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Understanding How to Reduce the Impact of Transactional Distance in Large-Enrollment Undergraduate Courses

by

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Abstract

Universities started to recruit more students to address the issues of funding cuts after entering the twenty-first century. With more students enrolled and stagnating numbers of instructors, higher education institutions decide to enlarge classes by putting over one hundred students into one class. However, large-enrollment courses brought some drawbacks to students, teaching faculties, and the institution. At the same time, based on Moore's theory, big classes also increase the transactional distance, a psychological distance between the instructor and the students. To improve students' experience in large classes and reduce the transactional distance, practitioners have applied various instructional strategies, most of which are supported by technology. To organize the present research, the author conducted this critical literature review to demonstrate how large-enrollment courses increase the transactional distance, how a high transactional distance influences the learning outcomes, and what technological solutions can be applied to achieve a low transactional distance. It is found that large undergraduate courses involve less dialogue between students and teachers, have a high structure with less flexibility and less freedom for students, and require more learner autonomy. However, since students possess different learning patterns and abilities, they also present different levels of learner autonomy. In the end, in-class and out-of-class technological solutions that can be applied by teaching faculties are introduced.

Keywords: large undergraduate class, transactional distance, instructional strategies, technological solutions

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Introduction

The student population enrolled in undergraduate programs increased drastically after entering the twenty-first century, leading to an increase in the number of students enrolled in undergraduate courses (Exeter et al., 2010). Large enrolment classes are a high risk for students, instructors, and higher education institutions. It is reported that classroom facilities need to be improved, lectures lack structure, and there needs to be more discussion in class (Carbone & Greenberg, 1998). Different solutions have been offered for highly enrolled courses, especially within the educational technology community (e.g., blended learning, flipped classes, student response systems), to compensate for the larger societal issues (e.g., reduced funding, differential tuition, and increasing enrolments). However, large enrolment is a complex issue with no quick and easy fix.

Beginning over a decade ago, many universities added Massive Open Online Courses (MOOCs) to their online learning opportunities. However, instructors and students resist this teaching method and prefer to be involved in high enrolment courses. However, big class sizes can be more challenging than teaching a MOOC. For example, large enrolment classes require instructors to reduce what Moore (1993) describes as the 'transactional distance', which is the communication distance (or 'cognitive space') between instructors and learners that often occurs in large classes. Moore (2019) gives the latest definition of transactional distance as "the gap between the understanding of a teacher (or teaching team) and that of a learner".

The purpose of this review is to better understand the relationships between class size, transactional distance, and learning outcome. At the same time, it is designed to provide higher education administrators and facilitators with technological solutions. Since the paper is a

literature review on the topic, it also aims to synthesize the present scholarly literature. It offers effective instructional strategies to address the problems caused by a high transactional distance.

Literature Review

Large enrollment classes have been defined in different ways. Some studies define *huge classes* as any first-year course in which 550 or more students are enrolled (Exeter et al., 2010). De Paola and Scoppa (2011) analyzed the effects of class size on the probability that the student will pass an exam and the grade obtained at exams by experimenting on students from class sizes between 136 and 308. Borden and Burton (1999) investigated extensive enrollment courses of introductory level with 100 to 199 students. In this study, we use Kanuka's (2008) definition of large-enrollment classes, which includes more than 90 students registered.

Transactional distance was first developed in distance learning to understand the relationship between instructors and students. The separation between learners and teachers affects learning and teaching. It also causes a communication and psychological space of potential misunderstanding between the two parties (Moore, 1993). Such a separation is also evident in onsite large enrollment undergraduate courses because the amount and intensity of interactions and exchanges between students and teachers generally reduce as class size increases (Mulryan, 2010). Nowadays, the transactional distance has been reconsidered by scholars. Giossos et al. (2009) stated that transactional distance is one of the results of teaching: the action and structure, autonomy and dialogue are mechanisms. Hence, transactional distance should be examined at the level of the interpersonal relationship between teacher and learner, the relationship among the members of the learner group, and the mediating relationship between learners and the course material.

