconsistencies in the categorizations and the number of subgroups in MOOCs, and that a more rigorous method to identify subgroups in MOOCs would benefit prediction models. To determine subgroups, two research questions were posed:

- How many subgroups would emerge from a latent class analysis (LCA)?
- What characteristics would each subgroup have in common?

Identifying the characteristics of subgroups provides a foundation to develop the features of adaptive learning in MOOCs. Answering the two research questions, we profile the homogeneity of behavioral patterns in each subgroup and develop tailored strategies for learning activities and student achievement.

Method

Course Description, Samples, and Demographics

A MOOC, *Job Success: Get Hired or Promoted in 3 Steps*, was selected for this study. This course was offered through Coursera, which is a platform to deliver MOOCs, and was taught only in English. The purpose of this course was to show job seekers how to stand out in a crowded applicant pool so that they would get hired, and to teach anyone who already had a job how to get recognized and promoted. This course was self-paced, but it was suggested that students spend three hours per week over the course of three weeks to complete the MOOC. This course encompassed three sections and included 10 video lectures and 4 quiz assessments. The quiz assessments were formative and could be taken multiple times.

To collect students' behavioral data from Coursera, we requested the clickstream data on the selected MOOC from September 1, 2016 to February 22, 2017 via Coursera's research exports (https://github.com/coursera/courseraresearchexports), where MOOC researchers request Coursera research data such as assessment submission data, course grade data, course progress data, demographic data, and discussion data. In total, 3,955 learners enrolled in the course and their behavior patterns were part of the data. In order to better understand learners' backgrounds, the demographic survey embedded in the course was part of this study, though participation in the survey was voluntary.

Among the 3,955 learners, 1,489 (37.6%) completed the embedded survey. This included 470 (31.6%) male and 724 (48.6%) female learners, with missing values of 295 (19.8%). Learners came from 121 countries (41 Asia, 35 Europe, 17 Africa, 15 North America, 10 South America, and 3 Oceania). All respondents to the survey were included in the clickstream data.

Using Kizilcec et al.'s (2013) four MOOC subgroups (see Table 1), learners were asked about their intentions. Most enrolled to complete the entire course, i.e., 765 (51.4%), while 185 (12.4%) intended to look around and review items of interest, 180 (12.1%) planned to follow most of the course lectures and videos without completing assignments, and 25 (1.7%) aimed to finish at least the first unit. To understand how many learners had powerful motivation to achieve their goals, the Grit Scale was included in the survey. Grit in this case is defined as "trait-level perseverance and passion for long-term goals" (Duckworth & Quinn, 2009, p. 166). The average score on the Grit Scale was 3.4, indicating learners were moderately passionate about achieving their long-term goals in a MOOC. Finally, most of these students had prior experience with MOOCs: 560 (37.6%) had completed 1 to 3 courses, 208 (14.0%) had participated in 4 to 6 courses, and 170 (11.4%) had taken 7 or more courses. Only 212 (14.2%) fell into the category of having had no experience with MOOCs.

Instruments

The clickstream data from Coursera are defined as learners' interactions, based on clicking information, which is automatically saved in the Coursera system. The clickstream data cover two domains: (a) video (interactions with lecture videos such as start, stop, pause, change subtitles, and heartbeats) and (b) access (accessing the course description page and course materials). As the raw clickstream data were very segmented and unclean in the Coursera platform, they had to be transformed into an analyzable format using Microsoft Access data mining functions. In this study, we defined patterns of learners' behavioral engagement with the two primary features of the course: video lectures and assessments. In the two representative studies of subgroups in MOOCs, i.e., Kizilcec et al. (2013) and Ferguson and Clow (2015), the same indicators of behavioral patterns were used. Subgroups classified by these indicators can be generalized into other MOOC contexts regardless of course content or instructional strategies.

Learners' interactions with 10 video lectures and 4 quizzes were used to determine the behavioral patterns of subgroups. For each of the 10 video lectures, a learner was coded as *0* for *not watching a video lecture* or *1* for *watching video*. To ensure watching a video lecture was completed, *1* was coded only to the learner who watched a video lecture to the end. If a learner started to watch a video lecture, but did not complete it, *0* was coded for that particular learner and video. In addition, for each of the 4 quizzes, a learner was coded as *0* for *not taking quizzes* and *1* for *taking quizzes*. For instance, if a learner watched all 10 video lectures and took all 4 quizzes, the coding for that learner was [1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1]. If a learner watched all 10 video lectures but took only one quiz, the coding for that learner was [1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 0, 0, 0]. If a learner enrolled in the course, but did nothing during the course, the coding for that learner was [0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0].

Data Analysis

LCA was employed to cluster and determine the optimal number of latent subgroups. LCA is a statistical technique used to identify a set of mutually exclusive subgroups of individuals who have similar characteristics. In MOOC research, LCA has been recently adopted as a novel methodological approach to categorize relatively smaller and homogeneous subgroups from entire heterogeneous populations using learners' behavioral engagement patterns such as discussion viewing (Bergner, Kerr, & Pritchard, 2015), forum use (Poquet, Dowell, Brooks, & Dawson, 2018), and profiles of student motivation (Moore & Wang, 2020). The ultimate goal of these studies was to develop tailored instructional interventions for each subgroup based on profiles.

LCA is considered methodologically superior to any of the other algorithms such as *k*-means clustering in that (a) while *k*-means uses an ad hoc approach, LCA uses a probabilistic model that enables cases to be classified into clusters, and (b) while *k*-means provides no diagnostics for determining the number of clusters, LCA can use a variety of model selection indices such as the Akaike information criterion (AIC) and the Bayesian information criterion (BIC) (Magidson & Vermunt, 2002). Based on this model, learners have membership in certain latent classes instead of the researcher finding clusters with arbitrarily chosen distance measures as is the case in *k*-means clustering.

To determine the optimal number of subgroups and maximize the model fit in LCA, model fit indices such as the AIC and BIC and interpretability were considered (Lanza, Collins, Lemmon, & Schafer, 2007). The optimal number of subgroups among MOOC learners was determined based on evidence that minimized AIC and BIC from among groups that measured a frequency of at least five percent.

Results

The results of the LCA showed five distinct subgroups as the optimal number in a MOOC. Students in each of the five subgroups showed similar behavioral patterns of learning engagement. Table 3 shows the results of fitting the latent class models (two to six classes) for indicators according to the model selection process.

Table 3

*The Model Fit Information for Latent Class Models of MOOCs (*N *= 3,955)*

Subgroups	2-latent class model		3-latent class model		4-latent class model		5-latent class model		6-latent class model	
	n	%	*n*	%	*n*	%	*n*	%	*n*	%
Class 1	3,404	86	499	13	835	21	261	7	262	7
Class 2	551	14	888	22	346	9	190	5	172	4
Class 3			2,568	65	2,503	63	184	5	201	5
Class 4					272	7	2,485	3	2,432	61
Class 5							835	21	505	13
Class 6									383	10
Goodness of fit statistics										
AIC	31053.06		26016.39		24968.17		24211.24		23635.64	

BIC	31235.26	26292.83	25338.86	24676.16	24194.80

Note. AIC = Akaike information criterion; BIC = Bayesian information criterion. A smaller number in BIC and AIC indicates a better model fit.

The final model specification and the optimal number of latent classes were determined by considering the model fit indices and the interpretability of the results (Lanza et al., 2007). First, model selection indices AIC and BIC were used to determine the optimal number of subgroups in a MOOC. According to Chen, Luo, Palardy, Glaman, and McEnturff (2017), AIC and BIC are preferable and the most effective model selection indices when the sample size is large and a model is misspecified, as compared to other model selection indices such as the Vuong-Lo-Mendell-Rubin likelihood ratio test (VLMR), and the adjusted Lo-Mendell-Rubin likelihood ratio test (ALMR). VLMR and ALMR have a tendency to over extract the number of classes when the sample size is large. Because of the large sample size (N = 3,955), AIC and BIC were the most effective model selection indices for this study. Analyzing the results of the model selection indices, the values of AIC and BIC decreased from the 2-latent classes model to the 6-latent classes model, indicating a better model fit as the number of classes increased. However, I stopped with the 6-latent classes model since, at that point, the proportion of class 2 was less than 5%, which is hard to interpret as a subgroup.

Second, to determine which of the 5-latent class or 6-latent class model had a better fit, the interpretability of the results was considered based on findings in previous literature profiling subgroups in MOOCs. Classes 1, 2, 3, and 4 in a 6-latent class model showed no or little change in the proportion compared to the 5-latent class model. Class 5 from the 5-latent class model was divided into only two subgroups in the 6-latent class model. These two subgroups were not found or interpretable based on previous literature. On the other hand, Class 5 in the 5-latent class model could be defined as the *sampler* or *sampling* group based on previous literature (e.g., Kizilcec et al., 2013; Ferguson & Clow, 2015). Consequently, the 5-latent class model was selected as the best fitting model given the fit indices AIC and BIC as well as the interpretability of the results.

Given the overall probability of endorsing the consequences, the five subgroups were categorized and named after discussions with the research team as follows: class 1 was the *completing* group; class 2 was the *disengaging* group; class 3 was the *auditing* group; class 4 was the *enrolling* group; and class 5 was the *sampling* group. The *enrolling* group (63%) exhibited the highest probabilities for being defined as a subgroup, followed by the *sampling* group (21%), the *completing* group (7%), the *disengaging* group (5%), and finally the *auditing* group (5%).

Overall, the behavioral patterns of each subgroup were almost the same as in the subgroups identified in Kizilcec et al. (2013). The *completing* group showed the highest level of completion of quiz assessments and watching video lectures and consisted of 6.6% of the entire enrollment. This group watched almost all 10 video lectures and completed all 4 quizzes. The *disengaging* group accounted for about 5% of the entire enrollment. In the *disengaging* group, almost half the students took the 4 quizzes and watched the first video lecture. However, the proportion of students watching video lectures decreased over time. The *auditing* group made up about 5% of the entire learner enrollment. In the *auditing* group, most learners watched almost all video lectures, but they completed only the first quiz or no quizzes during the course. This group aimed to get domain-specific knowledge from the course. Most of the learners in the *sampling* group watched only the first 4 of the 10 video lectures. In addition, they took no quizzes during the course. This *sampling* group consisted of more than 20% of the entire enrollment. The *enrolling* group comprised the largest proportion of the entire enrollment. They consisted of almost 63% of the entire enrollment. This group enrolled in the course but did nothing or did not show up for the course. This group is a new subgroup found only in this study; it has never been categorized as a subgroup in previous studies. For instance, although Anderson (2013) briefly mentioned the similar *enrolling* group who enroll in MOOCs, but never login to or show up the course, those learners were not profiled or paid attention to as an important subgroup we should focus on in MOOCs. Table 4 shows the characteristics of each subgroup in this study.

Table 4

Characteristics of the Five Subgroups

Subgroup	Description
Class 1: Completing group	• Learners watched almost all 10 video lectures and took almost all 4 quizzes. On average, 95% of learners watched 10 video lectures and 93% of learners took 4 quizzes.
Class 2: Disengaging group	• About 30% of the learners watched video lectures. In the beginning, about half the learners watched the first video lecture and then the proportion decreased over time. On average, 54% of the learners took all 4 quizzes and tended to show a slight decrease in taking quizzes over time.
Class 3: Auditing group	• About 86% of the learners watched most of the videos (8 out of 10), but they had a tendency to show a slight decrease in watching the last two video lectures. In addition, 61% of the learners took the first quiz and then the proportion who took the rest of the quizzes sharply decreased up until it reached only 3%.
Class 4: Enrolling group	• Learners enrolled, but they did almost nothing in the course. Only 2% of these learners watched some of the video lectures and only 1% took the quizzes.
Class 5: Sampling group	• Almost all learners watched the first two video lectures and then the proportion who watched decreased from the fourth video lecture. From the fifth video lecture, almost all learners did not watch. In addition, only 30% of learners took the first quiz and did not take the rest of the quizzes.

Discussion

Completing and auditing groups were considered successful subgroups since they achieved the goals they set going into the MOOCs. Thus, there remain three at-risk subgroups: disengaging, sampling, and enrolling. Tailored interventions are discussed in this section.

Different Tailored and Effective Interventions

Disengaging group. Learners in this group showed lower levels of engagement in the MOOC. For some reason, learners' intentions to complete the course changed negatively, which in turn resulted in lower levels of engagement over time. Kizilcec et al. (2013) pointed out that there were two reasons why learners in this group disengage over time: personal commitment and conflict with schedules at work. Personal commitment, combined with a lower level of motivation, resulted in a lower level of engagement. This often occurred when the learner failed to set clear goals. This was related to self-regulated learning skills, namely goal setting and strategic planning. Kizilcec, Pérez-Sanagustín, and Maldonado (2017) found that these two self-regulated learning strategies were positively related to goal attainment. Thus, an orientation session on self-regulated learning strategies would be helpful for increasing the confidence level of learners in this group.

Another primary cause of disengaging in MOOCs was conflict with schedules at work. According to Chen, Alcorn, Christensen, and Eriksson (2015), 60% of learners who completed MOOCs were full-time employees. They successfully managed their time and the effort needed for their MOOCs. However, some learners in this *disengaging* group failed to balance their work with their learning in the MOOC. This may have been caused by too much work, too many obligations, and a lack of organizational support. According to Waddoups (2016), only 17% of workers receive organizational and supervisory support for training, reaffirming that most organizations do not use and support MOOCs for professional development. To get support from supervisors and organizations, employees may pursue certificates through MOOCs since some employers are willing to pay for certificates and will support such types of professional development (Hamori, 2019). A further factor to consider is that some organizations will provide time off rather than tuition reimbursement to support employees' professional development through MOOCs, since MOOCs involve little or no cost (Hamori, 2019). However, to take time off for MOOCs, employees need to receive approval from supervisors and organizations before enrolling. MOOC instructors may consider developing a MOOC readiness assessment checklist that would help learners determine the status of supervisory and organizational support for MOOCs before they enroll.

Sampling group. Like the *disengaging* group, learners in this group showed a relatively lower level of engagement. They watched about 4 or fewer of the 10 video lectures and did not take any quizzes. One difference between the two groups is that while the *disengaging* group watched only the first few video lectures and were not engaged in the latter part of the course, the *sampling* group explored the video lectures both in the beginning as well as later in the session. Learners in this group aimed to explore the content and materials. In this sense, they were passive learners who were not willing to engage in diverse activities.

The reasons why the *sampling* group was passive can be found in the course's task design and/or level of facilitation during the MOOC (Cassidy, Breakwell, & Bailey, 2014). For instance, learners who prefer learning in a group are more likely to engage in discussion forums, while others who only seek specific information are more likely to engage in individualized tasks and learning activities. Thus, MOOC instructors should develop a variety of tasks such as individual work (e.g., quizzes, tests, case studies, and knowledge checks) and group work (e.g., small group discussions and peer-reviewed assignments), taking into consideration the characteristics of individual learners. In addition, instructors should help learners get more involved in activities by posting announcements, participating in discussion forums, and encouraging completion of the course.

Enrolling group. Although learners in this group enroll mostly out of curiosity, and have no intention to complete their courses, they should be carefully dealt with since they comprise the largest portion of enrollees (e.g., 63% in this study). While little is known about the characteristics of this group, enrollment itself could be understood to mean that learners have an interest in or curiosity about the contents or learning in MOOCs. Participants in this group are potential subjects who may return to enroll in future MOOCs. According to Reich (2014), learners' intentions can change, and these "intention flips" are a good indicator of success in MOOCs. Thus, course designers and instructors should try to understand how they could help these learners change from having no or little intention to complete the MOOC into an intention to instead get involved.

There are several possible reasons why these learners do nothing after enrolling: (a) the course content is different from what was expected (irrelevance); (b) learners are unsure about their abilities to master the contents (less confidence); (c) learners have no experience of MOOCs (no experience); and/or (d) there is poor user interface design. Instructors could take a number of steps to address these issues.

Instructors could provide a video preview giving a quick glimpse of a course so that *enrolling* learners could determine whether their interests and intentions fit the course. Instructors could send a video preview link to the *enrolling* learners to remind them about participating in the course.

In addition, instructors could create a short description of the characteristics that lead to success in MOOCs, such as self-regulated learning. Those who have no experience of MOOCs are unlikely to have successful strategies for completing the courses they enroll in. Like the *disengaging* and *sampling* groups, this group may need to develop self-regulated learning skills and perform activities to set their goals and strategically plan at the beginning of the course.

Finally, if it is the user interface design that is causing problems, steps can be taken to improve the situation. For example, when learners first log in, a road map or short tutorial might be helpful to guide those who have no experience of MOOCs. A navigation pane would also be helpful for predicting the course structure. Table 5 shows a summary of tailored interventions for the three at-risk subgroups.

Table 5

Tailored Instructional Design and Intervention Strategies for the Three At-Risk Subgroups

At-risk subgroups	Instructional design and intervention strategies
Disengaging group	• Strategy 1. Create an orientation session for self-regulated learning strategies to teach goal setting and strategic planning. • Strategy 2. Create a MOOC readiness assessment checklist that helps learners review the status of supervisory and organizational support for MOOCs.
Sampling group	• Strategy 3. Develop a variety of tasks that consider individual learning preferences. • Strategy 4. Facilitate learners to participate in various learning activities by sending messages and reminders.
Enrolling group	• Strategy 5. Change no intention into a good intention by providing a video preview, creating a short description on learning in MOOCs, and improving the user interface design.

Implications

Methodological implications. In this study, LCA was adopted to profile individual learners' behavioral patterns of watching videos and completing assessments. LCA is a model-based approach to clustering subgroups from an entire population. An advantage of using a model-based approach over a data-driven cluster approach (e.g., *k*-means clustering) is to provide fit statistics that help researchers determine the most appropriate model for data and to compare models to arrive at the optimal number of subgroups for hypothesis testing. On the other hand, the results of the existing studies using *k*-means clustering showed an arbitrary or inconsistent number of subgroups in MOOCs. Furthermore, LCA is a more rigorous approach to clustering subgroups in MOOCs and helping researchers find model-based subgroups. LCA can be extended into any open and distributed learning environment (e.g., online learning, MOOCs, and blended courses) in order to cluster subgroups and develop tailored interventions. LCA as a novel approach has wider applicability to open and distributed learning environments.

Practical implications. The *disengaging* and *sampling* groups are at-risk learner groups since they start a course with good intentions and interest but they do not continue to engage in learning. For unknown reasons, their good intentions change into negative ones. To promote engagement in these two at-risk subgroups, this study suggests tailored interventions for the *disengaging* group (e.g., an orientation session for self-regulated learning strategies and a MOOC readiness assessment checklist) and for the *sampling* group (e.g., a variety of tasks responding to individual preferences and encouragement strategies for active participation). These tailored interventions provide insights and information on effective instructional strategies for MOOC instructors and learners.

The characteristics of the *enrolling* group are unknown and have not been included in previous MOOC research. Although inactive, learners in this group could return to the course in the future. As this group comprises the largest proportion of the entire number of enrollees, they should be dealt with as one of the subgroups in MOOCs. Although the *enrolling* group has no clear intention and thus does not perform the behavior necessary to complete the course, their interest or curiosity caused them to enroll in the first place. Thus, the first step to develop strategies for this group is to find a way in which to help them discover their own intention to learn (e.g., through a video preview), and to translate these intentions into performing behaviors (e.g., the activity for goal setting and strategic planning).

Conclusion

This study identified the subgroups and determined the optimal number of subgroups in a MOOC using an LCA. First, focusing on the three at-risk subgroups, tailored interventions were developed. These tailored interventions will help MOOC instructors and designers get insight into instructional strategies for each of the at-risk subgroups. Second, LCA, a model-based approach to clustering subgroups in a MOOC, provided convincing evidence on the optimal number of subgroups so that MOOC instructors can develop tailored and effective interventions. In conclusion, this study is the first step towards more theoretically and empirically grounded research into learner engagement in MOOCs and contributes to developing the foundation of adaptive learning analytics.

Limitations and Suggestions for Future Research

Based on limitations, this study suggests some areas for future research. First, one of the limitations of this study was the use of only two types of behavioral engagement (watching video lectures and completing assessments) from the clickstream data to identify subgroups. However, the clickstream data included many other types of indicators such as average play speed of a video, stop, pause, and rewind, and whether the learner started the quiz and left without answering any questions. Using multiple indicators of learners' behavior in the clickstream data, the profiles of each subgroup could be elaborated. Thus, the granularity of the behaviors in the clickstream data could help refine the profiles of each subgroup.

Second, only one aspect of behavioral engagement was used to identify subgroups. In fact, there are other types of learner engagement in MOOCs such as cognitive engagement, affective/emotional engagement, and social engagement. Jung and Lee (2018) indicated that learner engagement in MOOCs includes the multidimensional approach to emotional, cognitive, and behavioral aspects. Thus, as the results of this study are limited to behavioral aspects of learner engagement, future research should delve into the multidimensional aspects of engagement in MOOCs by collecting data from multiple sources such as surveys, clickstream data, and interviews. For instance, follow-up interviews with learners in at-risk groups would help better understand why they are failing to complete courses. A variety of external factors could be addressed while collecting multiple data.

Finally, the data were collected from a single 3-week MOOC. Although this study provides empirical evidence of the sub-groups that emerged from an LCA, the findings may be hard to transfer or generalize into other MOOC courses and contexts. Thus, data could be collected from multiple MOOC courses, with diverse content, from different disciplines, of varying duration, and from various providers and platforms.

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Dealing With Isolation Using Online Morning Huddles for University Lecturers During Physical Distancing by COVID-19: Field Notes

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Abstract

Isolation can affect our well-being negatively. To prevent the spread of the infection COVID-19, many workers, including university lecturers, are required to work from home. In order to maintain high levels of well-being and team cohesion, academics at the University of Derby Online Learning initiated a virtual huddle to briefly socialise and check on their colleagues' well-being every morning. This piece of field notes reports the context (COVID-19 in the United Kingdom), the details of this morning socialization, the first-hand experience of attending this huddle, and possible applications. Perceived positive impacts of our huddles include better well-being, cultivating compassion in team culture, and enhanced team cohesion. These advantages can be also useful in student supervision, wider socialization with colleagues to counter the silo mentality, and other occupational sectors. Our field notes will be helpful for lecturers and other types of employees who work collaboratively yet in isolation during this uncertain and challenging time of crisis.

Keywords: isolation, well-being, team cohesion, COVID-19, crisis management

COVID-19 in the United Kingdom

The coronavirus 2019 (COVID-19) pandemic originated in Wuhan, China (Hui et al., 2020), with the first case confirmed in December 2019 (Chen et al., 2020). As of June 4, 2020, there were 6.42 million cases with more than 382,800 deaths worldwide (European Centre for Disease Prevention and Control, 2020; World Health Organization, 2020). The United Kingdom (UK) has been as susceptible as any other country to the effects of COVID-19 because systems in society are integrated—a risk factor for infection (United Nations, 2019). Accordingly, in the UK and many other countries, what seem to be innocuous day-to-day activities such as going to work and socialising in person are now restricted (Coronavirus Act, 2020). Whilst the majority of the population will survive, the spread of COVID-19 is worrying because of the infectivity and recency of the disease; we do not fully understand the effects and therefore the human and economic costs of the virus (Coronavirus Act, 2020).

Since February 2020, many European countries and other countries in the world implemented measures of physical distancing and working from home to reduce new cases of infection and deaths, colloquially referred to as *flattening the curve* (Anderson, Heesterbeek, Klinkenberg, & Hollingsworth, 2020; Mahase, 2020). Physical distancing is thought to be a key defence against the spread of the virus, therefore the UK government encouraged physical distancing and urged employers to facilitate working from home where possible, enacted in emergency legislation on March 23, 2020 (Cabinet Office, 2020; Coronavirus Act, 2020).

In order to comply with the government regulation, examples of good practice were reported, e.g., delivering teaching and holding meetings online instead of on campus, and changing arrangements for in-person summative assessments (Universities UK, 2020). At the University of Derby (UOD), teaching was suspended March 23 with all sites apart from Halls of Residence effectively closed on March 27, 2020, and all staff working from home (UOD, 2020).

The rapid move to working from home has forced individuals and organisations to learn how they can continue delivering education, requiring the implementation of multiple changes. At the University of Derby Online Learning (UDOL), while the curricula are offered almost solely online, onsite staff normally work together at the university due to various needs such as liaison with on-campus staff and engagement with external stakeholders. The majority of onsite academic staff at UDOL typically work three days at the university and two days at home. The three onsite days vary by portfolio (e.g., Monday, Tuesday, and Wednesday for our Inter-Professional portfolio). Accordingly, meetings and socialisation events are scheduled on those onsite days. This onsite-offsite work balance is similarly practiced by the on-campus academics who teach face-to-face. It is known that isolation can negatively affect our mental health (Holt-Lunstad, Smith, Baker, Harris, & Stephenson, 2015) and academics' workplace team morale (Dolan, 2011). In order to mitigate such risks, academics at UDOL started short online gatherings every morning, which are being referred to as "morning huddles."

Online Morning Huddles

The morning huddles are scheduled from 9:00 to 9:15 a.m. daily. The online meeting link is established on Microsoft Teams (MS Teams), sent to 12 academics in the Inter-Professional portfolio (encompassing nursing, counselling, social work, and environmental studies), as recurring calendar invites with no set agenda. Many members log in before 9 a.m. to engage in casual conversation. The primary purpose of the huddle is to check everyone's well-being and to determine how they are maintaining their well-being in isolation. The conversations maintain a cordial and relaxed tone, and efforts are made to ensure that all colleagues get a chance to engage. In addition to video/audio interaction, a chat box is available to communicate with texts that provide additional information such as helpful links or, in some cases, little jokes which colleagues enjoy and respond to. Although scheduled for 15 minutes, conversations usually continue much longer. The huddle ends when we have exhausted all relevant issues and colleagues offer each other best wishes for the day.

Perceived Positive Impacts of the Huddle

Although it has been just two months, notable perceived positive impacts have been already reported by the attending staff, which can be summarised as (a) enhanced well-being, (b) cultivating compassion in team culture, and (c) team cohesion (Table 1). Staff feedback was collected in the huddles, and reviewed by each co-author independently, who then discussed and agreed with the final output.

Table 1

Characteristics of Online Morning Huddles

Perceived positive impacts	Suggestions for possible applications
• Enhanced well-being (connectedness reduces loneliness). • Cultivating compassion in team culture (placing well-being first). • Enhanced team cohesion (daily check-in with team).	• Huddles with student groups (e.g., personal academic tutoring or supervision in the independent study). • Huddles with a wider range of colleagues (e.g., academics in other disciplines, administrators, learning design or admission team). • Workers in other sectors who normally work in the office but now need to isolate.

Note. Attended by 12 academics in the Inter-Professional portfolio (encompassing nursing, counselling, social work, and environmental studies).

Whereas general team meetings can provide opportunities to discuss ideas and make decisions (Kauffeld & Lehman-Willenbrock, 2012), our morning huddles focus on caring for each other's well-being, which is the priority of this meeting (e.g., asking how they and their family are doing). By attending the huddle, we feel more compassionate and connected with the team (Dolan, 2011), which can counteract loneliness (a debilitating factor for well-being) in isolation to protect our well-being (Kotera, Green, & Van Gordon, 2018; Victor et al., 2018).

At a team level in general, daily interactions in the huddles can enhance the compassionate culture and team cohesion echoing previous research into huddles in which workers report sincere care for and connection with colleagues (Chapman et al., 2020). We indeed perceived higher levels of caring for each other, and unity as a team at this uncertain time. Though often under-emphasised, these perceived positive impacts referring to connectedness are especially important to university lecturers as we are referred to as "connected professionals" (Oddone, Hughes, & Lupton, 2019, p.109).

Using these advantages, the huddles may be effective in other contexts. For example, periodic brief check-ins with supervised students, focusing on their well-being, may be useful in an independent study or a research project module. These types of check-ins may be more effective in distance education, as talking about non-academic issues may allow lecturers to see their supervisees more holistically (e.g., understanding their background). The caring and compassionate culture is important in many aspects of education, including the relationships with students (Claessens et al., 2017). The theory of human caring can support these ideas, because it asserts that humans are not objects, and thus can only be understood in the holistic perspective, and that caring transcends distance and physicality (Watson, 2008).

Additionally, huddles with a wider range of staff may be also useful, relating to enhanced team cohesion. The silo mentality is a problem in many higher education institutions (Reinholz & Andrews, 2019), however, this easy-to-access meeting (just by clicking the link) may help different university colleagues mingle, leading to higher performance as a team. Likewise, huddles can be used by workers in different industries. For many office-based workers, home-based working as a result of COVID-19 is an enormous transition, demanding a great degree of adjustment (Stewart & Menon, 2020). Regular, brief online catch ups can support their adjustment and foster their well-being.

Discussion

The present field notes report the utility of online morning huddles for university lecturers dealing with isolation under the COVID-19 pandemic. The perceived positive impacts of huddles include better well-being, cultivating a caring culture, and team cohesion, which suggest the usefulness of sharing this good practice with many other academics and workers in the world, who are in a similar situation. Particularly, well-being of faculty is often an under-recognised area of research (Ng, 2006), indicating the value of this piece of field notes.

One of the original values of the present field notes may be that while our experience supports the usefulness of occasional meetings among lecturers for socialisation purposes (Naidu, 2014), this paper reports that online huddles may be even more effective during an uncertain crisis such as the COVID-19 pandemic. This relatively easy-to-do practice can be useful to an increasing number of institutions worldwide that have started online provision of courses, managing their diverse faculties (Gallagher & Garrett, 2013). Previously, several studies have highlighted advantages and disadvantages of remote working for academics. Isolation is one of the salient difficulties they experience and feeling isolated can impact negatively on lecturers' performance (Kotera et al., 2019). Regular contacts with colleagues can enhance a sense of belonging, leading to better teaching performance and higher retention (Dolan, 2011). For lecturers and other types of workers who are in isolation during this crisis, the huddles may be one means to support their own and their team's well-being.

Whether or not you are a key worker, such as a nurse, doctor or delivery driver, the restrictions associated with the COVID-19 pandemic affect everyone. For university staff and those with office-based employment, working from home is viable, at least in the short term. John F. Kennedy noted how the word *crisis* was written in Japanese and Chinese using the characters that mean *danger* and *opportunity* (危機). We hope this crisis will turn from danger to opportunity by maintaining our well-being using practices such as the morning huddles.

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Writing and Implementing an Open Textbook in World Regional Geography: A Case Study

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Abstract

As the rising cost of college textbooks has outpaced both inflation and increases in tuition fees, this expense has created a significant barrier to student learning. Some instructors have adopted or created open educational resources, meaning materials which are freely and openly available. While the most obvious benefit of open course content might be cost savings, the fact that these materials can be freely adapted and changed can have substantial impact on the learning experience itself and enable an instructor to completely change the structure and outcomes of a course. This paper provides a case study on writing an open textbook for a course called World Regional Geography and details the writing process and platform options. I also offer practical guidance for faculty interested in authoring open materials and insight into how writing open materials might be framed in terms of a faculty member's larger portfolio of professional activity.

Keywords: case study, geography, open textbook, open educational resources, OER, open textbook authoring

Introduction

Authoring an open textbook might seem like a tedious endeavour in altruism. By their very nature, open textbooks are free, so they carry neither the professional accolades of traditional texts nor the associated royalty fees. However, writing open educational materials can actually provide significant professional opportunities, from scholarship of teaching and learning research to the possibility of framing the adoption of open content as evidence of reflexive teaching. Furthermore, for faculty passionate about teaching, writing an open textbook can be an enjoyable process of adapting existing course content into a more cohesive narrative form. This paper outlines the authoring and publishing process for an open textbook in geography and provides practical guidance for faculty interested in writing open content.

While much of the research on open educational resources focuses on issues related to efficacy and cost-savings, relatively little research has been done exploring open education as pedagogically transformative. By their very nature, open educational resources can be adapted, remixed, and reconfigured to suit individual instructors, and authoring open content for students can provide an opportunity to completely rethink the way a course is designed and taught. As explored in this paper, authoring an open textbook for World Regional Geography enabled a complete shift in pedagogical approach that would not have been possible with a traditional textbook and has yielded a number of significant benefits for students.

Situating Open Textbook Authoring

It is no secret that the cost of college has risen substantially over the past few decades. But while the high cost of tuition and fees is often highlighted, the cost of textbooks has actually risen at an even faster rate, an increase of 88% from 2006 to 2016 within the United States according to the Bureau of Labor Statistics (2016). Looking back to the 1970s, textbook costs have actually increased more than 1,000% compared to today's prices (Popken, 2015). This high cost is having a significant impact on students that is, in turn, affecting the classroom experience for instructors, leading some to adopt or write their own content that is available freely and openly (Bissell, 2009; D'Antoni, 2009; Downes, 2007). Not surprisingly, many proponents of open educational resources (OER) tout the cost savings (see Bliss et al., 2013; Hilton & Wiley, 2011), but research has also found that students who use open textbooks can have better learning and student success outcomes than those who use traditional texts (Colvard, Watson, & Park, 2018; Hilton, 2016; Hilton et al., 2016; Bowen, Chingos, Lack, & Nygren, 2014; Pawlyshyn et al., 2013; Feldstein et al., 2012; Hilton & Laman, 2012; Lovett, Meyer, & Thille, 2008). Authoring open content then provides an effective way to address broader learning outcomes and enable a more accessible course experience for students.

As the use and adoption of OER has expanded, so too have guides for prospective authors interested in writing open content. The Open Textbook Network, for example, which manages the widely regarded Open Textbook Library (https://open.umn.edu/opentextbooks/), published *Authoring Open Textbooks*, a guide for prospective authors and others involved in the adoption of open content (Falldin & Lauritsen, 2017). The guide, published openly, is free to view and download. BCcampus, another widely regarded organization promoting open education, has the comprehensive *Self-Publishing Guide* for prospective authors which is similarly free and openly available (Aesoph, 2018). Specific institutions also often have information on open publishing, such as Virginia Tech's "getting started" guide, containing a comprehensive list of guides, resources, and groups pertaining to open textbook authoring, editing, and adapting (Virginia Tech, 2019). This paper builds upon existing guides and research to offer a specific case study about the textbook writing process from start to finish as well as practical guidance for how this work might be framed in a professional context.

The Open Authoring Process

During the summer of 2016, I wrote and published an open textbook for my World Regional Geography course, an introductory undergraduate class. The original goal, however, was not to write an open textbook but instead to revise my course using the backward course design model developed by Wiggins and McTighe (1998), where an instructor begins course planning by considering the desired end results, determines appropriate assessment methods, and plans learning experiences (see Bowen 2017), and to shift to a team-based learning approach, where students work together in small groups to solve real-world problems. Traditional World Regional Geography classes and textbooks essentially take a novice approach to the discipline, focusing on fact-based information about the world and the locations of specific places, most often in a lecture format. For expert geographers, though, it is the connections between places that matter as well as their underlying geographic contexts. What I wanted students to gain from my course and remember years later was not the location of particular cities or rivers but a deeper understanding about how the world is connected and interrelated—essentially an expert understanding rather than a novice approach. With team-based learning, students could come to class, either in person or in a virtual setting, with a basic foundational understanding of core geographic ideas and then apply these concepts to case studies.

One critical barrier to revising the class and adopting a team-based learning approach, however, was the textbook itself. With traditional World Regional Geography textbooks, specific places and particular issues are emphasized over connections between regions and underlying geographic concepts. In essence, they favor breadth over depth. World Regional Geography courses, which typically attempt to teach students, often non-majors, about the geography of the world in a single semester at the 100-level, necessarily have to synthesize and generalize, but rather than accept focus on core ideas of geography and synthesizing where needed, most textbooks seem to concentrate on the details. With this approach, teaching World Regional Geography often feels disconnected—one instructor describes it as "like teaching the encyclopedia"—with no overarching themes tying the world's regions together. Furthermore, emphasizing breadth over depth in a discipline that few students are exposed to before college often leaves them feeling overwhelmed and having difficulty identifying what's important. Other geography instructors have clearly faced similar challenges, as evidenced by a session at the 2019 Annual Meeting of the American Association of Geographers, which was titled: "Teach the World, No Problem: Challenges to Teaching World Regional Geography in One Semester." Using the backward course design model, one of the main revised objectives for the course was for students to learn how to think like geographers and connect concepts across complex world regions; traditional textbooks did not adequately address this goal.

In exploring my course notes, which I had amassed teaching the course for almost a decade, I realized that my lecture notes themselves would be more useful to students than the textbook I had previously assigned, and, with the addition of a narrative framework, could develop into a textbook of sorts. This notion of not feeling tied to a particular book already in print was pedagogically freeing. If I did not have to follow a particular book's approach and learning outcomes, I could develop entirely new objectives for my course and chapters and write content that specifically addressed these goals.

The first step, then, again following the backward course design model, was to develop overarching course goals, which would become the focus of the textbook and would be woven throughout each chapter. A laundry list of ten learning objectives for the course was whittled down and revised to four specific and measurable outcomes, most notably that students "learn how to think like a geographer by integrating concepts across complex world regions and by synthesizing and analyzing information from a geographic perspective." In addition, a focus on globalization and inequality would provide a cohesive thread to weave the chapters together, avoiding the disconnect that was common in previous iterations of the course.

Next, I developed learning objectives for each chapter. In my experience, the learning objectives featured in traditional World Regional Geography textbooks often seemed tangential to the chapter content. Students rarely made use of them, and they often failed to capture the breadth of the material present in the reading. Instead, I wanted the learning objectives of my chapters to guide the writing of the material, not be written after as a summary of the content. With World Regional Geography, again, most texts emphasized breadth over depth, and thus chapters might include a wide array of content, from physical features to important places to historical events to culture to politics to contentious issues, and the list goes on. For my text, I wanted each chapter to explore a core concept in geography through the lens of a particular world region. In the chapter on Europe, for example, the core concept is migration, and the chapter explores the geography of Europe as it relates to migration—investigating the industrial revolution and the subsequent rural to urban migration, including the physical geography and location of coal deposits, to the modern issues related to nationalism and debates over migration from North Africa and Southwest Asia. Once I established these learning objectives for each chapter, I adapted my course notes, adding a narrative framework, and wrote additional content where needed, but aligned closely with the learning objectives, eliminating any content that was not essential.

The resulting text was far more concise than a traditional geography textbook and, as confirmed by an online survey of students conducted at the end of each semester, was written in a much more approachable style. I was writing for *my* students, students who are generally not majors and come to my course either uninterested in geography or, worse, with a preconceived idea that they will not enjoy it. Thus, I wrote how I taught, with enthusiasm and in an attempt to convey to students that excitement about the relevancy of geography in today's society. To supplement the text, I added figures and images, most of which were open content that was found online, but some were diagrams I created or photographs I had taken. Open authors can search for images, maps, and figures using Google image search and filter by usage rights, and might also use Wikimedia Commons, public domain imagery and figures from government websites, or Flickr, which also allows searching for images by license. There is a wealth of high-quality open media available online.

There are a number of platforms for publishing open content and as I already had a personal domain provided by my institution, it seemed like publishing the text as a PDF that could be posted online or printed would be the best approach. I learned LaTeX, which is a free software program for high-quality typesetting, to create the PDF. LaTeX enables the creation of glossaries, figure captions, and tables of contents and is commonly used by academics to write scientific manuscripts. This PDF was then published on my domain, at http://caitiefinlayson.com/worldregional, as well as converted to an HTML file which was also published. Both files were published under the Creative Commons Attribution-NonCommercial-ShareAlike 4.0 International license, meaning the content can be freely copied, shared, and adapted so long as it is not for commercial purposes, the author is attributed, and the material is shared under the same license as the original. Other commonly used open licensing options include the GNU General Public License, often used for software, or simply releasing content into the public domain. Creative Commons content can also be printed by students without concerns about copyright restrictions, so I had our campus bookstore print my textbook in the same way it would print a lab manual or other course pack. The printed, black and white text was available for $15 (USD) at our bookstore.

While my intention was simply to create a textbook that would match my desired approach to teaching geography and would enable the use of team-based learning in my class, it became clear soon after posting the book to my domain that the text was of interest to instructors at other institutions. At the time it was published, it was one of only two open textbooks available for World Regional Geography and, including traditional textbooks, was the only one that approached the world's regions using thematic concepts. I began hearing from instructors that adopting my textbook had been similarly pedagogically freeing, enabling them to make use of additional news articles and case studies without overburdening students with lengthy and sometimes irrelevant textbook readings. As of June 2019, the textbook had been downloaded more than 15,000 times in over 30 different countries and had been adopted by a number of other institutions.

Now that it is clear the textbook has reach far beyond my class, I want to ensure the book is fully accessible. While LaTeX enables the creation of a high-quality PDF, it does not create an accessible document and does not support the use of alternative text (or "alt text"), for instance. In addition, while I have updated some maps to optimize black and white printing and to ensure a color scheme compatible with students who might be color blind, many black and white images and maps in the course pack from the bookstore were low quality. To address these issues, I will be shifting to hosting the textbook on Pressbooks, a platform for creating open content. Pressbooks will allow me to create a text that is fully accessible and will, unlike my current PDF, be optimized for any viewing platform. If students want to access the textbook on their mobile device, for example, it will be much easier to browse and scroll through. In addition, Pressbooks allows users to export files for publishing with print-on-demand services, so students at my university and other institutions will be able to order a full-color version of the textbook for around $40 depending on the print-on-demand platform. The text will still be fully open and free online and will continue to be published under the Creative Commons license.