Moore's (1997) theory of transactional distance can explain the learning relationship between instructor and student in large classes. Transactional distance refers to the psychological or communicative space that separates the instructor from the learner in the transaction between them occurring in a structured or planned learning situation (Moore, 1997, p. 1). In Moore's theory, three clusters of variables control the extent of transactional distance: Dialogue, Structure, and Learner Autonomy. High transactional distance refers to a highly structured learning environment, and teacher-learner dialogue is non-existent (large enrolment classes). On the other hand, low transactional distance is in those learning environments with much dialogue and little predetermined structure (most small classes).

"Learner autonomy is the extent to which in the teaching/learning relationship it is the learner rather than the teacher who determines the goals, the learning experiences, and the evaluation decisions of the learning program" (Moore, 1997, p. 6). The greater the transactional distance, the more autonomy the learner must exercise. Therefore, if it is recognized beforehand that the targeted learners have a predilection for autonomy, the course can be designed in that direction. In undergraduate courses, especially in the first and second years, many students do not have high levels of learner autonomy, leading to high drop-out, time-out, or flunk-out rates (Kanuka, 2008). Moore's transactional distance theory has been developed over the past two decades, and the 2019 edition is applied in this review. However, since the latest version omits some information and only gives updates, some definitions and terms are still retrieved from the previous versions.

Allan (1999) defined *learning outcomes* in higher education as subject-based, personal transferable and generic academic outcomes. Maher (2004) indicated that the most well-known contribution to developing outcomes-based curricula was the publication of *A Taxonomy of*

Cognitive Objectives by Benjamin Bloom in 1956. Bloom's taxonomy provided a framework for classifying learning in cognitive terms that expressed different kinds of student thinking (i.e. knowledge, comprehension, application, analysis, synthesis and evaluation). This taxonomy has been the cornerstone of many outcomes-based curricula around the globe. To better evaluate the learning outcomes in HEIs, Nusche (2008) conducted comparative studies in OECD countries and provided 18 assessment instruments as a typology. The relationship between class size and students' learning outcomes has always been a popular topic among scholars, especially if the classes were online or hybrid. Gordon et al. (2019) found that large in-person undergraduate classes deteriorate learning outcomes, and a hybrid model seems like an approach to address the issue of increasing university enrollment. Other scholars also conducted studies to see which aspects of learning outcomes were affected. Rissanen (2018) indicated that students may not gain too much conceptual understanding in a traditional large class.

Different instructional strategies have been analyzed to study the effectiveness of large-enrollment courses. Smith and Cardaciotto (2011) analyzed the benefits of active learning (versus content review activities) and found that the method helped students gain greater retention of and engagement with the course materials. Chen et al. (2017) studied building a community of inquiry in a large-enrollment online course. They found that the community of inquiry increased students' level of cognitive presence, the perception of social presence, and teaching presence. Lynch and Pappas (2017) also designed a model to facilitate a "small class feel" when teaching large classes. They incorporated teaching methods to improve students' experiences in a big class: recruiting teaching assistants and graders, using narrative assignments to stimulate critical thinking, writing, and reflective skills, small group discussions, and turn-around group exercises.

Besides, technological tools become popular among scholars worldwide for providing a better teaching environment. The student response system is the most commonly used tool in teaching large classes, for example, clickers and backchannel. It allows students to communicate and participate in class discussions (Denker, 2013; Neustifier et al., 2016; Zhang et al., 2023). To meet some students' needs, universities began to provide video classes, either live or recorded, which offer resources for students to learn beyond the space (O'Callaghan et al., 2017; Whitley-Grassi, 2017; Rosenthal & Walker, 2020).

Thousands of studies have been conducted on big classes, transactional distance, and instructional strategies. However, scholars seldom tried to synthesize those studies or provide a panorama of the above topics to familiarize HEIs with their challenges and potential solutions.

Exploring the Teaching Context and Transactional Distance

The following part analyzes the relationships among large-enrollment courses, transactional distance, and learning outcomes. Based on Moore's (2019) theory, how big undergraduate courses increase transactional distance is explained first from dialogue, structure, and learner autonomy. Based on the above three aspects, the influences on learning outcomes are displayed. At the end of this section, effective technological strategies are introduced with empirical studies.

Big Undergraduate Courses and Transactional Distance

The three main factors of transactional distance defined by Moore (2019) are dialogue, structure, and learner autonomy. The following section will analyze how large-enrollment undergraduate courses increase transactional distance. Based on Moore's (2019) framework, this part will display facts from big classes found in the literature and classify them into dialogue, structure, and learner autonomy factors.