Open Authoring as Professional Activity

Though authoring open educational materials might not "count" as scholarly research in the traditional sense for tenure and promotion, there are a number of other ways faculty can get credit for work creating open content. In this section, I explore several possibilities for framing the authoring of open content within the context of a faculty member's professional activities.

Scholarship of Teaching and Learning

Within the realm of scholarly activity, authoring open educational resources provides a robust opportunity for faculty to develop research projects on the scholarship of teaching and learning. Faculty could consider situating their projects within the *COUP Framework* developed by the Open Education Group, exploring the issues of cost, outcomes, use, and perceptions of open educational materials (Open Education Group, n.d.). In this way, although an open textbook itself might not be peer reviewed, it could enable peer-reviewed research regarding its development and implementation. Faculty could apply for institutional review board approval to survey students about their use of the open resource. In my own course, for instance, I conducted an online survey of students about their perceptions of open educational materials before and after the semester began, finding that students are significantly more likely to rate open textbooks as better than traditional texts at the end of my course. Other projects might explore the costs of open textbooks and how frequently (or infrequently) students actually buy the required materials for their courses. Faculty could also work collaboratively within departments or across institutions to develop open course materials and exchange ideas.

Depending on the institutional framework and disciplinary expectations, these scholarly works might not carry the same weight as traditional publications, but could provide additional peer-reviewed scholarship as part of a larger portfolio of professional work. Moreover, if the criteria for promotion to full professor is recognition outside of the university, publishing open content could provide an opportunity for a faculty member to reach a much broader audience and network beyond a small disciplinary circle. There are numerous conferences both on open education, such as the annual Open Education Conference, as well as on the scholarship of teaching and learning, such as the annual conference of the International Society for the Scholarship of Teaching and Learning (ISSOTL). Even within disciplines where the scholarship of teaching and learning is not as valued as traditional academic scholarship, publications on open education and pedagogy are often themselves published openly and might be more widely read than disciplinary scholarship. Finally, faculty could consider publishing about open education within disciplinary pedagogical publications. In geography, for example, there are a number of peer-reviewed publications concerning pedagogical scholarship which include *The Journal of Geography* and the *Journal of Geography in Higher Education*.

Reflective Teaching

If disciplinary norms or institutional expectations limit the viability of publishing about open authoring or its implementation in a pedagogical journal, faculty could consider framing open authoring as evidence of reflective teaching practice, a common facet of tenure requirements. If traditional evaluation instruments are used, faculty could examine comments regarding the use and adoption of open materials in particular. In my own course, for example, evaluations improved after the adoption of the open textbook. Evaluation responses can be framed in terms of teaching efficacy and used as evidence of reflective and adaptive teaching. Instructors might also consider checking with their institution's center for teaching and learning, if one exists, for further guidance on framing open resource adoption in terms of teaching effectiveness within the particular institutional culture.

Fellowship and Grant Opportunities

Faculty could consider making use of grant opportunities to support the authoring of open materials, both internally and externally. Internal grants might not reference open content in particular, but instead focus on innovative teaching or pedagogical development. For my textbook, for example, I successfully applied for an institutional pedagogy improvement grant to add more active learning opportunities to my course, with no intention of authoring a textbook. However, as mentioned, the initiative to develop more active learning and flip my course eventually developed into a textbook authoring project. This could have easily been written into the grant application on the outset and the pedagogical improvements framed in terms of the open content. There is ample research on the benefits of open content adoption from cost savings to learning outcomes, and grant applications can reference this scholarship. External funding opportunities could include a fellowship with the Open Education Group, an exceptional opportunity especially for faculty who are interested in authoring open content but who might be new to research into open educational materials. States might also have specific initiatives to fund open content authoring and adoption. Faculty might check with their university library as a resource. Virginia's Academic Library Consortium (VIVA), for example, offers course redesign grants to fund the adoption and creation of open content (see VIVA, 2019) and a number of states have similar initiatives.

Conclusion

Authoring an open textbook can certainly seem daunting. After all, if a paper can take several weeks (or more) to write, authoring a textbook would seem an almost impossible challenge. But there are a number of key differences between writing an academic manuscript and authoring an open textbook. For one, depending on the book, it may be written in a much more conversational style, which can make writing it quite enjoyable. I found myself writing the book as if I were having a conversation with a student and intentionally tried to keep my voice present. In addition, the open textbook likely focuses on content you may have taught numerous times before. Thus, while there might be gaps in knowledge that need shoring up or cross-referencing of key facts and figures, you probably know far more about the material than you realize. You know where students often make mistakes and what might need to be explained more. You know what students enjoy and what you might elaborate on a bit more. You know how to teach the material in a way that makes connections with what students have learned before. All of these key pieces equate to a positive writing experience that might be, at times, little more than creating a narrative framework around lecture notes that you have refined and tweaked for the past decade. Finally, though ideally the same could be said of traditional scholarly research projects, the open textbook content likely concerns information you are deeply passionate about and knowing that the open content is going to be of substantial benefit to your students can be highly motivating.

It is important to remember that you do not have to embark on open authoring alone. By the very nature of open content, other faculty who have written open materials are likely to be very willing to share advice and guidance with prospective authors. I have been amazed by the generosity of other open authors when I have reached out with questions. Furthermore, open content can be remixed and adapted, so open authoring does not have to constitute sitting down to a blank screen and typing a manuscript from scratch. Rather, you can find and make use of existing open content and remix it to fit particular course goals and objectives. You will likely find the open authoring process a supportive and positive academic endeavor.

As state legislatures and institutions move toward the adoption of open content in institutions of higher education, additional opportunities to fund the authoring of OER will likely arise. Even absent funding, however, you can find ways of framing the authoring of open content as part of a larger portfolio of professional academic activity. Open authoring can provide a gateway into a new avenue of pedagogical scholarship and can open the window of possibility into teaching innovations that might not be possible with traditional texts. Authoring an open textbook, which enabled a complete overhaul of my course, transformed the way I teach and continues to shape my professional career.

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Recommender Systems for MOOCs: A Systematic Literature Survey (January 1, 2012 – July 12, 2019)

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Abstract

In recent years, massive open online courses (MOOCs) have gained popularity with learners and providers, and thus MOOC providers have started to further enhance the use of MOOCs through recommender systems. This paper is a systematic literature review on the use of recommender systems for MOOCs, examining works published between January 1, 2012 and July 12, 2019 and, to the best of our knowledge, it is the first of its kind. We used Google Scholar, five academic databases (IEEE, ACM, Springer, ScienceDirect, and ERIC) and a reference chaining technique for this research. Through quantitative analysis, we identified the types and trends of research carried out in this field. The research falls into three major categories: (a) the need for recommender systems, (b) proposed recommender systems, and (c) implemented recommender systems. From the literature, we found that research has been conducted in seven areas of MOOCs: courses, threads, peers, learning elements, MOOC provider/teacher recommender, student performance recommender, and others. To date, the research has mostly focused on the implementation of recommender systems, particularly course recommender systems. Areas for future research and implementation include design of practical and scalable online recommender systems, design of a recommender system for MOOC provider and teacher, and usefulness of recommender systems.

Keywords: recommender system, massive open online course, MOOC, systematic review, implemented recommender system

Introduction

Access to higher education can be restrictive and expensive but it can also be improved by implementing enhanced and novel methods and solutions. Massive open online courses (MOOCs) are a potential solution that have been used for more than a decade. Their spread is enabling learners to satisfy learning needs in an open, participatory, and distributed way. The term MOOC was first introduced in 2008 when the course *Connectivism and Connective Knowledge* was offered by George Siemens and Stephen Downes (Downes, 2008). Siemens designed this course according to the principles of connectivism, and due to the vast number of participants, it was named a massive open online course (Adham & Lundqvist, 2015). In 2011, at Stanford University, a MOOC different from Siemens and Downes' was designed. Learning objectives and plans were defined, and it followed a traditional teaching style (Sunar, Abdullah, White, & Davis, 2016). This is known as a content-based MOOC (xMOOC). Currently most MOOCs are not designed on the principles of connectivism, but instead are xMOOCs.

The number of MOOCs and the number of students registered in MOOCs are growing every year. By the end of 2018, more than 900 universities were offering MOOCs with 11,400 courses available, and around 101 million students had registered in them (Shah, 2018), providing learners with a wide variety of choices. With such a high number of courses available, learners now face the problem of selecting courses without being overwhelmed.

With the increase in e-commerce and online business, the number of users attracted to online Web services has increased. Both MOOC providers and online businesses advertise their courses and services while learners search for courses that match their interests and needs. In these situations, recommender systems play an important role, and have attracted the attention of researchers. Recommender systems are algorithms and techniques that recommend matching and relevant courses or services to the learner depending upon their interests, information about which comes from learner profiles and histories gathered by the systems. Recommender systems help MOOC providers grow and learners find more appropriate and customized services tailored to their personalities and interests. An example is provided below.

Mark has a free slot in the evening, and he wants to polish his professional skills by registering in a part-time course *Introduction to Java*. Mark has no idea about the course, and he does not want to waste his money on something that will not help his career. What will he do? Mark has different options: he can ask his friend who has completed this course, or he can observe details of the course, such as the content, length, pre-requisites, and instructors to reach a decision. In this case, Mark is searching for recommendations or inferring data to generate a recommendation for himself. What should we do if we face the same problem in our online learning life? We could use recommender systems, which help diminish information overload.

Recommender systems discover patterns in considerable datasets to learn the preferences of different users and predict items that correlate to their needs. Here *item* is a generic term that represents any course, learning element, book, service, application, or product. Recommender systems mostly use machine learning and data mining techniques to achieve their goals (Ricci, Rokach, Shapira, & Kantor, 2010). These systems are used intensively in e-commerce and by retailers to lift their sales and audience and now, increasingly, for learning purposes in MOOCs.

According to Manouselis, Drachsler, Verbert, and Duval (2013), recommender systems can be divided into two broad categories: collaborative filtering recommender systems and content-based recommender systems. There is a third type called the hybrid that contains characteristics of both collaborative filtering and content-based recommender systems.

Collaborative filtering recommender systems perform recommendations on the assumption that people who have had similar taste in the past will make similar choices in the future. This can be compared with real life scenarios in which, when we have to choose from multiple available options, we consider the recommendations of family and friends who have similar interests (Dakhel & Mahdavi, 2013).

Content based recommender systems consider the profile of users and items. Profiles of users can include age, gender, education, and residency area. Characteristics of items, for example in the case of movies, might include actor, genre, category, and type. These recommender systems analyze the items rated by a user and try to design a model that reflects the interests of that user. This model is employed to recommend new items to the user (Lops, de Gemmis, & Semeraro, 2011).

With the increased use of MOOCs, data produced by MOOCs is also expanding. This data contains information about the interests and behaviors of learners and the courses in which they are registered, and that data can be used by a recommender system to make recommendations (Ricci et al., 2010). Recommender systems in MOOCs can help the learner find related learning objects or elements. MOOC providers can also use these systems to inform MOOC design and creation.

The purpose of this systematic literature review was to fully scope and report on: (a) how recommender systems have been used in MOOCs between 2012 and 2019, (b) the trends over this period, and (c) the types of recommender systems yet to be explored. This research reviewed all related work between January 1, 2012 and July 12, 2019, in the English language only. We chose 2012 as the starting year because it was declared the *Year of the MOOC* by The New York Times (Pappano, 2012) and, from that year, publication of peer-reviewed research on recommender systems in MOOCs started.

Method

According to Fink (2005), a systematic literature review is an organized, comprehensive, and reproduceable method of review. Using this definition as a framework, the purpose of this study was to

- report on work on recommender systems for MOOCs; and
- provide a comprehensive analysis that could be used to find opportunities for research and implementation in the field.

Our methodology consisted of two fundamental steps: data collection and data analysis. The analysis was further divided into quantitative and qualitative analyses.

Data Collection

Gathering data from the literature was performed with care to maximize accuracy. A set of rules describing the criteria for selection of research papers was established. These rules involved four significant points: (a) search terms, (b) research period, (c) sources, and (d) publication type. *Search terms* are used to find related published work from specific *sources*, while *research period* refers to the publication date, and *publication type* refers to the type of paper, such as journal article, conference paper, book chapter, or review article. The following sections explain these rules in more detail.

Search terms. This review involved two main concepts: massive open online courses and recommender systems. Therefore, we started with the following search terms: "massive open online courses" AND "MOOCs" AND "recommender system." We added "RS," a common abbreviation for recommender systems, but that resulted in many unrelated papers. Similarly, we used "MOOC" instead of "MOOCs," which also resulted in many unrelated papers since MOOC is used as an abbreviation for other terms such as "multiple optical orthogonal code sequences" and "management of organizational change." We also used "adaptive MOOCs" and "personalized MOOCs" along with "recommender system" and "massive open online courses." With "personalized MOOCs," we only found one related paper which was already in our database, whereas the term "adaptive MOOCs" resulted in seven papers, though they were also part of our database. Most of the unrelated papers in the latter case were about making MOOCs adaptive and not about recommending any resource or service to users.

Thus, we finalized the search terms: "massive open online courses" AND "MOOCs" AND "recommender system" because these were the most efficient for locating the literature we were seeking.

Research period. We reviewed papers published between January 1, 2012 and July 12, 2019.

Sources. To determine the sources of research, we followed the same methodology as Liyanagunawardena, Adams, and Williams (2014). We used Google Scholar, academic databases, and the reference chaining technique of Gao, Luo, and Zhang (2012). The initial searching was in Google Scholar, followed by selected academic databases. We chose five databases from the area of computer science and education: the Institute of Electrical and Electronics Engineers (IEEE) Xplore, the Association for Computing Machinery (ACM) journals/Transactions Springer Link, ScienceDirect, and the Education Resources Information Centre (ERIC). Reference chaining was performed at the end to find any further related work.

Publication type. Peer reviewed conference papers, journals, and book chapters were included in this literature review.

Data Analysis

We performed both quantitative and qualitative analysis on the data. In the quantitative analysis, we classified data based on publication year, publication type, and the geographical region of authors. In the qualitative analysis, we used open coding content analysis (Gao et al., 2012). In this technique, there were two phases; first, we read all papers to extract themes and, second, the themes were classified. Then the same process was repeated to refine the classification and synthesis.

Limitations

For this systematic literature review, we only considered:

- articles published between January 1, 2012 and July 12, 2019. (We note that there may have been conference papers presented before July 12, 2019 that were not published by the cutoff date for this study and that they were not included in our literature review.).
- five academic databases and Google Scholar.
- peer reviewed journal articles, conferences, and book sections.
- papers in which the recommender system for MOOCs is proposed, implemented, or discussed as a need, or in which different recommendation algorithms for MOOCs are compared.
- articles that were published in English. While searching Google Scholar and performing reference chaining, we found related articles in other languages, such as French. These other articles are not included.

The Google Scholar search returned more than 30,000 items (13 October 2019). These items included websites, blogs, videos, etc. However, we did not include these resources because they are subjective and usually not considered for peer review. We did, however, include existing literature reviews.

Results and Analysis

Descriptive/Quantitative Analysis

The initial Google Scholar search resulted in 424 research papers. After analyzing titles and abstracts, 124 papers were classified as relevant. After a detailed analysis of each of these papers, we considered only 89 to be related to the topic of recommender systems in MOOCs.

Table 1 contains the results of the searches from the academic databases. Springer Link showed 144 publications, of which 26 were related to our research. IEEE and Springer contained the highest number of related publications, but ERIC revealed no related research papers. Many of the unrelated papers were about recommender systems used in technology enhanced learning other than MOOCs.

Table 1

Distribution of Papers Found in Academic Databases

Academic database	Number of related papers
IEEE	26
Springer	26
ACM	20
Science Direct	7
ERIC	0

After searching the databases, we performed reference chaining and found another 10 related papers. As a result, we had 116 papers, which included 88 conference papers, 26 journal articles, and 2 book chapters. Both book chapters were published in 2019. Figure 1 shows yearly distribution of literature in these categories.

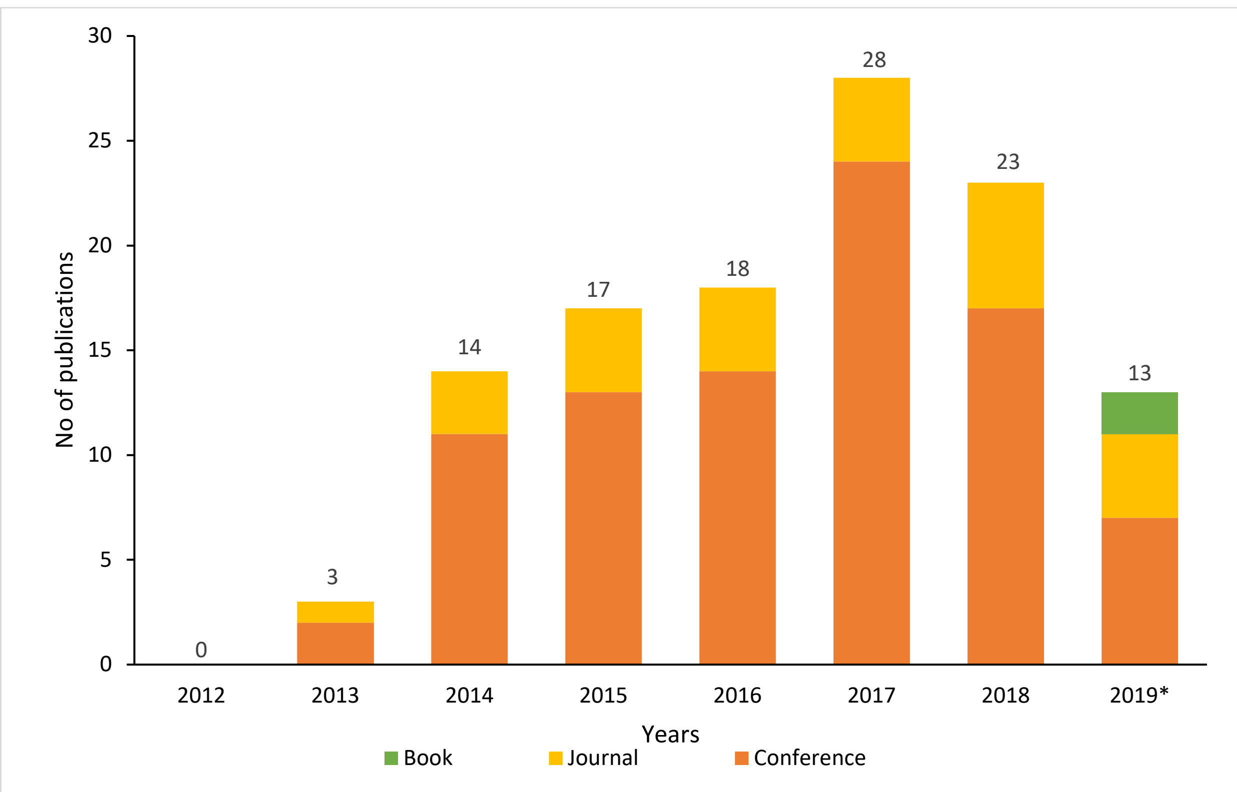

Figure 1. Yearly distribution of literature by type: journal article, conference paper, or book chapter. *2019 data includes research published only up to July 12, 2019.

There were no publications on recommender systems in MOOCs in 2012, but subsequently, a gradual increase in the number of publications per year is visible. The highest number of publications was in 2017. (Note that 2019 covers only 6 months.)

Table 2 shows groups of authors who have had more than one publication in this research area. Of 319 authors, we found 68 had at least two papers in this area, and the maximum number of papers from a single author was five.