Dialogue

Moore (2019) always believes dialogue is a particular interpersonal interaction between students and instructors. Additionally, the extent and nature of dialogue are determined by different factors, including the number of students in charge of an instructor and the course structure; the latter factor is analyzed in the next part.

Fewer Interactions between Teachers and Students in Class. Due to the increased class size, students are less engaged, and interactions between students and instructors become less frequent (Hudson et al., 2014; Mulryan-Kyne, 2010). Compared with small classes where fewer students are involved in the learning process, facilitators teaching a large class with over 90 students or even hundreds of students are less likely to interact with each student due to the time limit and interactions being time-consuming (Bowen & Wingo, 2012). Such a lack of interaction hinders further communication between the two learning parties. Thus, students may be less likely to ask questions, and instructors may not frequently ask about students' concerns or misunderstandings. Also, Kassandrinou et al. (2014) found that tutors' support and interaction are significant in engaging students in class and preventing drop-outs. In other words, the interaction is essential to keep the learning process alive.

Less Feedback on Assignments from Instructors. With the class size increasing, the assessment of student learning is also affected, and individualized feedback becomes impractical with hundreds of students (Winstone & Millward, 2012). Effective feedback usually requires meta-cognitive assessment and guidance, which can be time-consuming and laborious in a big class (Morales-Almazan et al., 2021). Also, due to the time limit and the significant number of students, instructors find it challenging to give different types of assessments, which help realize students' understanding of the class. Even if students are given those types of assignments,

teachers will find it challenging or even impossible to provide feedback to students. Therefore, instructors of large classes are often limited to assessment using multiple-choice exams and other quickly graded assignments (Bowen & Wingo, 2012). Since less personal feedback is given on multiple-choice questions, students lose opportunities to interact more with their instructors about their performance and progress.

Structure

The structure of a course is the set of activities used to familiarize students with course material and encourage them to practice using it (Beck & Rossa, 2020). Moore (2019) explains both high and low degrees of structure based on the flexibility of the course's educational objectives, teaching strategies, and evaluation methods.

First and foremost, most large-course instructors rely on lectures as the primary mode of content delivery due to the class size (Hudson et al., 2014). In this case, instructors are more likely to be the party to share ideas and information. At the same time, students may need to be given more opportunities to talk about their misunderstandings and outstanding questions.

Secondly, the assessment of student performance in a big class is exclusively based on multiple-choice exams and other quickly graded assignments (Hudson et al., 2014). At the same time, different types of assessment are seldom used, including open-ended essay tests, short-answer tests, or writing tasks in general. The multiple-choice tests fail to provide for in-depth processing of ideas by students (Maringe & Sing, 2014).

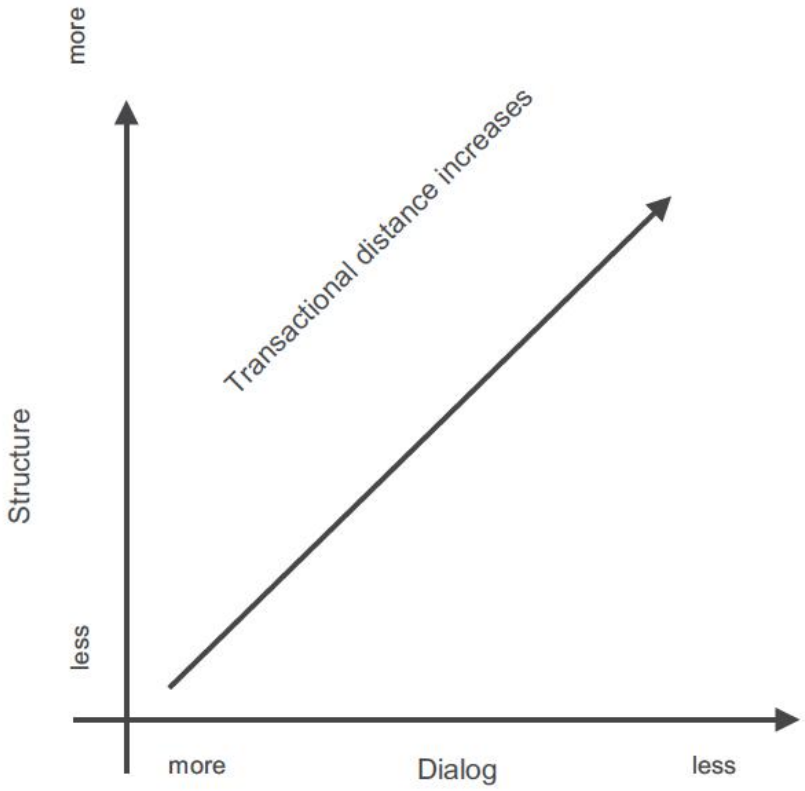
Large-enrollment undergraduate courses, especially intro-level courses, are generally heavily lectured, impersonal with low student interaction, and rely on few high-stakes assessments (Morales-Almazan et al., 2021). They also have some characteristics of a high transactional distance; for example, all activities might be very strictly specified by the

instructor, leaving little room for deviation. Every student needs to follow the same sequence of reading and assignments, and everyone must accomplish each step of the course in a tightly controlled sequence (Moore, 2019).

Figure 1 was made by Moore (2019), which suggests how the transactional distance increases with less dialogue and more structure in a course. As illustrated above, the large classes have a high structure that prevents students from having too much freedom and less dialogue or interaction with the instructor. Ultimately, the transactional distance between students and the instructor increases gradually.

Figure 1

Relation of Course Structure and Instructor-Student Dialogue in Transactional Distance



Learner Autonomy

When the theory of transactional distance was publicly presented, learner autonomy was regarded as the second dimension of independent learning. It was defined as the ability of students to share responsibility for their learning processes (Moore, 1972). To reduce the transactional distance, besides the two variables mentioned above, the knowledge about each student's ability to be engaged with varying degrees of teaching is also vital (Moore, 2019). The greater the transactional distance, the more autonomy the learner must exercise. Therefore, if it is recognized beforehand that the targeted learners incline autonomy, the course can be designed in that direction.

In a big class with over 100 students and only one instructor, students have to take the initiative to learn by themselves; for example, they are expected to prepare before the class and review after class even without being told to do that. Hall and Webb (2014) conducted a quantitative study to investigate the role of autonomy in the student experience in a large-enrollment undergraduate introductory physics course. They found that learner autonomy positively correlates with student adjustment in the course. In addition, the degree of their perceptions of autonomy-supportive instructors is positively related to their performance in the class.

In a big undergraduate course with over 100 students, every learner presents different learning abilities and levels of autonomy. It can be inferred from Hall and Webb's (2014) study that students with low autonomy are less likely to adjust themselves to the learning environment; for example, they may fail to meet instructor expectations, assignments may be challenging to complete, or they may not be able to understand in class. The failure to adjust is bound to result

in a psychological distance between the instructor and the students, which is a high transactional distance.

Transactional Distance and Learning Outcomes

Since the large size of undergraduate courses increases the transactional distance, this change is bound to influence the learning outcomes somewhat. Learning outcomes refer to the specific knowledge, practical skills, areas of professional development, attitudes, or higher-order thinking skills that instructors expect students to develop, learn, or master by the end of their learning (Suskie, 2009).

According to Ekwunife-Orakwue and Teng (2014), the transactional distance between students and the instructor affects students' intrinsic motivation, learning experiences, and learning outcomes, measured by student satisfaction and grades. This part will examine how the high transactional distance in a large-enrollment undergraduate course influences the learning outcomes.

Dialogue

Ekwunife-Orakwue and Teng (2014) found that increased dialogue will improve student learning outcomes. The dialogue includes Learner-Instructor interaction, Learner-Learner Interaction, and Learner-Content interaction. Even though those three types of interactions influence students' learning outcomes to different degrees, students are likely to have higher satisfaction rates. With more interactions in the learning process, students are given more chances to share their thoughts and receive answers and feedback from the instructor.

Additionally, Kang and Im (2013) classified the interactions into instructional interaction and social interaction; they found that instructional interactions positively affect students'

learning achievement and satisfaction as learning outcomes than social interactions. However, they also summarized that these two types of interactions positively influence learning outcomes.