Table 2

Groups of Authors Having More Than One Publication

Group of Authors	No. of Publications	Publications
Ayse Saliha Sunar* Nor Aniza Abdullah Su White Hugh C. Davis Ahmed Mohamed Fahmy Yousef	5	• Sunar et al. (2016) • Sunar, Abdullah, White, & Davis (2015a, 2015b) • Sunar, Abdullah, White, & Davis (2015c) • Yousef & Sunar (2015)
Francisco Iniesto Covadonga Rodrigo	4	• Iniesto & Rodrigo (2015, 2016, 2018, 2019)
Hugues Labarthe François Bouchet Rémi Bachelet Kalina Yacef	4	• Bouchet, Labarthe, Bachelet, & Yacef (2017) • Bouchet, Labarthe, Yacef, & Bachelet (2017) • Labarthe, Bachelet, Bouchet, & Yacef (2016) • Labarthe, Bouchet, Bachelet, & Yacef (2016)
Jian Zhao Chidansh Bhatt Matthew Cooper David A. Shamma	4	• Bhatt, Cooper, & Zhao (2018) • Cooper, Zhao, Bhatt, & Shamma (2018a, 2018b) • Zhao, Bhatt, Cooper, & Shamma (2018)
Diyi Yang Jingbo Shang Carolyn Penstein Rosé*	3	• Yang, Piergallini, Howley, & Rosé (2014) • Yang, Shang, & Rosé (2014) • Yang, Adamson, & Rosé (2014)
Fei Mi Boi Faltings	3	• Mi & Faltings (2016a, 2016b, 2017)

Group of Authors	No. of Publications	Publications
Guanliang Chen Dan Davis Markus Krause Efthimia Aivaloglou Claudia Hauff Geert-Jan Houben	3	• Chen et al. (2016, 2018) • Chen, Davis, Krause, Hauff, & Houben (2017)
Hiba Hajri Yolaine Bourda Fabrice Popineau	3	• Hajri, Bourda, & Popineau (2017, 2018, 2019)
Hao Zhang Tao Huang Zhihan Lv Sanya Liu Heng Yang	3	• H. Zhang, Huang, Lv, Liu, & Yang (2019) • H. Zhang, Huang, Lv, Liu, & Zhou (2018) • H. Zhang, Yang, Huang, & Zhan (2017)
Olga C. Santos Jesus G. Boticario	2	• Santos & Boticario (2015) • Santos, Boticario, & Pérez-Marín (2014)
D.F.O. Onah J.E. Sinclair	2	• Onah & Sinclair (2015a, 2015b)
Fatiha Bousbahi Henda Chorfi	2	• Bousbahi & Chorfi (2015) • Ouertani & Alawadh (2017)
Panagiotis Adamopoulos	2	• Adamopoulos (2014a, 2014b)
Daniel Burgos Alberto Corbí	2	• Burgos & Corbí (2014) • Corbi & Burgos (2014)
Yifan Hou Pan Zhou Ting Wang Li Yu Yuchong Hu Dapeng Wu	2	• Hou et al. (2016) • Hou, Zhou, Xu, & Wu (2018)
Thanasis Daradoumis Roxana Bassi Fatos Xhafa Santi Caballé	2	• Bassi, Daradoumis, Xhafa, Caballé, & Sula (2014) • Daradoumis, Bassi, Xhafa, & Caballé (2013)

Group of Authors	No. of Publications	Publications
Marwa Harrathi Narjess Touzani Rafik Braham	2	• Harrathi, Touzani, & Braham (2017, 2018)
Sara Assami Najima Daoudi Rachida Ajhoun	2	• Assami, Daoudi, & Ajhoun (2018, 2019)
Rodrigo Campos Rodrigo Pereira dos Santos Jonice Oliveira	2	• Campos, dos Santos, & Oliveira (2018a, 2018b)
Naima Belarbi Nadia Chafiq Mohammed Talbi Abdelwahed Namir Elhabib Benlahmar	2	• Belarbi, Chafiq, Talbi, Namir, & Benlahmar (2019a, 2019b)
Panagiotis Symeonidis Dimitrios Malakoudis	2	• Symeonidis & Malakoudis (2016) • Symeonidis & Malakoudis (2018)
Jakub Macina Ivan Srba* Joseph Jay Williams Maria Bielikova Peter Babinec	2	• Babinec & Srba (2017) • Macina, Srba, Williams, & Bielikova (2017)
René F. Kizilcec Mar Pérez-Sanagustín* Jorge J. Maldonado Carlos Alario-Hoyos Derick Leony Iria Estévez-Ayres Israel Gutiérrez-Rojas Carlos Delgado Kloos	2	• Alario-Hoyos et al. (2014) • Kizilcec, Pérez-Sanagustín, & J. Maldonado (2017)

Note: * Authors who have publications with more than one group of authors.

At this stage, we analyzed research links between authors and how they are grouped. Figure 2 shows the network of authors who have at least two papers in this area, and their links with other groups of authors.

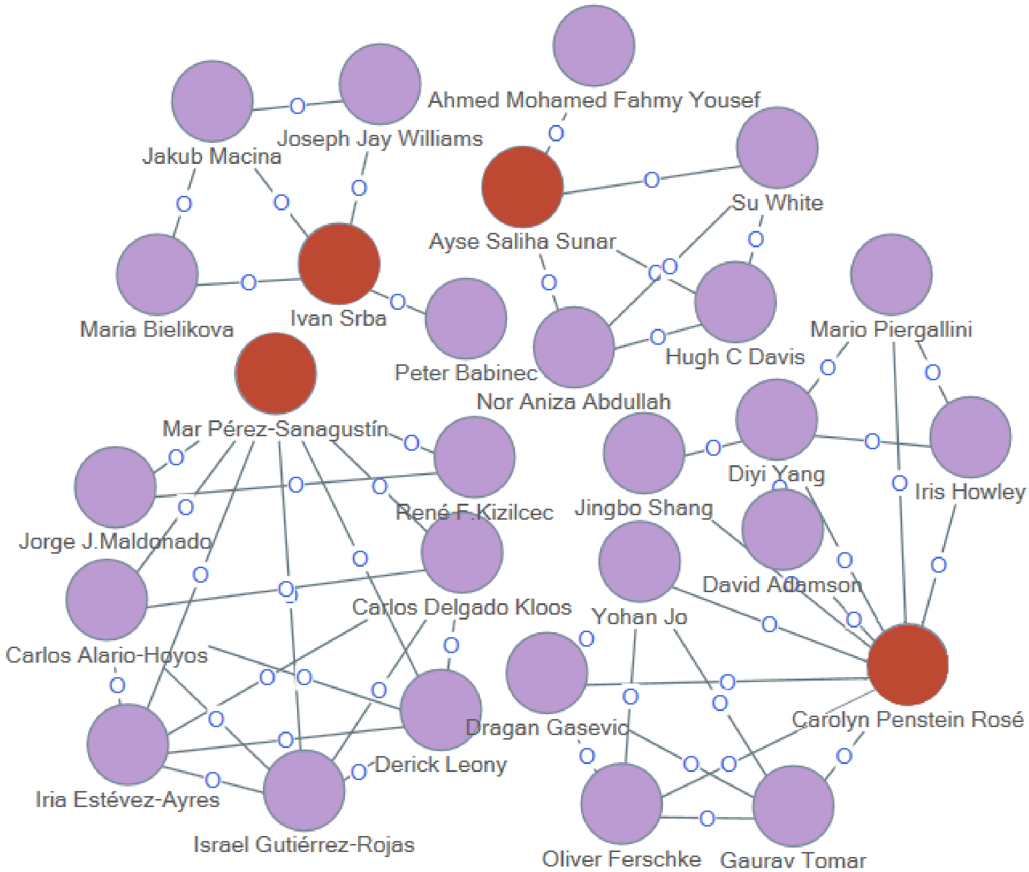

Figure 2. Network diagram of authors who are linked with other groups of authors. Red nodes indicate authors who have publications with more than one group.

By observing the country of the first author, we determined that the majority of work (43%) is from Europe whereas 24% and 22% of research in this field was performed in Asia and the USA respectively. Ten percent of the research is from Africa, with 1% from Australia. In Asia, most of the research is from China. Figure 3 shows the distribution by country.

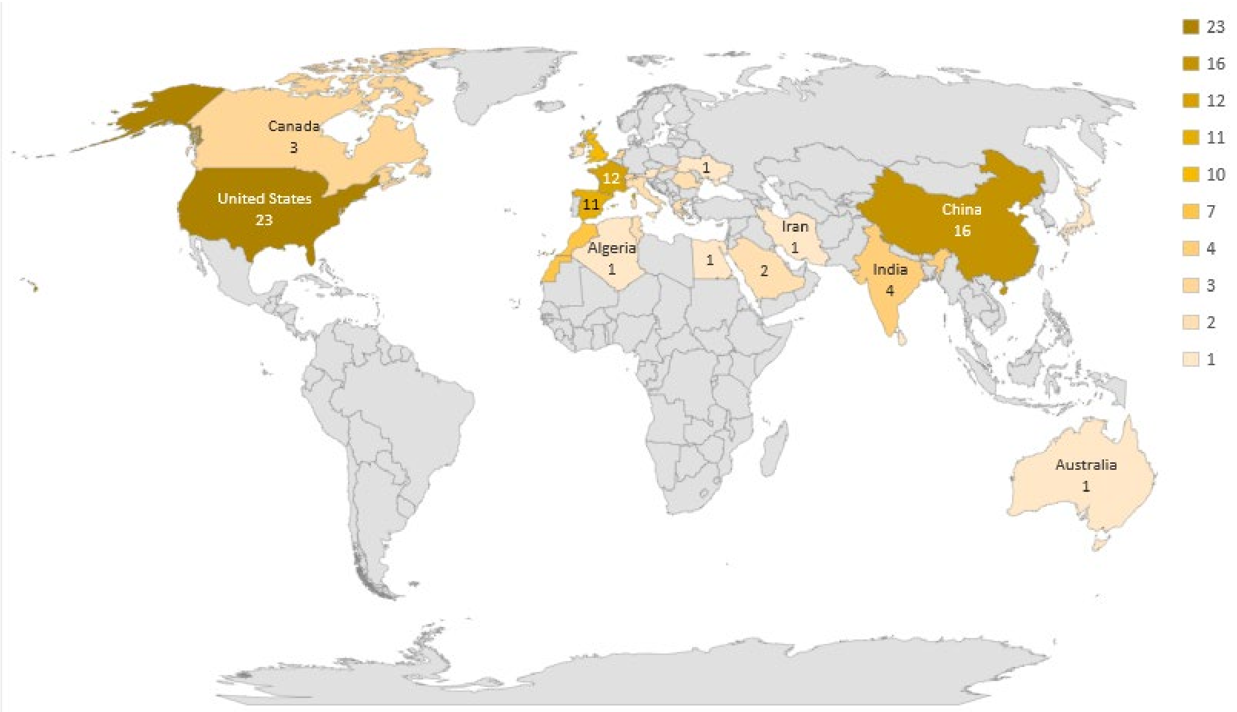

Figure 3. Distribution of work with respect to country/region of first author.

We classified the literature into four categories: need, design proposal, implementation, or other. These are defined as follows:

- *Need*: Papers that mainly focused on the importance of recommender systems in MOOCs.
- *Design proposal*: Papers in which the author has given an abstract proposal for a recommender system.
- *Implementation*: Research work in which authors designed an algorithm and implemented it on a dataset.
- *Other*: All other papers in which authors reviewed the current work, guidelines, or challenges.

Figure 4 shows trends in these categories between 2012 and 2019. Implementation was the main focus of research throughout this period, and from 2016 onwards, the number of published papers in this area rose rapidly. The reason for this rapid increase is that researchers not only implemented new techniques but also implemented their proposals from their 2014 and 2015 research work. Research on design proposals for recommender systems in MOOCs showed a gradual decrease after 2016. A similar pattern is evident in the need category.

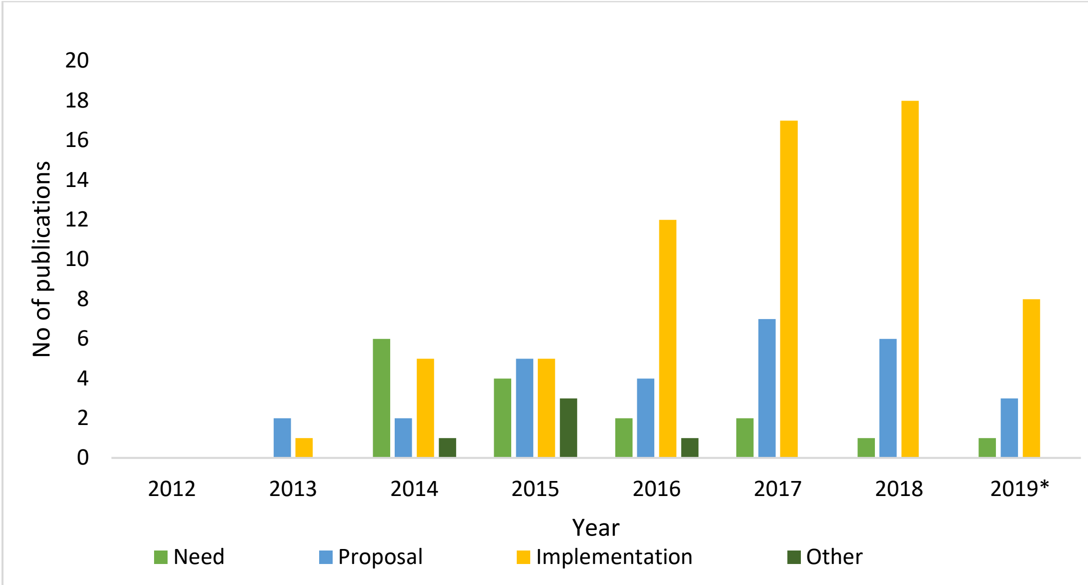

Figure 4. Distribution of different types of research work 2012-2019. *2019 data includes research published only up to July 12, 2019.

In the implementation category, some authors also evaluated their work using metrics and baselines. Table 3 illustrates the number of implemented and evaluated recommender systems. Among all implemented systems, 42% were evaluated using different datasets and evaluation techniques. Most authors used datasets of edX and Coursera, but some also created their own datasets. For evaluation, most authors used receiver operating characteristic (ROC), recall and precision metrics, as well as accuracy metrics. The remaining 58% did not evaluate their proposed solutions and instead presented evaluation as future work.

Table 3

Number of Publications on Implemented and Evaluated Recommender Systems

Year	Implementation	Evaluated
2012	0	0
2013	1	1
2014	5	4
2015	5	4
2016	12	10
2017	17	11
2018	18	11
2019*	8	7

Note: *2019 data includes research published only up to July 12, 2019.

Content/Qualitative Analysis

To carry out a comprehensive review of a topic, it is necessary to conduct an in-depth analysis through synthesis. In a systematic review, synthesis provides a bottom-line statement regarding any gaps and missing links through pooling and exploring the results (Fink, 2005). In this section, we highlight the main issues addressed and major contributions on recommender systems in MOOCs. We found that research could be broadly categorized into seven main themes.

- Thread recommender: Thread recommender involves thread/discussion, question recommendation, and question tag recommendations.
- Learning element recommender: Learning element recommender includes learning activities, suggestions on the study, video lectures, next page recommender, source, and learning path recommenders.
- Course recommender: Only involves course recommendation.
- Student performance recommender: Student performance recommender involves jobs, grades, student difficulty based, student dropout, work plan, and paid task recommenders.
- Peer recommender: Social interactions are a key factor in successful learning, and peer recommender involves systems that recommend related peers or fellow learners to interact with instead of recommending a learning resource or another class to follow. It uses demographics and progress made in a course for recommendations.
- MOOC provider/teacher recommender: This involves curriculum recommendations, news of MOOCs, and MOOC provider feedback.
- Others: This category involves improved and personalized MOOCs, adaptive content, and special user recommender systems.

We found that more than 60% of the literature is on course and learning element recommender systems for MOOCs. A possible reason for this is that universities or institutes that offer MOOCs do so to increase enrolment and throughput, and therefore, they recommend further courses to those already enrolled. Figure 5 shows the percentage distribution of research in different categories.

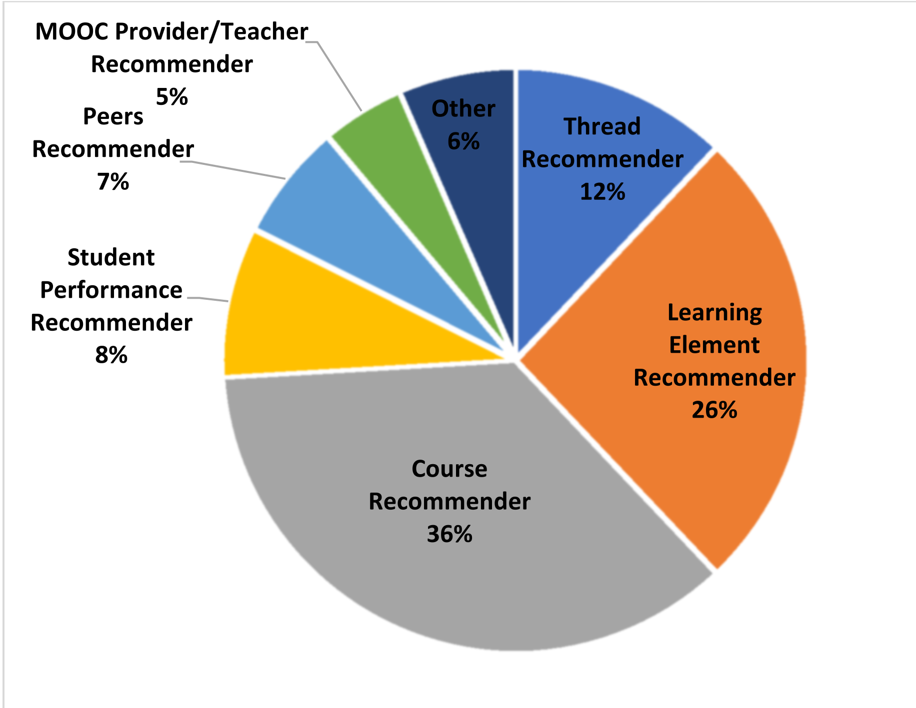

Figure 5. Distribution of work done on different types of recommender systems in MOOCs.

To analyze the type and trends of work found in the literature, we grouped the research work with respect to the area of MOOCs where the recommender system is applied. Table 4 shows a detailed categorization of different areas of MOOCs where recommender systems have been applied.

Table 4

Distribution of Work in Recommender System Categories

Research concern	Related studies
	Thread recommender
Thread /discussion recommender	Cohen et al. (2013); Yang, Piergallini, et al. (2014); Sunar et al. (2015b); Jo, Tomar, Ferschke, Rosé, & Gašević (2016); Mi & Faltings (2016a, 2016b); Kardan, Narimani, & Ataiefar (2017); Mi & Faltings (2017); Lan, Spencer, Chen, Brinton, & Chiang (2019).
Question recommender	Yang, Adamson, et al. (2014); Yang, Shang, et al. (2014); Macina et al. (2017).
Question tag recommender	Babinec & Srba (2017).
	Learning element recommender

Research concern	Related studies
OER/learning element /activity recommender	Piedra, Chicaiza, López, & Caro (2014); Itmazi & Hijazi (2015); Niu et al. (2015) Onah & Sinclair (2015b); Paquette, Mariño, Rogozan, & Léonard (2015); Kopeinik, Kowald, & Lex (2016);
	Hajri et al. (2017); Harrathi et al. (2017); Hajri et al. (2018); Harrathi et al. (2018); Xiao, Wang, Jiang, & Li (2018); Chanaa & Faddouli (2019); Hajri et al. (2019); H. Zhang et al. (2019).
Suggestion to study	Corbi & Burgos (2014); Niu et al. (2015).
Video /lectures/clip recommender	Agrawal, Venkatraman, Leonard, & Paepcke (2015); Gómez-Berbís & Lagares-Lemos (2016); Bhatt et al. (2018); Cooper et al. (2018a, 2018b); Mawas, Gilliot, Garlatti, Euler, & Pascual (2018); Zhao et al. (2018); Belarbi et al. (2019a, 2019b).
Next page recommender	Pardos, Tang, Davis, & Le (2017).
Learning source recommender	Brigui-Chtioui, Caillou, & Negre (2017).
Learning path recommender	Popescu, Portelli, Anagnostopoulos, & Ntarmos (2017).
	Course recommender
Course recommender	Ahera & Lobo (2013); Apaza, Cervantes, Quispe, & Luna (2014); Bousbahi & Chorfi (2015); Onah & Sinclair (2015a); Fu, Liu, Zhang, & Wang (2015); Yanhui, Dequan, Yongxin, & Lin (2015);
	Fazeli, Rajabi, Lezcano, Drachsler, & Sloep (2016); Gómez-Berbís & Lagares-Lemos (2016); Hou et al. (2016); Piao & Breslin (2016); Symeonidis & Malakoudis (2016);
	Dai et al. (2017); Gope & Jain (2017); He, Liu, & Zhang (2017); Jing & Tang (2017); Y. Li & Li (2017); Ouertani & Alawadh (2017); Shaptala, Kyselova, & Kyselov (2017); EL Alami, Eddine, & Mohamed (2017); Yuqin Wang, Liang, Ji, ShiweiWang, & YiqiangChen (2017); Yuanyuan Wang, Maruyama, Yasui, Kawai, & Akiyama (2017); H. Zhang et al. (2017);
	Assami et al. (2018); Campos et al. (2018a, 2018b); Chen et al. (2018); Hou et al. (2018); Iniesto & Rodrigo (2018); Jain & Anika (2018); Jun Xiao et al. (2018); X. Li, Wang, Wang, & Tang (2018); Pang, Liao, Tan, Wu, & Zhou (2018); Rabahallah, Mahdaoui, & Azouaou (2018); Symeonidisa & Malakoudis (2018); H. Zhang et al. (2018);
	Agrebi, Sendi, & Abed (2019); Aryal et al. (2019); Boratto, Fenu, & Marras (2019); Chanaa & Faddouli (2019); Margolis et al. (2019).
	Student performance recommender
Jobs recommender	Symeonidis & Malakoudis (2016).