Based on the two studies, dialogue plays a vital role in learning outcomes. The learning outcomes are satisfying if there are more interactions, especially instructional interactions concerning the course content, between the students and the instructor (low transactional distance). On the contrary, fewer interactions (high transactional distance) are detrimental to the learning outcomes.

Structure

In the previous section, we found that the structure of big classes increases the transactional distance in the following ways. For example, the courses are heavily lectured with no other delivery formats involved, they rely on a few high-stakes assessments such as multiple-choice questions, and students have almost no flexibility or freedom in the learning process.

Large lectures are encouraged as a viable option for delivering course material in large general education courses in higher education institutions (Jacobi & Cvancara, 2019). It is difficult for teachers to incorporate interactive, discussion-based, and student-centred teaching in a traditional lecture format. Students are more likely to be passive listeners instead of actively participating in the course discussions since fewer opportunities are given, considering the significant number of students registered in one course. Consequently, those students demonstrate limited thinking skills and depend primarily on low-level learning skills, emphasizing memorizing textbook knowledge. Students also find learning in large classes extremely challenging and dissatisfying (Maringe & Sing, 2014).

Multiple-choice questions are used in over half of the undergraduate courses, especially in lower-year and high-enrolment (over 95 students registered) courses (DiBattista & Kurzawa, 2011). Melovitz Vasan et al. (2018) analyzed how multiple-choice (MCQ) versus open-ended questions (OEQ) influence students' performance in an anatomy course. They found that the OEQ format created more challenging expectations and motivated students to develop an effective strategy for in-depth learning (conceptual understanding instead of simple memorizing) compared with MCQ, which favours memorization only. Even though this study was conducted in a small group, we can still infer that multiple-choice questions might not be an ideal way of assessment to achieve satisfying learning outcomes in a small class and a giant class with over 90 students in the same room. Additionally, instructors cannot provide too much personal feedback based on multiple-choice questions since there are specific right and wrong answers, and this lack of feedback fails to give the students suggestions on how to improve their study.

Less flexibility exists in large-enrollment undergraduate courses, which increases transactional distance; for example, students are required to follow the same reading sequence and accomplish each course step in a tightly controlled sequence (Moore, 2019). With over 95 students in one class, students' learning abilities and learning needs vary. However, since the course structure is inflexible, facilitators can hardly make a teaching plan that meets individual student's needs. Gradually, students may lose interest in the course and become dissatisfied with the teaching.

Learner Autonomy

Students vary in their ability to exercise autonomy; some might want greater freedom in some courses than others. Also, with greater transactional distance, it is more necessary for the learners to exercise autonomy (Moore, 2019).

Based on Moore's (2019) theory, since large-enrollment undergraduate courses have low structure and less dialogue, students are expected to be more autonomous. However, students in the same class are very likely to present different levels of autonomy; some students can prepare before the class, review after the class, and finish the assignment with enough attention, while others may be the opposite. Under these circumstances, those students who fail to learn actively will find it difficult to follow the class instructor and eventually lose attention and interest in that course. The psychological distance between those students and the instructor will become greater compared with students who prepare well in advance and are attentive in class. Consequently, a higher transactional distance is made between the two parties.

Technological Instructional Strategies and Transactional Distance

Hanover Research (2010) delivered a report exploring common strategies and guidelines universities use to teach high-enrollment undergraduate classes in the United States and worldwide. Four areas of strategies commonly employed are introduced:

1. Preparing the class with a clear structure and set of expectations and communicating those to the students (organization)
2. Actively engaging students with the course material, fostering student-faculty interaction and organizing smaller group meetings for students outside the classroom (teaching strategies)
3. Using technology to give lectures and using audience response systems (in the classroom)
4. Creating electronic forums and sharing information online (out of the classroom)

Based on this report, some technological tools which can be used in a large classroom to reduce transactional distance are introduced in this part. These strategies are classified into

"technology in the classroom" and "technology out of the classroom". The following section details these strategies and explains how they reduce transactional distance in a big class.

Technological Strategies in the Classroom

Audience response systems create an environment where students can participate in a big class to achieve active learning (Hanover Research, 2010). Clickers and backchannels are two popular tools for instructors to apply in a big classroom to get students involved in the learning process. These strategies create opportunities for more dialogue and interaction between students and teachers.

Clickers. The clicker is a small device that looks like a remote control and generally includes a ten-digit numeric keypad and some additional keys (e.g. "yes" and "no" buttons), allowing students to give a variety of simple responses to questions. This technology will enable professors to collect different types of feedback from students in a large-enrolment class and has received positive feedback from both students and professors to stimulate interactive learning environments (Hanover Research, 2010). For example, instructors can give multiple-choice questions and ask students to finish them. Based on students' performances in the whole class, the instructor can have a general idea of how well the students have grasped the knowledge.

Bojinova and Oigara (2013) researched microeconomics and physical geography courses to analyze students' attitudes toward using clickers. 80% of the students in the geography course and 90% in the microeconomics course believed that the class discussions following the clicker questions were beneficial in understanding the course material. All students in the two courses indicated they benefited from the instructor's and their peers' immediate feedback.

Besides completing multiple-choice tasks, clickers allow students to express themselves more freely while remaining anonymous, for example, initiating quick polls. Thus, students can

freely express themselves, and more interaction can be prompted. Holland and Schwartz-Shea (2013) found that almost 70% of students in their classes thought clickers helped express views on politically contested topics. Also, 7% of students supported that using clickers in a controversial class makes it easy to voice their opinions without worrying about being judged or emotionally degraded by peers.

Backchannel. *Backchannel* is a technology-mediated communication tool facilitating a secondary electronic conversation during a lecture or instructor-led learning activity. Backchannel technology can allow students in large lecture courses to communicate with each other and the instructor. This technology enables instructors to capture, summarize, and integrate student questions, ideas, and needs into course content.

Du et al. (2012) did a field study of ClassCommons, a backchannel platform, in a Human-Computer Interaction class in the Fall of 2011 at a large university in Northeast America to evaluate students' appreciation of backchannel. Two screens were installed in the classroom; the backchannel platform was displayed on the smaller screen on the right, while the teacher's slides were on the larger one on the left. After gathering the postings and classifying them based on the topics, the study found that the backchannel platform actively engaged students to make comments, ask questions, discuss class subjects, offer and ask for help.

Apart from different platforms, using Twitter for communication in academic settings is often called a "backchannel". For example, with an established conference hashtag, attendees can engage in conversation and share resources. In an economics class, Jones and Baltzersen (2017) asked students to discuss business cases through Twitter with a hashtag of their group number in class and displayed the tweets on a screen. They highlighted the relevant tweets and sometimes called upon the student to comment or expound upon their tweet further. They

surveyed at the end of the term to understand students' perceptions of using Twitter in class. 95% of the students agreed that using Twitter increased their participation, and 85% agreed to recommend using this method in the future. More than 70% of the students agreed that using Twitter improved their understanding of the subjects and believed Twitter was a valuable resource for the class. In short, the study found that using Twitter leads to increased student participation and engagement.

Technological Strategies Out of the Classroom

Learning should be completed both in class and out of class; the technological tools are only helpful for students to be attentive in class. Even though the following strategies are regarded as supportive outside the classroom, the nature of those tools is to strengthen students' in-class learning.

Flipped Classroom. This model encompasses a lot of other teaching methods. It is an approach where students watch the lecture before the class, and in-class time is for inquiry, application, and assessment" (Jungic et al., 2015). According to the survey by Jungic et al. (2015), the flipped classroom model encourages students to take a more active role in the learning process, including interactions among students and between students and the instructor. Balaban et al. (2016) also found that students' final exam performance improved by 0.5 standard deviations in an introductory course in Economics (with 300-400 students in one session) after employing a flipped classroom model.

Large lecture classes often give students little time to discuss and engage with the material in or out of the class (Hanover Research, 2010). To combat this problem, universities have begun to adopt technologies that allow students to engage with course material in electronic forums, including social networking sites like Twitter, Facebook, and WhatsApp and course

management software (CMS) like Blackboard and Canvas. These platforms create a place where students and faculty can discuss and share information outside the lecture hall.

CMS is an integrated set of web-based tools for course administration and delivery. Different platforms aid faculty members in meeting their instructional goals. Course materials, such as a syllabus, PowerPoint slides, readings, assignments, and web links, can be uploaded to the course and accessed anytime. Students can also communicate with their peers and complete online discussions. In turn, faculty can evaluate assignments, provide feedback, and post scores within the CMS, enabling students to know their standing in the class at all times. Finally, the learning modules tool helps faculty keep classroom materials organized and communicate expectations to students concerning what they should be learning and how course content fits together.