Research concern	Related studies
Grades improvement recommender	Elbadrawy et al. (2016); Luacesa, Díeza, Alonso-Betanzosb, Troncosoc, & Bahamondea (2017).
Student difficulty based recommender	Hussain, Zhu, Zhang, Abidi, & Ali (2018).
Student dropout based recommender	H. Zhang et al. (2019); M. Zhang, Zhu, Wang, & Chen (2019).
Work plan recommender	Alario-Hoyos et al. (2014).
Paid task recommender	Chen et al. (2016); Chen et al. (2017); Chen et al. (2018).
Peers recommender	
Peer recommender	Sunar et al. (2015a); Labarthe, Bouchet, et al. (2016); Bouchet, Labarthe, Yacef, et al. (2017); Prabhakar, Spanakis, & Zaiane (2017); Potts et al. (2018).
MOOC provider/teacher recommender	
Recommender for teacher	Zhou et al. (2015); Medio et al. (2017).
Curriculum recommender	Tan & Wu (2018).
News of MOOCs	Holotescu (2016).
MOOC provider feedback	Dai, Vilas, & Redondo (2017).
Others	
Improve and personalize MOOC	Daradoumis et al. (2013); Burgos & Corbí (2014).
Adaptive content	Ardchir, Talhaoui, & Azzouazi (2017).
Special user	Iniesto & Rodrigo (2016).

Table 5 shows research on the implementation or proposal of recommender systems in MOOCs. There are some papers in which authors have discussed the recommender systems in a generalized way, while in other papers they have provided guidelines or a literature review of existing work. We have classified these papers into four broad categories: preliminary study; literature review; challenges and effects of recommender systems in MOOCs; and design guidelines. A description of each category follows:

- Preliminary study: All research papers which discuss initial steps of the design of a recommender system in MOOCs. In these papers, the authors discuss steps and possible techniques for preprocessing of data.
- Literature review: We found two related literature reviews. However, these reviews discussed personalized MOOCs and not recommender systems.
- Challenges and effects of recommender systems in MOOCs: Papers in this category target the challenges of implementing a recommender system in MOOCs and the effects on MOOCs after introduction of a recommender system.
- Design guidelines: Papers in which authors have described guidelines to design a recommender system are in this category.

Table 5 shows the distribution of research work by year into these four categories.

Table 5

Yearly Distribution of Research Work Discussing Recommender Systems in MOOCs

	Preliminary study	Literature review	Challenges and effects of RS in MOOCs	Design guidelines
2013				
2014	Bassi et al. (2014); Santosa et al. (2014).		Adamopoulos (2014a, 2014b); Bassi et al. (2014); Ng et al. (2014).	Rădoiu (2014).
2015	Iniesto and Rodrigo (2015); Santos, Cechinel, Araujo, & Sicilia (2015).	Sunar et al. (2015c).	Yousef & Sunar (2015).	Santos & Boticario (2015).
2016	Marchal, Castagnos, & Boyer (2016).	Sunar et al. (2016).		
2017	Kizilcec et al. (2017).			
2018				
2019 (up to July)	Assami et al. (2019).			

Figure 6 shows the trend in the types of recommender systems researched over time. Until 2017, a gradual increase in research was evident. Initially, researchers focused on thread and course recommender systems, which then extended to peer, learning element, and student performance recommenders. By 2016, MOOC provider recommender systems were added to the research stream, and this trend continued in 2017. In 2018, most of the research was into course recommender systems, while no work was found on thread recommenders. Up until July 2019, course and learning element recommenders were the focus of research.

Figure 7 presents the number of research publications based on the different types of recommender systems applied to MOOCs. Overall, course recommender and learning element recommender systems are the most popular areas of research in the application of recommender systems.

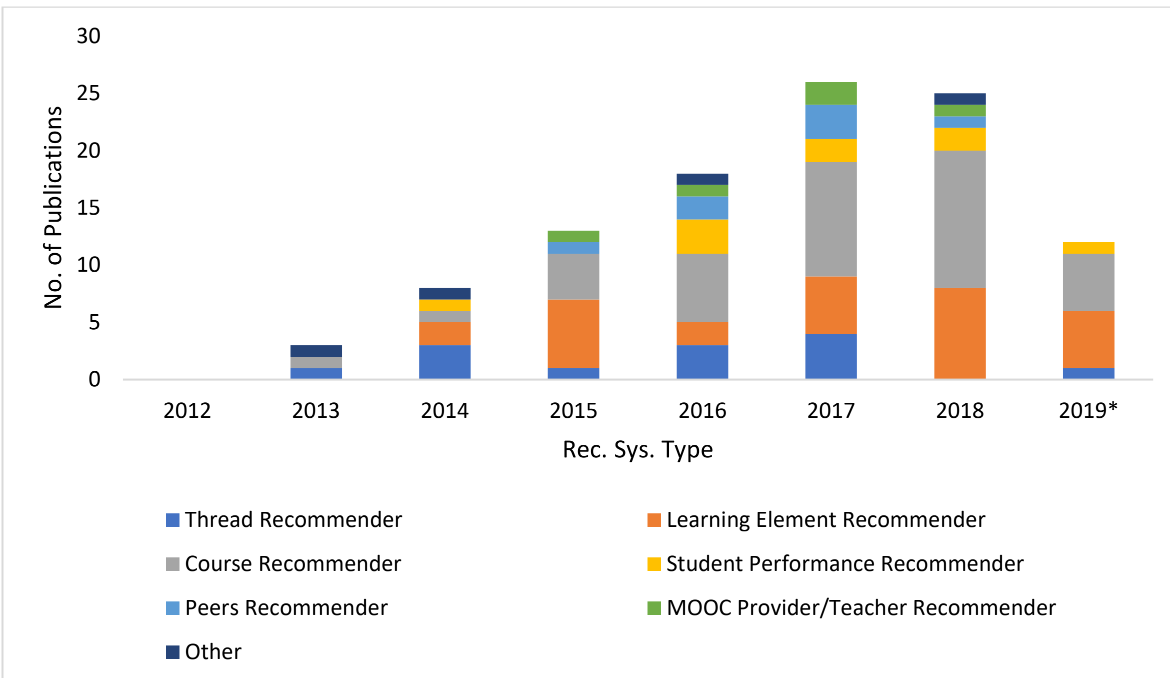

Figure 6. Change over time in the types of recommender systems in MOOCs researched. *2019 data includes research published only up to July 12, 2019.

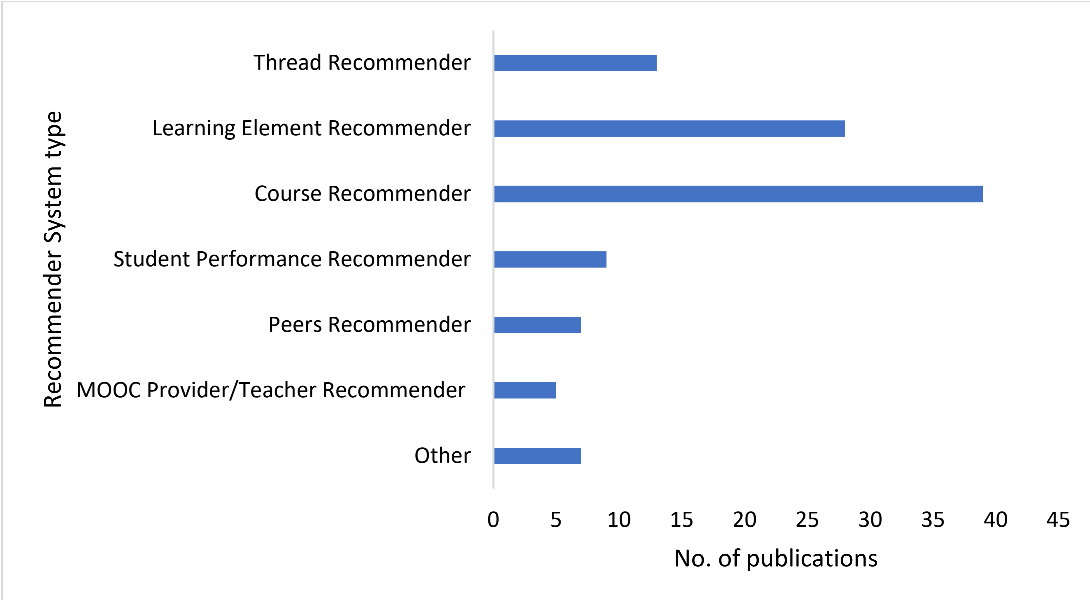

Figure 7. Distribution of research based on type of recommender system in MOOCs (2012 to July 2019).

Figure 8 shows the percentage of published work falling into each of the four broad classifications of research described in the Descriptive/Quantitative Analysis section of this paper. These are: (a) need, (b) design proposal, (c) implementation, and (d) other. The overall focus of research is the implementation of recommender systems in MOOCs. The category of *other* includes no implementation, and around 70% of this research is about proposed systems only. A possible reason for this could be that the work included in this category is meant only for a specific group of people.

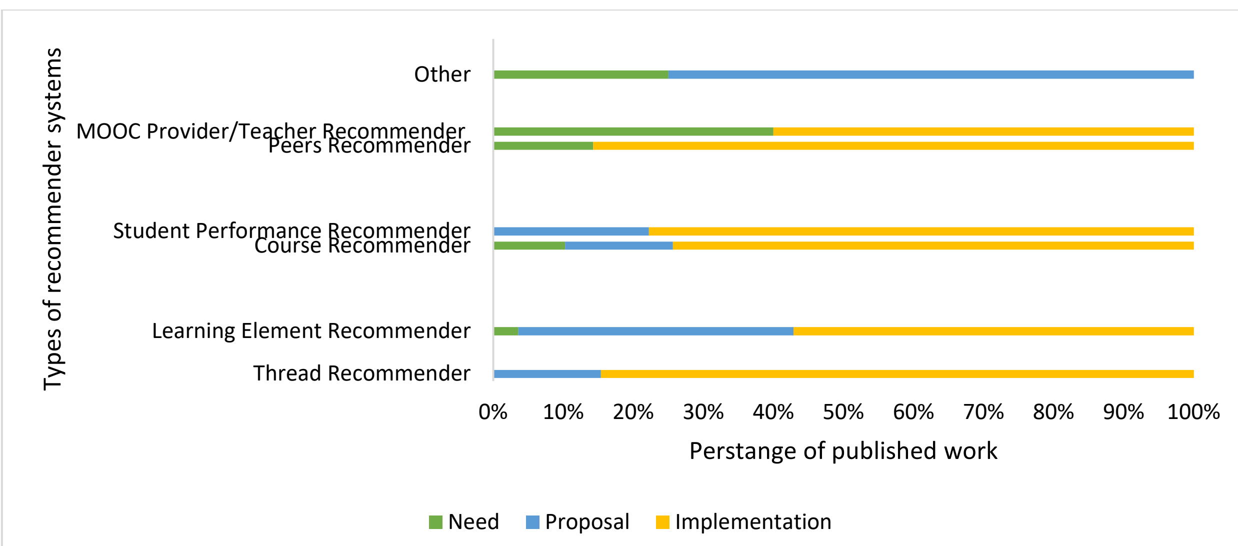

Figure 8. Proportion of literature categorized with respect to type of recommendation and type of research.

Discussion

To the best of our knowledge, this is the first systematic literature review on the use of recommender systems in MOOCs from 2012 to July 12, 2019. Published work falls into three major categories: the need for recommender systems, proposed recommender systems, and implemented recommender systems in MOOCs. We classified the types of recommender systems into seven themes: course recommender, learning elements recommender, peer recommender, thread recommender, student performance recommender, MOOC provider/teachers' recommender, and others. In this section, we discuss the types and trends of research carried out within each of these themes. We also identify gaps in the current literature which may be areas for future research.

Course Recommender Systems

The implementation of course recommender systems was a key focus of much of the research. This could be due to the availability of data and the interests of MOOC providers, because course recommender systems can help in improving enrolment and the learning experience. From 2013 to 2016, most of the work on the implementation of the recommender system for courses used collaborative and content-based filtering (Onah & Sinclair, 2015a; Piao & Breslin, 2016). Some researchers discussed the need for course recommender systems in MOOCs (Campos et al., 2018a; Fu et al., 2015; Ouertani & Alawadh, 2017). Campos et al. (2018b) implemented a course recommender system using knowledge reuse in ecosystems, and Hou et al. (2016) considered the context of the learner while performing recommendations.

After 2016, along with collaborative and content-based filtering for course recommendation (Boratto et al., 2019; He et al., 2017; Hou et al., 2018; Rabahallah et al., 2018) researchers started to use neural networks, pattern mining, and deep learning for preprocessing of data and recommendations (Agrebi et al., 2019; Jain & Anika, 2018; Jing & Tang, 2017; H. Zhang et al., 2019). We also observed the introduction of association rule mining and hybrid algorithms (Xiao et al., 2018; Y. Li & Li, 2017; Pang et al., 2018) Gope and Jain (2017) used the learning style of the student to recommend courses. Their prototype was based on a learning system model and worked exclusively with edX courses. It scanned every course to identify learning objects and then made recommendations.

Learning Elements Recommender Systems

More than half the work we reviewed focused on the implementation of recommender systems and the work concerns content-based filtering or hybrid algorithms (Cooper et al., 2018a; Itmazi & Hijazi, 2015; Zhao et al., 2018). Researchers have designed recommender systems for different types of learning elements, such as video clips, next page, and additional resources helpful to the learner. Kopeinik (2016) compared existing algorithms that provide a recommendation of learning resources and tags to annotate these resources. Onah and Sinclair (2015b) recommended a suitable path to learners by considering scores on concept-based quizzes. A low score indicated that the learner needed more resources related to a concept, and so this system would recommend instructional material according to a learner's profile.

While preprocessing the dataset, we observed an increase in the use of neural networks, pattern mining, and machine learning in more recent years (Cooper et al., 2018a; Hajri et al., 2019; Xiao et al., 2018; Pardos et al., 2017; H. Zhang et al., 2019). Cooper and his colleagues researched the recommendation of video lectures to learners by analyzing the content of videos. They designed a user-friendly interface that suggested related videos while learners were watching another video (Bhatt et al., 2018; Cooper et al., 2018a, 2018b; Zhao et al., 2018).

Peer Recommender Systems

Another group of authors completed detailed research in the field of peer recommender systems. They investigated the effect of a peer recommender on overall student performance (Labarthe, Bachelet, et al., 2016; Labarthe, Bouchet, et al., 2016). They compared the results of different peer recommender systems in terms of student engagement (Bouchet, Labarthe, Yacef, et al., 2017). These researchers also attempted to identify the reasons for peer communication usage in MOOCs through conducting surveys of peer recommender user and found that most students express their emotions about course work through communicating with peers (Bouchet, Labarthe, Bachelet, et al., 2017). Reciprocal scores were used by some authors to find and recommend suitable peers for learners (Potts et al., 2018; Prabhakar et al., 2017).

Thread Recommender Systems

Most research on thread recommender systems focused on implementation. We found only two papers related to the algorithm proposals (Cohen et al., 2013; Sunar et al., 2015a). Implementation work was mostly performed by using matrix factorization, collaborative filtering, and content-based filtering for recommender systems (Garg & Tiwari, 2016; Yang, Piergallini, et al., 2014). Mi and Faltings (2016a, 2016b, 2017) used a context tree for online thread recommendations. Yang et al. (2014) designed a recommender system for threads in a forum that recommends questions for students to answer based on their expertise. They also managed learner workload by defining a threshold on the number of questions recommended to each learner. After proposing an initial algorithm, Yang, Shang, et al. (2014) then improved this algorithm by adding sub-modularity to make it computationally less expensive. Agrawal et al. (2015) designed a recommender system that recommends video clips from lectures based on questions asked in forums.

Student Performance Recommender Systems

To increase student performance and engagement, some researchers (Alario-Hoyos et al., 2014; Luacesa et al., 2017; M. Zhang et al., 2019) presented work focused on the design of recommender systems only. Chen et al. (2016) first proposed and then designed and implemented a system that recommends to learners course-related paid tasks from freelancing websites such as Upwork or Witmart (Chen et al., 2018; Chen et al., 2017). The main idea was to make it possible for learners to earn money while using MOOCs.

MOOCs Provider/Teacher's Recommender Systems

Only two studies paid attention to designing recommender systems for MOOC providers and teachers. Holotescu (2016) designed a chatbot for MOOCs that works with Facebook and provides news about MOOCs that can deliver the latest news about MOOCs to teachers and providers. Zhou et al. (2015) designed an Android application to improve a course, and this application takes feedback from students during the course and makes suggestions to the teacher based on this feedback.

Conclusion

The use of recommender systems in MOOCs presents exciting opportunities to increase the popularity of MOOCs and improve the learners' experience. Research to date has mostly focused on the implementation of recommender systems in MOOCs, particularly course recommender systems which was the most prolific research line throughout the period.

From 2012 to 2016, researchers modified existing recommender systems that were designed for e-commerce, music, videos, or books, to make them appropriate for use in MOOCs; however, from 2017 onwards, researchers started to apply neural networks, deep learning and data mining techniques in data preprocessing to apply recommender systems in MOOCs. Researchers focused on learners and strived to exploit their learning habits.

Future Directions

Although a considerable number of recommender systems in MOOCs have been proposed and implemented, only a few authors have discussed the time and space complexity of their proposed and implemented algorithms (Ahera & Lobo, 2013; Hou et al., 2018; Mi & Faltings, 2016a, 2017; H. Zhang et al., 2018). MOOCs produce a large amount of data that can be used for recommender systems and researchers should focus on systems that scale well with the increase in data and have linear time and space complexity. In evaluating their solutions, authors have ignored the training and recommendation time that their recommender system is taking.

One reason for overlooking this aspect of their algorithms could be the batch/offline nature of proposed algorithms. Batch/offline algorithms use existing datasets for training and recommendations. For this purpose, algorithms require memory space and time, the amount of which depends upon the type of dataset. Online recommender systems consider only the current context of the user while computing recommendations. In MOOCs, the current context of the user is an important factor, and researchers should put more focus on this. We found only one such work, Mi and Faltings (2016b, 2017), that addressed online recommender systems.

There is also a lack of standardized datasets available for the evaluation of recommender systems in MOOCs. Researchers have mostly used publicly available datasets of Coursera, edX, and, in some cases, datasets from their own institutes to evaluate recommender systems (Aryal et al., 2019; Dai et al., 2017; Kardan et al., 2017; Mi & Faltings, 2016a; Shaptala et al., 2017; Yang, Adamson, et al., 2014; Yang, Piergallini, et al., 2014). Other authors have created datasets (Onah & Sinclair, 2015a; He et al., 2017; Iniesto & Rodrigo, 2019; Zhou et al., 2015). A lack of standardized datasets can be a significant limitation when benchmarking or comparing algorithms or techniques of different researchers. Furthermore, most researchers used datasets from computer science-related courses for testing their recommender systems (Aryal et al., 2019; Bhatt et al., 2018; M. Zhang et al., 2019; Zhou et al., 2015) which limits the research to one academic field.

Scant attention has been paid to designing recommender systems for MOOC providers and teachers. Such systems can help providers and teachers in planning course materials, delivery styles, and the content of the MOOC. Recommender systems could also help providers decide which courses should become MOOCs.

The effect of recommender systems on student engagement and completion rates is another useful topic to pursue.

We also observed that previous research has overlooked different types of MOOCs, such as cMOOCs, xMOOCs, and sMOOCs, and has not considered the characteristics of types of MOOCs while designing recommender systems. In future, recommender systems could cater to different types of MOOCs.

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Growth and Collaboration in Massive Open Online Courses: A Bibliometric Analysis

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Abstract

Massive open online courses (MOOCs) are an important approach for achieving UNESCO's aim of open and accessible education. However, there are concerns regarding fragmentation or bias of MOOCs toward certain disciplines or countries. This study sought to: (a) examine how MOOCs research has evolved and is distributed, (b) determine what key areas are discussed in MOOCs research, and (c) identify the major players in MOOCs research and their collaborations. This study conducted a bibliometric analysis of 3,118 scholarly works related to MOOCs as recorded in the Scopus database in July, 2019. Specifically, we analyzed the evolution of MOOCs research by examining (a) published studies, (b) source titles, (c) types of sources and documents, as well as (d) the languages in which the documents were written in. We further analyzed the key areas of MOOCs research by looking into common subject areas, keywords used most often, and title analysis. Finally, we sought to increase our understanding of the major players in MOOCs research and their collaborations by examining (a) which countries contributed most to MOOCs research, (b) the main institutions involved, as well as (c) authorship and citation analysis. Findings indicated that in their early development starting in 2009, MOOCs caught the attention of scholars from both the East and the West, and the number of publications grew consistently over the 10 years after that. MOOCs research has been well distributed but has yet to adequately encourage inclusiveness. There has been healthy cross-country collaboration, but there is a gap in MOOCs research originating from certain countries as compared to the rest of the world. Our findings provide important input towards improving the inclusivity and global reach of MOOCs.