CMS or flipped classrooms rely heavily on learner autonomy since too many assignments must be completed before or after the class, and students must work on them actively without too much supervision from the instructor. McCabe and Meuter (2011) studied students' perceptions of using Blackboard at a Californian business school. They found that the "course content" tool is the favourite for students and "encouraging active learning" ranked the fourth most important of the seven principles. Based on this survey, it can be inferred that the CMS promoted learner autonomy to some extent.

Twitter. In this paper, Twitter is listed as a separate strategy outside of the flipped classroom because this tool serves as an electronic forum and forms a community among students. Twitter can be a backchannel platform where students share comments, resources, and opinions for in-class usage. However, we focus on the usage after class in this section, stating

that Twitter fosters a sense of community and belonging by allowing students to maintain discussions outside of class (Jones & Baltzersen, 2017).

Ross et al. (2015) launched a study to test the outcomes of using Twitter as a learning tool in three large courses: Geography course (700 students), Psychology course (350 students), and Nursing course (350 students). Each course was divided into a control group and an experimental group. The scholars used a six-point Likert scale to see students' comfort level with using Twitter both in and out of class; 44.3% chose comfortable, and 18.3% very comfortable. Also, students participating in the Twitter portion of the course were significantly more likely to perceive that it is easy to find support from peers outside of class and agree that there is a sense of community among students and instructors.

Moreover, since a hashtag is made for the course and the information is public, individuals outside the classroom can also participate in the discussion (Jones & Baltzersen, 2017). Those participants may be professionals in a specific field or previous students who can bring more case studies and novel opinions to the class. With those different contents, the class is more flexible and is organized towards a low-structure course.

By using Twitter outside the classroom, more dialogue and a lower course structure are achieved to reduce the transactional distance between the students and the instructor.

Virtual Office Hours. Instead of meeting with students in person, virtual office hours can address issues related to low attendance and yield productive interactions between the two learning parties (Andrade et al., 2020). This strategy increases the opportunities for interactions beyond time and space.

Unlike most other studies gathering student data, Andrade et al. (2020) interviewed three teaching faculties in engineering programs about their perceptions of using this new way to

communicate with students. Professor A stated that typically quiet students participated in the VOH and were comfortable asking questions while they were hesitant even to raise their hands in class. Moreover, more students joined the VOH than in actual office hours. Professor C also found that assignment participation and scores were higher with VOH.

Such a novel way to have office hours encourages timid students to have more conversations with the teaching faculty, and the learning outcomes improve under some circumstances. VOH can be applied through many platforms, for example, Zoom, Teams by Mircosoft, and Google Meetings.

Conclusion

Large-enrollment classes are an ongoing instructional challenge many instructors and students face in publicly funded universities (Kanuka, 2008). Scholars and instructors have applied and invented different instructional strategies to meet the challenges of teaching a big class. Learning outcomes are expected to be maintained or even strengthened through strategies to achieve active learning and foster student-faculty interaction. Different instructional strategies are introduced after collecting abundant up-to-date data from the University of Alberta library database.

This review presents how large undergraduate courses increase the transactional distance from the literature. Based on Moore's (2019) transactional distance theory, the facts of less dialogue, high structure, and various levels of learner autonomy result in a high transactional distance in massive undergraduate courses. In the next step, the high transactional distance deteriorates students' learning outcomes. Finally, in-class and out-of-class technological tools are introduced to help teaching facilities address this issue, and most of these tools achieve more dialogue between students and teachers.

However, this review needs to pay more attention to the disciplinary differences due to the limited time and insufficient empirical studies after 2010. There might be differences in choosing strategies and ways of interaction based on the nature of the discipline (i.e. natural science courses versus social science and humanities courses). Researchers are expected to delve into instructional strategies in a specific domain.

This paper overviews the technological instructional strategies applied to large-enrolment undergraduate introductory courses. More research is needed in big undergraduate courses to examine further the feasibility of using the above techniques to improve learning outcomes. The critical literature review is hoped to benefit educational practitioners and researchers as they continue to investigate and build a knowledge base of instructional strategies for large classes.

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