Keywords: massive open online courses, MOOCs, distance education, online learning, collaborative research, inclusiveness

Introduction

Education is a human right, and massive open online courses (MOOCs) are an important tool whereby digital technology may be used to enhance access to quality education and lifelong learning opportunities for all. The number of MOOC offerings has grown exponentially, partly due to the Internet revolution as well as in response to the call to address the need for access to quality education in an equitable and affordable manner as inspired by the United Nations Sustainable Development Goal 4, which forms part of a universal agenda (United Nations General Assembly, 2015). In the period between 2012 to 2013, MOOCs came to be widely accepted by universities around the world, and outsourcing companies were launched to provide the necessary infrastructure (Baggaley, 2013). Since then, MOOCs have been a popular research topic—rapidly developing, while inspiring new approaches, innovations, assessments, and discussions.

Several studies have looked into trends in MOOCs research. Review studies have not only focused on different time periods, but have also examined different research goals, perspectives, and contributions. Liyanagunawardena, Adams, and Williams (2013) presented the first systematic review of MOOCs literature. They looked at the period from 2008 to 2012, categorized 45 specific pieces of literature into 8 different areas, and analyzed on the basis of types of publications, year of publication, and contributors. Since then, the literature on MOOCs has grown, so it is important to examine the latest developments.

Several studies have looked into the interdisciplinary aspects of MOOCs research. Studies revealed common research themes (Ebben & Murphy, 2014; Gašević, Kovanović, Joksimović, & Siemens, 2014), as well as research methods used and dominance of researchers from the field of education (Gašević et al., 2014). Gašević et al. (2014) also raised the concern of fragmentation in the research community and the need to enhance interdisciplinary efforts, but their study focused only on proposals submitted to the MOOC Research Initiative. Similarly, Veletsianos and Shepherdson (2015) found that MOOCs research published from 2013 to 2015 was mostly conducted by researchers from the education and computer science disciplines, though an interdisciplinary trend was also emerging. Veletsianos and Shepherdson (2016) further examined the geographic distribution, publication outlets, citations, data collection, and analysis methods of research focusing on MOOCs during 2013 to 2015. This study, however, excluded literature authored in languages other than English, and recommended that future research examine whether MOOC literature was biased towards certain countries or regions.

Other aspects of MOOCs research have also been studied. Deng and Benckendorff (2017) indicated that most research has used surveys, interviews, and logged files to understand instructors' and students' use of MOOCs. Ichimura and Suzuki (2017) analyzed literature focusing on MOOC course design. Zancanaro and Domingues (2017) analyzed 294 papers on MOOCs. They (a) investigated the number of publications, (b) mapped the institutions involved, (c) looked at authors with the most publications, (d) classified themes, and (e) examined the most frequently cited articles to reveal the emerging and most promising trends of MOOCs. Zhu, Sari, and Lee (2018) explored 146 empirical MOOCs research articles published between 2014 and 2016, and looked into research methods, research focus, as well as geographical distribution of the various research projects. They then extended their research by comparing data from 2014 to 2016 with data from 2016 to 2017. They found that most authors collaborated within the same country and most research on MOOCs originated from the U.S., U.K., Spain, and China (Zhu, Sari, & Bonk, 2018). However, these studies looked at only a small amount of MOOC literature, which did not show the bigger picture of MOOCs as a global movement.

Previous studies have focused on understanding MOOCs from various perspectives, but little has been done to determine whether MOOC development is equally shared or collaborated on in different parts of the world. This question is crucial, since MOOCs are viewed as a tool to reduce the educational gap across the world. As MOOCs require technology infrastructure, digital skills, and language fluency, these factors could also potentially increase the digital divide (Jiang, Williams, Warschauer, He, & O'Dowd, 2014; Lee, Hong, & Hwang, 2018) and cause serious social polarization across the world. There are also concerns about the often-overlooked cultural dimension of MOOC providers offering global education solutions (Nordin & Norman, 2018).

This paper presents a bibliometric analysis of scientific literature on MOOCs by looking into three main research questions: (a) how has MOOCs research evolved and been distributed, (b) what key topic areas have been discussed in MOOCs research, and (c) who are the major players in MOOCs research and how have they collaborated. The remainder of this paper offers details on research methods, results and their interpretations, as well as discussion of different considerations and issues involved in answering the research questions above. To answer these three questions, our bibliometric analysis considered the following aspects of the literature on MOOCs.

a) Evolution and distribution of MOOCs research:

- number of published studies per year;
- sources and document types; and
- languages of documents.

b) Key areas of MOOCs research:

- subject area;
- frequency of keywords; and
- title analysis (e.g., frequency of words and phrases).

c) Major players and research collaboration:

- countries with most contributions;
- main institutions;
- authorship analysis; and
- citation analysis.

The purpose of this study was to gain a more in-depth understanding of the MOOC phenomenon, particularly with respect to its global reach and collaborations. It was necessary to examine the latest data in order to help researchers propose recommendations for future research in the development of MOOCs.

Method

This bibliometric study accessed the Scopus scientific database to analyze publications with the word MOOC or massive open online learning in their title. It considered all types of documents published in the Scopus database from the year 2009 until 2020. Scopus is one of the largest abstract and citation database of peer-reviewed literature; it contains approximately 23,700 peer-reviewed journals as well as over 24,000 titles, 360 trade publications, 750 book series, 195,000 non-serial books, and 60 million records from various areas of knowledge. Such a large database is able to provide a comprehensive overview of the world's research output. Scopus is also recognized by the international scientific community as one of the main sources of relevant information.

This study employed bibliometric analysis and used quantitative and statistical analysis to describe distribution patterns of research articles within specific topics and time periods (Martí-Parreño, Méndez-Ibáñez, & Alonso-Arroyo, 2016). The process involved identifying a keyword for search purposes. We used the term mooc* OR "massive open online course" when querying the Scopus database for information on article titles only. The search was conducted on July 17, 2019. The boundaries of the search specified results published from the year 2009 to 2020. Although a bibliometric analysis on MOOCs was conducted by Liyanagunawardena et al. (2013) and covered the initial introduction of MOOCs (i.e., 2008 to 2013), it dealt with different questions and aims. From our search, Scopus returned 3,118 document results, and retrieved several terms related to MOOCs research including MOOC, MOOCs, MOOCAT, MOOCEP, and Mooc-topia.

We analyzed the results in various ways in order to provide input in response to our research questions. Several results were directly retrieved from Scopus through the analyze search results function. Other results were inserted manually or exported to a new Excel file. From the file created for all the results, information such as percentages was analyzed. We also used VOSviewer to generate images to help with data interpretation. After the results were identified, analyzed, and synthesized, we wrote up the final report, which presented the findings and analysis. Through this paper we hope to contribute meaningful insights on the trends apparent in publications on MOOCs. Researchers can use these findings as a basis for future studies and discussions to enrich and further develop this area of research.

Results

This section deals with the results obtained from the bibliometric analysis related to the following questions: (a) how has MOOCs research evolved and been distributed, (b) what key topic areas have been discussed in MOOCs research, and (c) what are the characteristics of scientific collaborations in MOOCs research among authors in different countries.

Evolution and Dissemination of MOOCs Research

To address the question of the evolution of MOOCs research and trends in its dissemination, this study analyzed the following data: (a) number of publications by year, (b) source title, (c) source and document type, and (d) document's language.

Publications by year. Table 1 shows the statistics on annual publications of MOOCs research from the year 2009 to 2020 and indicates a trend of increasing numbers of publications. 2009 marks the first year documents on MOOCs were published and indexed by Scopus, with only three documents recorded. From 2009 until 2012, fewer than 20 documents on MOOCs were recorded in the Scopus database. Interestingly, there was a dramatic increase in the number of documents published on MOOCs starting in 2013 with 153 documents published that year. The number gradually increased from the year 2013 until 2018, reflecting the growing interest in MOOCs. Although there were only 298 publications in 2019, this study was conducted just past the midway point of July, 2019. Thus, the full number of documents for the year were yet to be published. In contrast, some journals had already produced their 2020 publications, so these numbers were also recorded by the Scopus database.

Table 1

Number of MOOCs Research Publications by Year

Year	Number of documents	Percentage (%)	Cumulative percentage (%)
2009	3	0.10	0.10
2010	2	0.06	0.16
2011	3	0.10	0.26
2012	11	0.35	0.61
2013	153	4.91	5.52
2014	358	11.48	17.00
2015	494	15.84	32.84
2016	517	16.58	49.42
2017	599	19.21	68.63
2018	678	21.74	90.38
2019	298	9.56	99.94
2020	2	0.06	100.00
Total	3,118	100.00	

Sources and document types. This study also sought to determine where MOOCs documents had been published by analyzing the data based on document source types. Table 2 shows that journals were the most common source, representing 1,322 (42.40%) of the total, followed by conference proceedings (n = 1,199; 38.45%) with a barely 4% difference only. Trade publications, normally intended for a specific industry, trade, or type of business and usually published in the form of a magazine periodical with the topical subject, were the least frequent document type (n = 11; 0.35%). Although these trade publications were seldom referred to, they are also scientifically relevant and useful in influencing policies on MOOC implementations.

Table 2

Sources for MOOCs Research

Source type	Number of documents	Percentage (%)
Journal	1,322	42.40
Conference proceedings	1,199	38.45
Book series	361	11.58
Book	225	7.22
Trade publication	11	0.35
Total	3,118	100.00

The data were also analyzed based on document types. The Scopus database focuses on primary document types from serial publications, which means that the author is also the researcher in charge of the presented findings. Secondary document types, where the author is different from the person conducting the research, such as book reviews, are not included in Scopus document types. As a result, our analysis revealed the volume of researchers conducting research on MOOCs and their publications.

As shown in Table 3, nearly half of the total publications came from documents presented at a conference or symposium (*n* = 1,518; 48.69%). This was followed by articles of original research or opinion (*n* = 1,146; 36.75%). Book chapters represented 8.11% (*n* = 253) of the publications on MOOCs. The other types of documents, such as reviews, editorials, letters, notes, books, conference reviews, short surveys, and erratum, each represented less than 2% of the total publications, respectively.

Table 3

MOOCs Research Document Types

Document type	Number of documents	Percentage (%)
Conference paper	1,518	48.69
Article	1,146	36.75
Book chapter	253	8.11
Review	57	1.83
Editorial	38	1.22
Letter	27	0.87
Note	24	0.77
Book	12	0.38
Conference review	9	0.29
Short survey	8	0.26
Erratum	5	0.16
Undefined	21	0.67
Total	3,118	100.00

Source titles. A book series called *Lecture Notes in Computer Science Including Subseries Lecture Notes in Artificial Intelligence and Lecture Notes in Bioinformatics* contributed the greatest number of publications on MOOCs (*n* = 183). This was followed by the *ACM International Conference Proceeding Series* (*n* = 133) and *CEUR Workshop Proceedings* (*n* = 121). The open access *International Review of Research in Open and Distributed Learning* (IRRODL) proved to be the leading journal of published research related to MOOCs (*n* = 87), followed by the *Communications in Computer and Information Science* (*n* = 44). Table 4 shows the top 20 sources of publishing on MOOCs.

Table 4

Top 20 Sources for MOOCs Research

Source title	Number of documents	Percentage (%)
Lecture Notes in Computer Science Including Subseries Lecture Notes in Artificial Intelligence and Lecture Notes in Bioinformatics	183	5.87
ACM International Conference Proceeding Series	133	4.27
CEUR Workshop Proceedings	121	3.88
International Review of Research in Open and Distributed Learning	87	2.79

Source title	Number of documents	Percentage (%)
Communications in Computer and Information Science	44	1.41
IEEE Global Engineering Education Conference (EDUCON)	43	1.38
Computers and Education	34	1.09
Journal of Advanced Oxidation Technologies	31	0.99
Proceedings Frontiers in Education Conference (FIE)	31	0.99
Advances in Intelligent Systems and Computing	30	0.96
Lecture Notes in Educational Technology	28	0.90
Proceedings of 2018 Learning with MOOCs (LWMOOCS 2018)	28	0.90
International Journal of Emerging Technologies in Learning	27	0.87
ASEE Annual Conference and Exposition Conference Proceedings	24	0.77
MOOCs and Open Education Around the World	24	0.77
British Journal of Educational Technology	22	0.71
Distance Education	22	0.71
L@s 2016 Proceedings of the 3rd 2016 ACM Conference on Learning at Scale	22	0.71
L@s 2017 Proceedings of the 4th 2017 ACM Conference on Learning at Scale	22	0.71
L@s 2014 Proceedings of the 1st ACM Conference on Learning at Scale	21	0.67

Languages used in documents. Table 5 reveals that English was most common and accounted for 94% of the 3,118 publications on MOOCs. Spanish was used second most often, but accounted for nearly 3% only. The rest of documents were published in nine other languages, namely French, Chinese, German, Portuguese, Russian, Hungarian, Japanese, and Korean, but these accounted for less than 0.5% of the total. While publications on MOOCs appeared in languages other than English, they accounted for only a small percentage. Finally, 35 documents were published in dual languages.

Table 5

Languages Used for MOOCs Research Publications

Language	Number of documents	Percentage (%)
English	2950	94.61
Spanish	92	2.95
English; French	10	0.32
English; Italian	9	0.29
French	9	0.29
Chinese	8	0.26
German	8	0.26
Portuguese	8	0.26
English; German	7	0.22
English; Spanish	5	0.16
Russian	3	0.10
English; Chinese	2	0.06
Hungarian	2	0.06
Japanese	2	0.06
English; Portuguese	1	0.03
French; English	1	0.03
Korean	1	0.03
Total	3,118	100.00

Key Areas of MOOCs Research

The key areas of MOOCs research were analyzed in terms of (a) main subject areas, (b) frequency of keywords, and (c) document titles.

Subject area. This study classified the documents based on their subject area, as presented in Table 6. The data showed that research on MOOCs has emerged in a variety of subject areas. Nearly 60% of studies involving MOOCs were in the area of computer science, representing 59.33% (*n* = 1,850) of the total articles, followed by a significant number of publications in the social sciences (*n* = 1,711; 54.87%). The subject areas of engineering, mathematics, decision sciences, business, management and accounting, arts and humanities, and medicine each accounted for more than 100 documents on MOOCs.

Table 6

Subject Areas of MOOCs Research

Subject area	Number of documents	Percentage (%)
Computer science	1,850	59.33
Social sciences	1,711	54.87
Engineering	517	16.58
Mathematics	331	10.62
Decision sciences	145	4.65
Business, management, and accounting	141	4.52
Arts and humanities	123	3.94
Medicine	101	3.24
Psychology	48	1.54
Chemistry	47	1.51
Economics, econometrics, and finance	44	1.41
Physics and astronomy	33	1.06
Materials science	31	0.99
Energy	29	0.93
Agricultural and biological sciences	24	0.77
Environmental science	23	0.74
Nursing	22	0.71
Biochemistry, genetics, and molecular biology	21	0.67
Health professions	19	0.61
Multidisciplinary	19	0.61
Chemical engineering	11	0.35
Neuroscience	9	0.29
Earth and planetary sciences	8	0.26
Pharmacology, toxicology, and pharmaceutics	8	0.26
Veterinary	5	0.16
Immunology and microbiology	4	0.13
Dentistry	3	0.10

Keywords analysis. Figure 1 presents a network visualization of the author keywords that each had a minimum of 10 occurrences. This study used VOSviewer, a software tool for constructing and visualizing bibliometric networks to map authors' keywords. The color, circle size, font size, and thickness of connecting lines represent relationships with other keywords. For example, keywords with the same color were commonly listed together. So, in this study, MOOCs, adaptive learning, blended learning, accessibility, SPOC, innovation, LMS, and xMOOC have similar colors, suggesting that these keywords were closely related and usually occurred together (Sweileh et al., 2017).

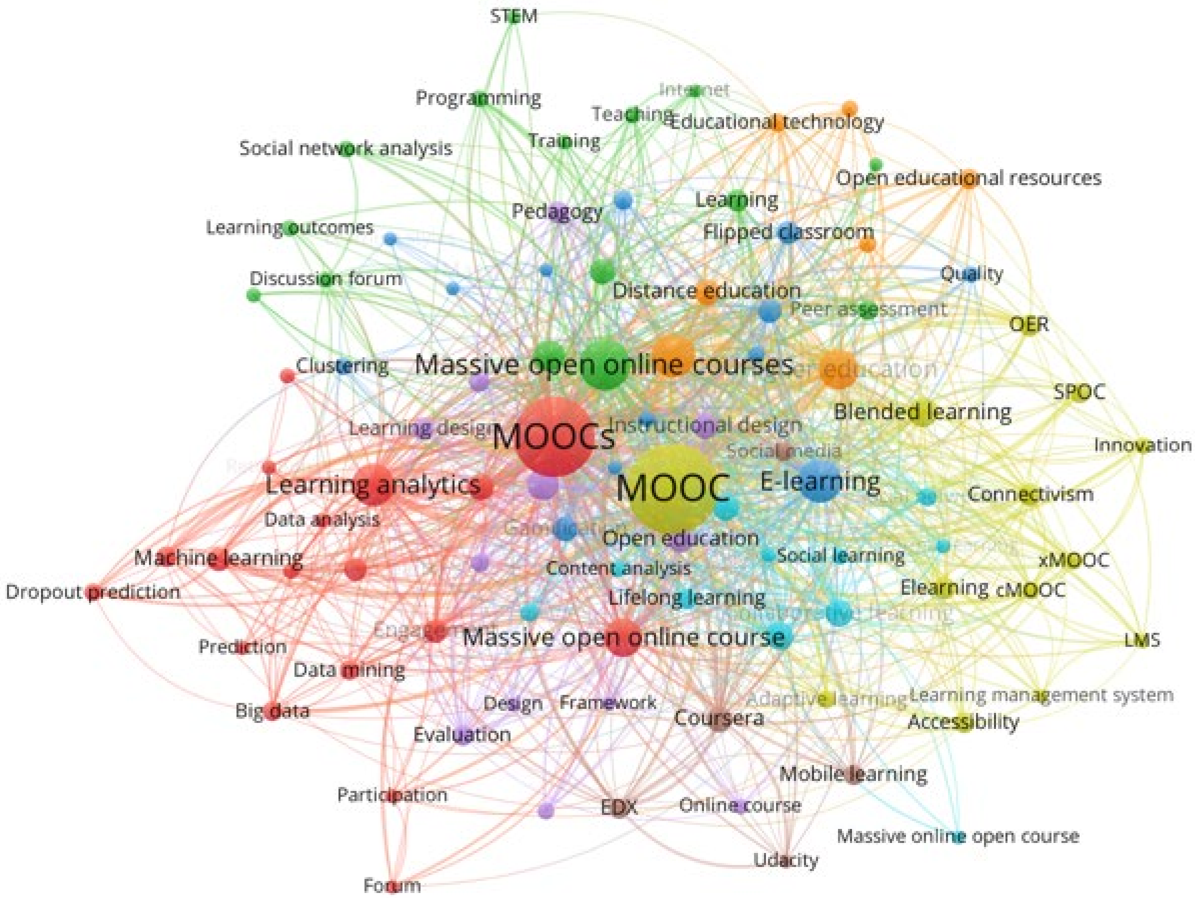

Figure 1. Network visualization map of author keywords with at least 10 occurrences.

Table 7 summarizes the most frequently used keywords in MOOCs studies. After excluding the core keywords related to the search query, the data further revealed that e-learning was the keyword most associated with MOOCs (n = 1,031). The keyword “massive open online course” was always used either in full or as an abbreviation (MOOC) and was also presented interchangeably either as a singular term or plural. Other keywords that appeared more than 500 times in documents related to MOOCs were education, teaching, and students. This indicated that MOOCs research was mostly concerned with teaching and learning. Other common keywords appearing more than 100 times were (a) curricula; (b) learning systems; (c) engineering education; (d) online learning; (e) higher education; (f) computer-aided instruction; (g) distance education; (h) social networking (online); (i) education computing; (j) learning analytics; (k) data mining; (l) human; (m) surveys; (n) artificial intelligence; and (o) motivation. These keywords were clustered mainly around computer sciences concepts.

Table 7

Keywords in MOOCs Research and Their Frequency

Keyword	Number of documents	Percentage (%)
E-learning	1,031	33.07
Massive open online course	936	30.02
MOOC	912	29.25
Education	828	26.56
Teaching	704	22.58
MOOCs	658	21.10
Students	506	16.23
Curricula	484	15.52
Learning systems	248	7.95
Massive open online courses	230	7.38
Engineering education	227	7.28
Online learning	204	6.54
Higher education	202	6.48
Computer-aided instruction	194	6.22
Distance education	182	5.84
Social networking (online)	170	5.45
Education computing	169	5.42
Learning analytics	166	5.32
Data mining	130	4.17
Human	120	3.85
Surveys	113	3.62
Artificial intelligence	110	3.53
Motivation	104	3.34

Title analysis. Figure 2 shows the visualization of a term co-occurrence network based on title fields with a minimum of 10 occurrences of a term. We used a binary counting method, wherein the number of times a noun phrase occurred in the title of a publication played no role (van Eck & Waltman, 2014). According to van Eck and Waltman (2014), a noun phrase that occurs only once in the title of a publication is treated in the same way as a noun phrase that occurs, for instance, 10 times. Figure 2 reveals the word “course” was the main term acting as the central node of the whole network (Verk, Golob, & Podnar, 2019) in MOOCs research. The size of the nodes indicates the weight of the occurrence of the terms, while the thickness of joining lines indicates the strength of the relationship among the terms. Related words, as indicated by the same color, frequently occurred together. For instance, the diagram suggested that (a) application, (b) innovation, (c) construction, (d) flipped classroom, (e) exploration, (f) MOOC environment, (g) library, (h) example, and (i) age (all colored purple) are closely related and usually occurred together. From the titles of the publications in our study, VOSviewer generated eight different colors representing eight clusters with 74 terms.

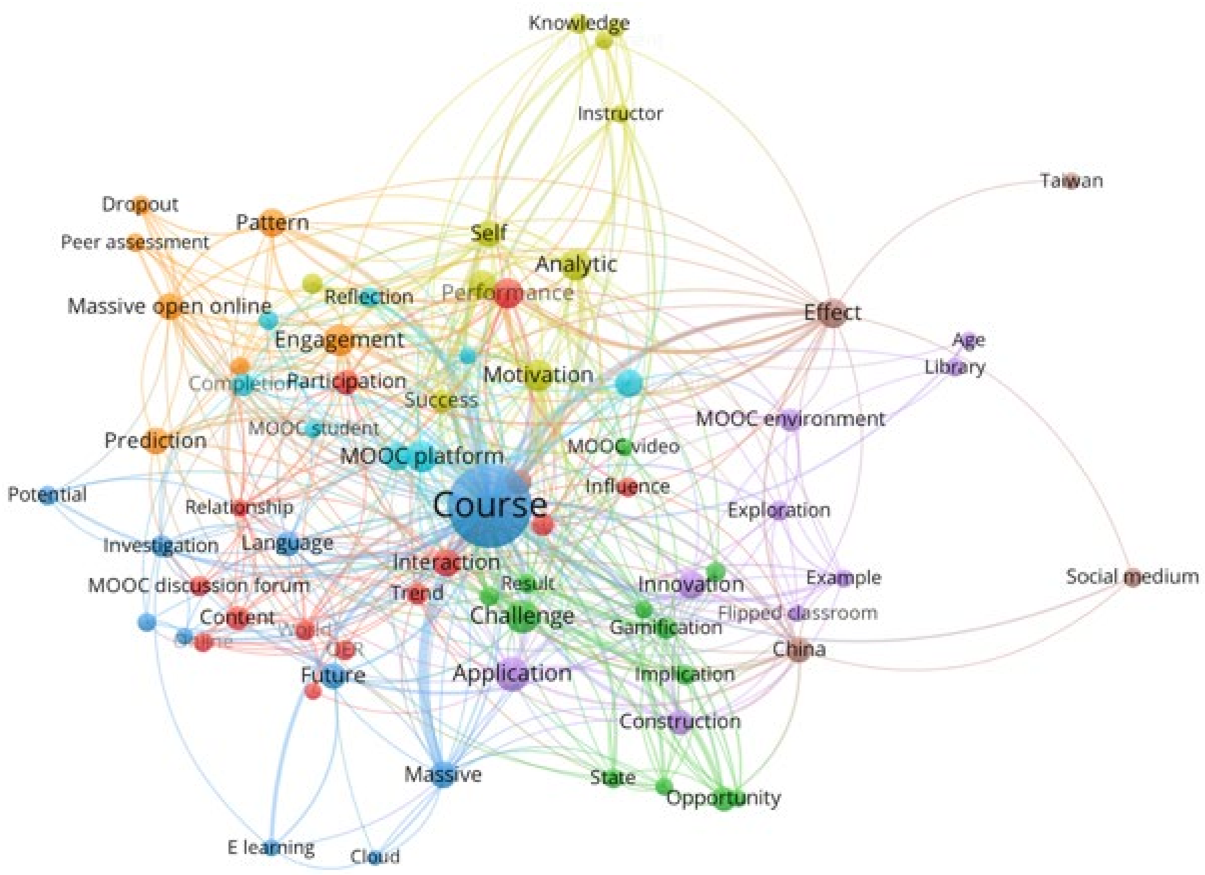

Figure 2. VOSviewer visualization of a term co-occurrence network based on title fields (binary counting).

Major Players and Collaboration in MOOCs Research

This study examined the characteristics of scientific collaborations on MOOCs research by analyzing (a) the countries that most frequently contributed, (b) the main institutions involved in MOOCs research, (c) authorship analysis, and (d) citations analysis.

Countries contributing most to MOOCs research. Table 8 indicates the top 25 countries from where most MOOCs research originated. The United States (23.03%) had the leading position, followed by China (14.69%) and Spain (11.61%). The remaining distribution of authors' national affiliations represented less than 10% and was spread across the globe—The United Kingdom, Australia, Germany, the Netherlands, India, Canada, France, Malaysia, Taiwan, Italy, Russian Federation, Ecuador, Switzerland, Mexico, Sweden, Portugal, Greece, Hong Kong, Norway, Austria, Morocco, and Turkey. Clearly, MOOCs play an important role in a wide range of geographic areas.

Table 8

Geographic Origins of MOOCs Research

Country	Number of documents	Percentage (%)
United States	718	23.03
China	458	14.69
Spain	362	11.61
The United Kingdom	246	7.89
Australia	176	5.64
Germany	127	4.07
The Netherlands	113	3.62
India	107	3.43
Canada	97	3.11
France	88	2.82
Malaysia	69	2.21
Taiwan	60	1.92
Italy	54	1.73
Russian Federation	54	1.73
Ecuador	47	1.51
Switzerland	47	1.51
Mexico	44	1.41
Sweden	42	1.35
Portugal	41	1.31
Greece	39	1.25
Hong Kong	39	1.25
Norway	38	1.22
Austria	36	1.15
Morocco	34	1.09
Turkey	30	0.96

Main institutions. Table 9 shows the institutions from which most of the publications on MOOCs originated. Out of the 3,118 documents, Universidad Nacional de Educacion a Distancia (*n* = 57), which is one of the world's largest universities, located in 13 countries in Europe, America, and Africa, contributed most to publications on MOOCs. This was followed by (a) Universidad Carlos III de Madrid (*n* = 47); (b) Delft University of Technology (*n* = 47); (c) Massachusetts Institute of Technology (MIT; *n* = 43); (d) Hasso-Plattner-Institut für Softwaresystemtechnik GmbH (*n* = 43); and (e) Carnegie Mellon University (*n* = 42).

Table 9

Institutions Contributing More Than 20 MOOCs Research Documents

Name of institution	Number of documents	Percentage (%)
Universidad Nacional de Educacion a Distancia	57	1.83
Universidad Carlos III de Madrid	47	1.51
Delft University of Technology	47	1.51
Open University	47	1.51
Massachusetts Institute of Technology	43	1.38
Hasso-Plattner-Institut für Softwaresystemtechnik GmbH	43	1.38
Carnegie Mellon University	42	1.35
Pennsylvania State University	37	1.19
Purdue University	36	1.15
Open University of the Netherlands	36	1.15
Universidad Politécnica de Madrid	34	1.09
Stanford University	33	1.06
University of Edinburgh	33	1.06
Harvard University	31	0.99
Tsinghua University	30	0.96
Beijing Normal University	28	0.90
University of Michigan, Ann Arbor	28	0.90
Technische Universität Graz	27	0.87
Swiss Federal Institute of Technology EPFL, Lausanne	27	0.87
Peking University	25	0.80
University of Southampton	25	0.80
Universitat Oberta de Catalunya	24	0.77
Universität Potsdam	24	0.77
Pontificia Universidad Católica de Chile	24	0.77
University of Pittsburgh	23	0.74
Universidad de Salamanca	23	0.74
Universidad Autónoma de Madrid	23	0.74
University of Melbourne	21	0.67

Authorship analysis. Table 10 shows the number of authors per document. From the 3,118 publications considered in this study, 619 (19.85%) documents were single-authored publications while the remaining had more than one author. Most of the articles on MOOCs were co-authored by two (23.86%) or three (23.60%) authors. There were only two documents co-authored by more than 20 authors.

Table 10

Number of Authors per Document

Author count	Number of documents	Percentage (%)
1	619	19.85
2	744	23.86
3	736	23.60
4	487	15.62
5	264	8.47
6	138	4.43
7	65	2.08
8	23	0.74
9	20	0.64
10	6	0.19
11	3	0.10
12	3	0.10
13	3	0.10
14	3	0.10
15	1	0.03
17	1	0.03
21	1	0.03
26	1	0.03
Total	3,118	100.00

Table 11 shows the most productive authors who contributed to research on MOOCs. Two authors had the most publications on MOOCs with 35 publications each, namely Carlos Alario-Hoyos, affiliated with Universidad Carlos III de Madrid, Spain, and Christoph Meinel, affiliated with Hasso-Plattner-Institut fur Softwaressystemtechnik GmbH in Potsdam, Germany. The third most productive author publishing on MOOCs was Mar Perez-Sanagustin (23 publications) from Pontificia Universidad Catolica de Chile, in Chile, and also a researcher at the IRIT Institu de Recherche Informatique de Toulouse, France. These three most productive authors in MOOCs studies all came from European countries and all had a computer science background.

Table 11

Most Productive Authors in MOOCs Research

Author	Number of documents	Percentage (%)
Alario-Hoyos, C.	35	1.12
Meinel, C.	35	1.12
Pérez-Sanagustín, M.	23	0.74
Staubitz, T.	19	0.61
Dillenbourg, P.	17	0.55
Reich, J.	17	0.55
Chen, L.	16	0.51
Khalil, M.	16	0.51
Zheng, Q.	16	0.51
Brooks, C.	15	0.48
Kalz, M.	15	0.48
Kloos, C. D.	15	0.48
Muñoz-Merino, P. J.	15	0.48
Renz, J.	15	0.48
Rosé, C. P.	15	0.48
Watson, S. L.	15	0.48
Burgos, D.	14	0.45
Davis, D.	14	0.45
Ebner, M.	14	0.45
García-Peñalvo, F. J.	14	0.45

VOSviewer software was used to present a network visualization (see Figure 3) of the mapping of co-authorship among different authors. This mapping used the fractional counting method and was based on data of those authors who had at least five documents on MOOCs and at least five citations. The color, circle size, font size, and thickness of connecting lines indicate the strength of the relationship among the authors. Related authors, as indicated by the same color, are commonly listed together. For example, the diagram suggests that Meinel, C., Staubitz, T., and Renz, J., who are all from the same institution in Germany, have collaborated closely. From the analysis, Alario-Hoyos seems to have had a strong collaboration with authors from different parts of the world including Chile, Portugal, Guatemala, Malaysia, and the U.K.

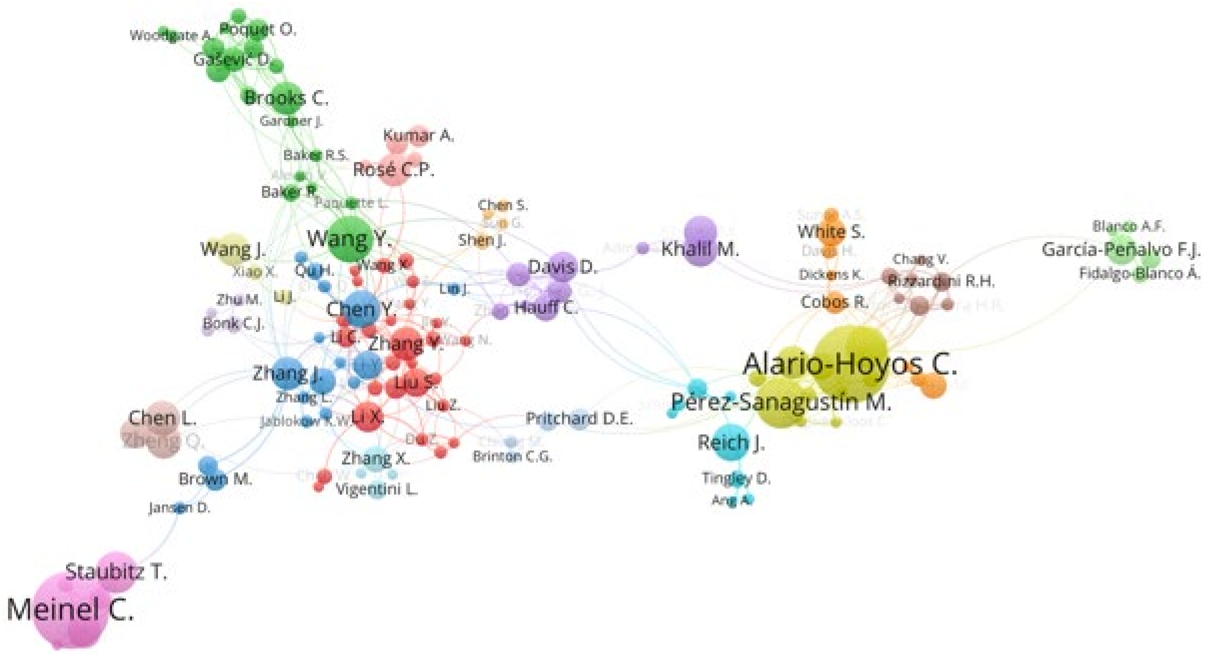

Figure 3. Network visualization map of MOOCs research co-authors.

Figure 4 further shows the network visualization map of the authors based on the countries they are affiliated with. Only countries with at least five documents and at least five citations were considered in this analysis. Based on the fractional counting method, it was clear that authors from the United States have played a prominent role in collaborating with authors from other countries in terms of MOOCs research. Authors from The United States have worked closely with colleagues from (a) Malaysia, (b) Saudi Arabia, (c) Japan, (d) Ireland, and (e) Singapore. Several collaborative efforts with colleagues in other countries have also been established by authors from Spain, The United Kingdom, Germany, and the Netherlands.

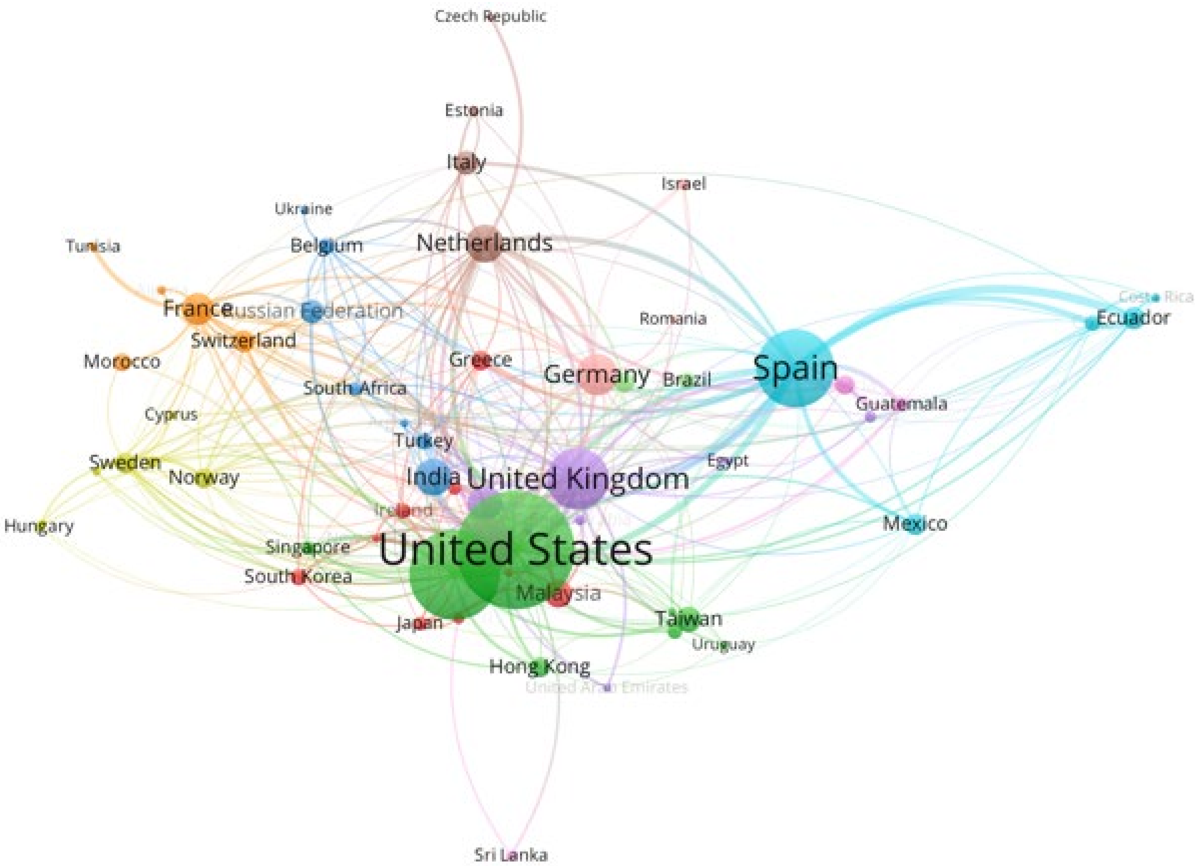

Figure 4. Network visualization map of MOOCs research co-authors by country.

Citation analysis. Table 12 reports the citation metric of the papers obtained from the Scopus database. There were 19,862 citations reported in 10 years (2009–2019) for 3,118 articles, with an average of 1,986 citations per year.

Table 12

MOOCs Research Citation Metrics

Metric	Data
Total papers	3,118
Total citations	19,862
Number of years	10
Citations per year	1,986.2
Citations per paper	6.37
Citations per author	9,322.76
Papers per author	1,432.02
Authors per paper	3.02
h-index	59
g-index	93

Table 13 summarizes the 20 documents on MOOCs most often cited, based on the number of times each was cited. The two documents most often cited were the systematic study on MOOCs conducted by Liyanagunawardena et al. (2013) in the early days of MOOC expansion, as well as another empirical study on how MOOC videos affected student engagement by Guo, Kim, and Rubin (2014). Other documents most often cited were literature reviews or those that addressed the issues of (a) learner disengagement, (b) enrolment and completion, (c) challenges, (d) quality, (e) motivation, and (f) pedagogy.

Table 13

Most Influential Documents: Those With a Minimum of 100 Citations per Document

Author (year)	Title	Source	TC	CPY	CPA
Liyanagunawardena, Adams, & Williams (2013)	MOOCs: A systematic study of the published literature 2008–2012	*International Review of Research in Open and Distributed Learning*	422	70.33	141
Guo, Kim, & Rubin (2014)	How video production affects student engagement: An empirical study of MOOC videos	*1st ACM Conference on Learning at Scale, L@S 2014*	422	84.40	141
Kizilcec, Piech, & Schneider (2013)	Deconstructing disengagement: Analyzing learner subpopulations in massive open online courses	*3rd International Conference on Learning Analytics and Knowledge, LAK 2013*	383	63.83	128
Jordan (2014)	Initial trends in enrolment and completion of massive open online courses	*International Review of Research in Open and Distributed Learning*	299	59.80	299
Kop (2011)	The challenges to connectivist learning on open online networks: Learning experiences during a massive open online course	*International Review of Research in Open and Distributed Learning*	243	30.38	243
Margaryan, Bianco, & Littlejohn (2015)	Instructional quality of massive open online courses (MOOCs)	*Computers and Education*	227	56.75	76
Hew & Cheung (2014)	Students' and instructors' use of massive open online courses (MOOCs): Motivations and challenges	*Educational Research Review*	227	45.40	114

Author (year)	Title	Source	TC	CPY	CPA
Kop, Fournier, & Mak (2011)	A pedagogy of abundance or a pedagogy to support human beings? Participant support on massive open online courses	*International Review of Research in Open and Distributed Learning*	200	25.00	67
Clow (2013)	MOOCs and the funnel of participation	*3rd International Conference on Learning Analytics and Knowledge, LAK 2013*	190	31.67	190
Martin (2012)	Will massive open online courses change how we teach?	*Communications of the ACM*	176	25.14	176
Fini (2009)	The technological dimension of a massive open online course: The case of the CCK08 course tools	*International Review of Research in Open and Distributed Learning*	173	17.30	173
Fox (2013)	From MOOCs to SPOCs	*Communications of the ACM*	136	22.67	136
Alraimi, Zo, & Ciganek (2015)	Understanding the MOOCs continuance: The role of openness and reputation	*Computers and Education*	124	31.00	41
DeBoer, Ho, Stump, & Breslow (2014)	Changing “course”: Reconceptualizing educational variables for massive open online courses	*Educational Researcher*	118	23.60	30
Reich (2015)	Rebooting MOOC research	*Science*	113	28.25	113
DeWaard, et al. (2011)	Using mLearning and MOOCs to understand chaos, emergence, and complexity in education	*International Review of Research in Open and Distributed Learning*	112	14.00	16
Daradoumis, Bassi, Xhafa, & Caballé (2013)	A review on massive e-learning (MOOC) design, delivery and assessment	*2013 8th International Conference on P2P, Parallel, Grid, Cloud and Internet*	108	18.00	27

Author (year)	Title	Source	TC	CPY	CPA
		Computing, 3PGCIC 2013			
Kay, Reimann, Diebold, & Kummerfeld (2013)	MOOCs: So many learners, so much potential.	*IEEE Intelligent Systems*	107	17.83	27
Gasevic, Kovanovic, Joksimovic, & Siemens (2014)	Where is research on massive open online courses headed? A data analysis of the MOOC Research Initiative	*International Review of Research in Open and Distributed Learning*	105	21.00	26
Zheng, Rosson, Shih, & Carroll (2015)	Understanding student motivation, behaviors, and perceptions in MOOCs	*18th ACM International Conference on Computer-Supported Cooperative Work and Social Computing, CSCW 2015*	101	25.25	25

Notes. TC=total citations; CPY=citations per year; CPA=citations per author.

Figure 5 presents the mapping of citations for documents with a minimum of 20 citations. It illustrates the key authors in the field and how their ideas were situated in relation to each other. Countries of origin are further reflected in Figure 6. The United States, Spain, and China appeared to be the most influential countries, as this was where the MOOCs research authors most often cited were based.

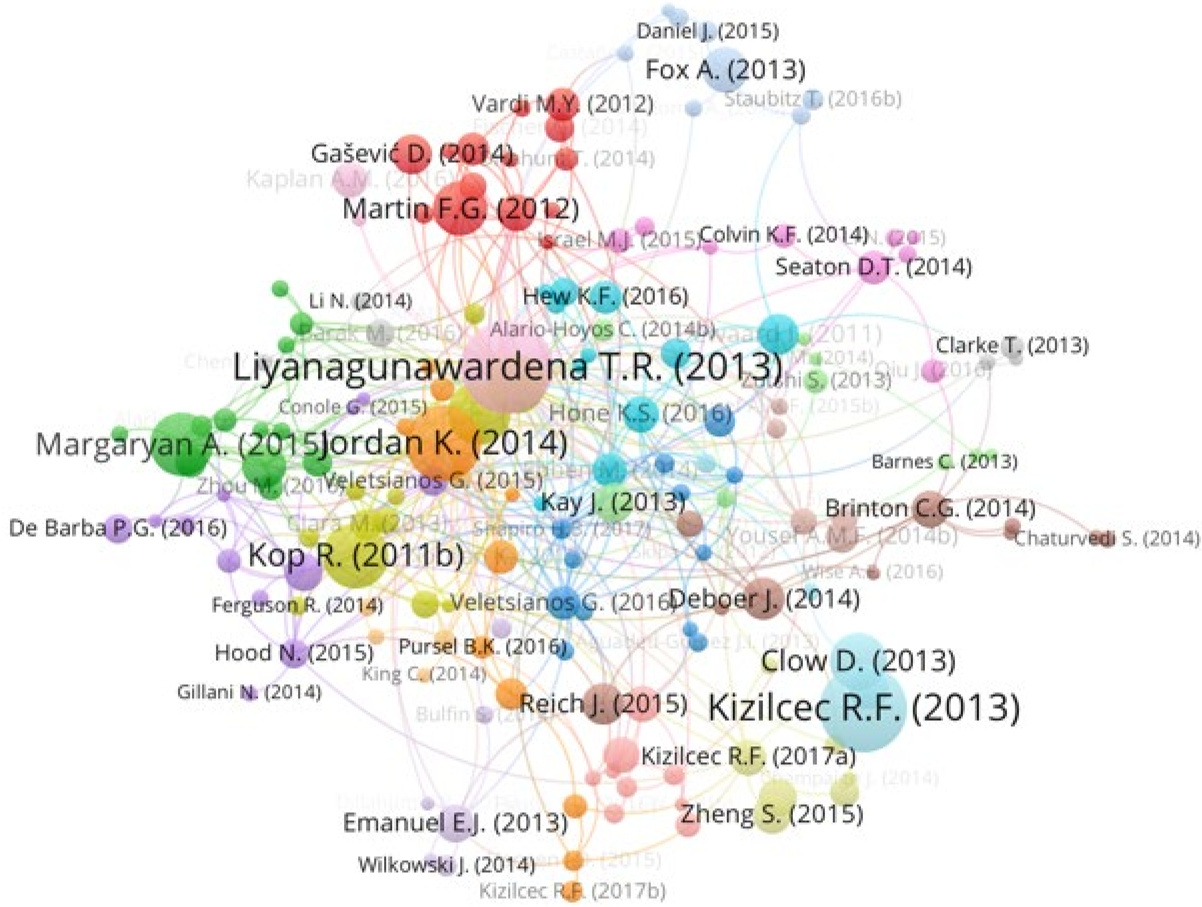

Figure 5. Network visualization map of citations of MOOC documents.

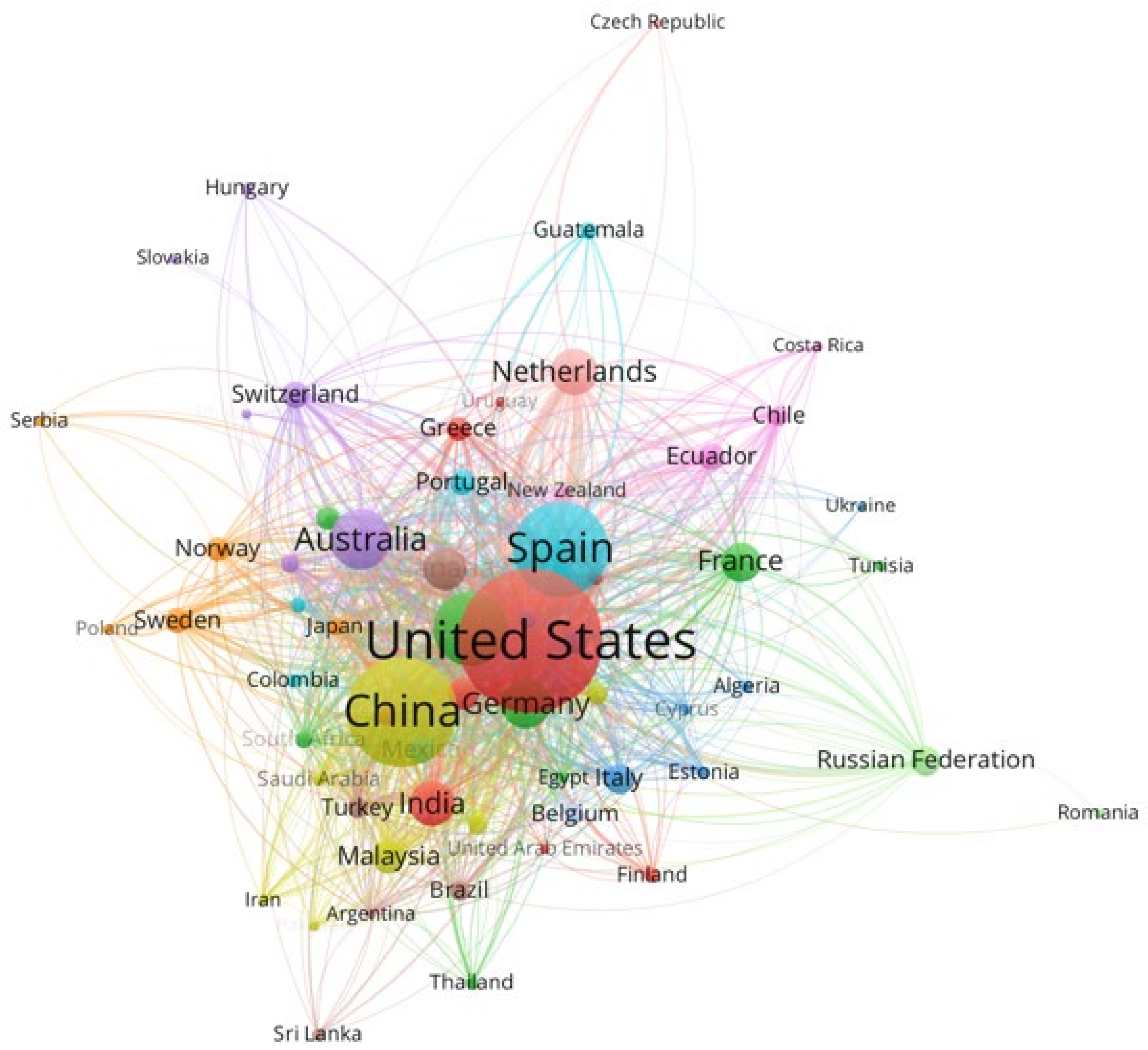

Figure 6. Network visualization map of citations of MOOCs documents by country, with a minimum of five documents per country and a minimum of five citations per country.

Discussion

This study was motivated by two observations. First, MOOCs have been regarded as a tool that contributes towards the universal agenda of addressing the digital divide and promoting equity in educational opportunities (Ma & Lee, 2019), as also stipulated in the Sustainable Development Goal 4 (United Nations General Assembly, 2015). Second, MOOCs have also been suggested as a strategy for the internationalization of higher education institutions (Kerr & Reda, 2019). However, questions have been raised as to whether research on MOOCs is interdisciplinary and conducted collaboratively across different parts of the world. Consultation with people from different local contexts and backgrounds represents inclusiveness, which is important in creating MOOCs (King, Pegrum, & Forsey, 2018). To address this issue, we conducted a bibliometric analysis of 3,118 items of MOOCs literature published during a period of 10 years (from 2009 to July 17, 2019), collected from the Scopus database. We considered three main research questions: (a) how has MOOCs research evolved and been distributed, (b) what key topic areas have been discussed in MOOCs research, and (c) who are the major players in MOOCs research and how have they collaborated. These three questions were analyzed according to different main themes.

With respect to the first research question on the evolution and distribution of MOOCs research, our findings showed that documents on MOOCs appeared in early 2009 shortly after the MOOC acronym was first coined by Dave Cormier and Brian Alexander in 2008 (Zancanaro & Domingues, 2017) and the number grew steadily for the 10 years that followed. The earliest documents on MOOCs were published in two different conference proceedings by two groups of authors, both from Sichuan, China, while another document was from an Italian author, published in the *International Review of Research in Open and Distributed Learning*. This shows that in their early development, MOOCs had been noticed by scholars from the East as well as the West. There was slow development within the four years after MOOCs were introduced (2009–2012). A significant change took place in 2013 when a sudden surge of documents was published, perhaps because MOOCs had received considerable media coverage driven by service providers such as Udacity, Coursera, and edX (Jansen, Schuwer, Teixeira, & Aydin, 2015). The number of documents grew consistently from 2013 to 2019, reflecting increasing interest in, as well as relevance and importance of MOOCs. This finding was compatible with the studies reported by Liyanagunawardena et al. (2013) and Zancanaro, Todesco, and Ramos (2015). Most research on MOOCs was found in journals and conference proceedings in the form of articles and conference papers. The documents most often appeared in titles meant for those working in the area of computer science, information systems, or information technology, and based in the U.S. and central Europe. In addition, most MOOCs documents were published in English, despite flourishing MOOCs delivered in different languages (Lambert, 2020). This suggests that the research has paid less attention to MOOCs as encouraging inclusiveness, and has undervalued their important role in promoting part of the United Nation universal agenda, particularly to achieve Sustainable Development Goal 4 in ensuring inclusive and equitable quality education for all by 2030. The underlying implication is that despite the thriving research on MOOCs, it has aimed mainly at a small, focused group. Potential stakeholders from different areas are missing out on the potential of MOOCs, as well as the latest developments, recommendations, and effects.

Regarding the second research question, our observations on subject areas, keywords, and titles suggested that MOOCs research has been confined mainly within the domain of computer science and the social sciences area, particularly as these relate to education. The clustering of MOOCs research in just two main subject areas is further evident by the keywords most frequently used. These indicated that most MOOCs studies were concerned with (a) education, (b) teaching, (c) students, (d) curricula, (e) learning systems, (f) engineering education, (g) online learning, and (h) higher education. This somewhat differs from Ebben and Murphy (2014), who showed that journals publishing MOOCs research lacked penetration into the traditional fields of study such as the humanities, sciences, and social sciences. Perhaps online and distance education journals, and those in computer science, have speedier publication processes due to rapid changes in their subject matter (Ebben & Murphy, 2014). The narrow disciplinary fragmentation may also due to the complexities of (a) carrying out MOOCs research, (b) framing diverse problems, and (c) aspiring for collaboration (Cairns, Hielscher, & Light, 2020). Therefore, it is important for future research on MOOCs to expand beyond the fields of distance education and computer science into different discipline-based and interdisciplinary research. For instance, a study on employer receptivity to using MOOCs in recruiting, hiring, and professional development (Radford et al., 2014) could create more awareness and use of MOOCs by various bodies or organizations. The expansion of subject matter, key areas, or large-scale field trials in MOOCs research may also help address the problem of abysmal completion rates in MOOCs, and focus on finding what works, where, and for whom (Kizilcec et al., 2020).

As regards the third research question, there seemed to be a reasonable amount of scientific collaboration on MOOCs research across the globe as reflected in our analysis of countries, institutions, authors, and citations. Although MOOCs initially began in Canada, the United States, China, and Spain were the top three countries from which scholarly writings on MOOCs have been published. This finding supports previous studies that found most publications on MOOCs, as well as the vast majority of MOOCs participants, were from North America and Europe (Lambert, 2020; Zancanaro & Domingues, 2018; Zhu et al., 2018a). The U.S. had the highest number of publications on MOOCs, which indicated that it was leading in MOOCs research and, potentially, had directed funding to it. This may be corroborated further by the fact that the U.S. has by far the most top-ranked universities in the world. The U.S., thus, has been in a much stronger position to bring the best possible content from the best schools and best professors to everyone with online access. In addition, most service providers and platforms for MOOCs originated in the U.S. and Europe, and various initiatives such as European OpenupEd supported the proliferation of MOOCs there. The big gap between MOOCs that originated from these countries compared to the rest of the world should be a point of concern, since one of the major goals of MOOCs is to promote inclusivity and equitable educational opportunities that are suitable in all contexts, not only in the U.S. or Europe. Factors such as technology infrastructure (Yousef, Chatti, Schroeder, Wosnitza, & Jakobs, 2014), access to the Internet, and participant literacies that are lacking in other institutions may be some of the factors that have discouraged the research on MOOCs in different countries. The implication of the lack of evidence-based research on non-mainstream consumers could potentially reflect a cultural hegemony that promotes Western values, language, and knowledge systems (Deng, Benckendorff, & Gannaway, 2019). Hence, it is crucial that future research on MOOCs promotes the understanding of different cultural contexts (Gameel & Wilkins, 2019), social needs, and economic development. This will help shape MOOCs that can respond better to different industries, participants, and characteristics across countries (Li, 2017).

Further analysis implies that MOOCs research was mostly collaborative, which is an opportunity for MOOCs studies. Co-authorship represents a valid proxy for collaboration, and it can be assumed that sharing authorship reflected a tangible engagement (Adam, 2013). This study revealed a broad spectrum of cooperation on MOOCs research among scholars, institutions, and countries. Confirming Zhu et al. (2018a) that most collaborations are within an institution and only a small percentage are international, this study revealed healthy cross-country collaboration, though proximity played a role in forging such collaboration. There was little collaboration in MOOCs research across Europe, the U.S., South America, and Asia. This may result in fragmented understanding of MOOCs, confined to geographical, economic, institutional, and cultural circumstances, despite the potential of MOOCs to penetrate across boundaries.

Probing the most often cited documents, those from the U.S., China, and Spain were cited most, but our findings also pointed towards a healthy citation impact from different countries around the globe. Citations of documents from multiple countries implies that authors recognize their scientific community in different geographical areas, which may contribute to forming scientific paradigms (Pan, Kaski, & Fortunato, 2012). Compared to the U.S., China seemed to have had more recognition in terms of citations from central Asia, which coincided with China's aspirations, since the end of the Cold War, to influence this part of the world (Rogers, 2007).

Collaboration is important so that MOOCs may adapt to local contexts (Ichou, 2018) and provide strategic insights into how best to design, manage, and implement MOOCs. Through collaboration, knowledge may be better transferred, combined, and reinforced. Countries can learn from each other's experiences in order to enhance MOOCs potential to encourage knowledge sharing across organizational boundaries. Connections with leading universities and prominent scholars in the area also promote academic reputations and serve to improve the visibility of publications. The transfer and reinforcement of knowledge are closely associated with the spillover of knowledge, which can be key to the successful implementation of MOOCs. It is, however, unclear to what extent collaboration on MOOCs research exists between universities in less developed regions. Collaborations among countries, institutions, and scholars are often associated with the transfer of knowledge and technology, which is extremely important for the world's economies. It is interesting to see how such collaborations monitor and manage the intellectual property aspects that have become critical to controlling original innovations. Views on the danger of MOOCs in reinforcing inequalities in education (Rohs & Ganz, 2015) and MOOCs that help distribute free education (Lambert, 2020) might also be addressed by forging more collaborations with different stakeholders. This effort will serve to encourage inclusive and equal access to education.

Conclusion

This study used bibliometric analysis to undertake a comprehensive overview of the publications relating to research about MOOCs or massive open online courses from 2009 to 2020. Mapping the evolution of MOOCs, key topic areas, and collaborations within a series of categories (i.e., number of published studies per year, sources, languages, subject areas, keywords, document titles, contributing countries, main institutions, authorship, and citations), indicated broad applications of the MOOCs format. Findings showed that early research on MOOCs was carried out by scholars from both the East and the West, and has continuously grown and been widely disseminated since then. Nevertheless, most MOOCs research has focused mainly on the same limited fields of computer science and distance education that dealt with topics connected to the social sciences discipline. This has led to disengagement from other disciplines and reduced the emergence of new ideas and innovation. There has been increasing collaboration on MOOCs research among scholars or institutions from a limited group of countries, implying a lack of perspectives from different economic, cultural, and institutional backgrounds. This evolution of MOOCs in general reflects a rising emphasis on open online courses conducted at a global level, thereby addressing the criticism that MOOCs are decreasing. In addition, collaborations and communications involving MOOCs research, which greatly influence educational decisions and perspectives, are confined mainly to certain geographical areas, and do not represent countries in the greatest need for the benefits of MOOCs. A sizeable increase in investment and dedicated funding to encourage stronger international participation from lesser developed nations will be valuable, and is recommended, to ensure that opportunities in MOOCs may be equally enjoyed and appreciated.

It must be acknowledged that this study relied solely on the Scopus database and on the choice of keywords used in document titles. We did not consider other rich databases such as Google Scholar or documents that discussed MOOCs but may have had titles outside our search parameters. Extending the procedures for text analysis to also include abstracts would likely reveal additional information and frequencies. In addition, some authors or institutions might have registered more than one name into Scopus or provided different spellings, and this may have resulted in inaccurate details on authors' affiliations or productivity.

Despite these limitations, this study contributes to a better understanding of the trends in MOOCs research and publications. Each of the indicators points towards growth in this field of research which may offer more opportunities for bettering current educational systems. This study extends and complements previous findings on MOOCs literature by using bibliometric methods. The current analysis produces several exciting observations that clearly highlight the rising importance of MOOCs in the educational environment around the world, as well as their dissemination, and the need for more research involving cooperation among various regions and different fields. More studies are needed to explore and help balance the education gap that may arise in the context of MOOCs development. Focusing efforts on cultural differences in MOOCs is one likely topic to be pursued. This will facilitate the attainment of educational goals worldwide and ensure that everyone may benefit from MOOCs.

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