Reflections on Multi-campus Teaching in a New Manufacturing Engineering Program

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Abstract

In 2019, the University of British Columbia (UBC) initiated a new multi-campus manufacturing engineering program involving two campuses situated over 450 km apart. Each institution is responsible for managing its own curriculum and specialization within manufacturing engineering, with some courses being taught in a multi-campus instructional (MCI) format. Although well established in some areas, managing and delivering a new program in a multi-campus format presents several challenges, exacerbated by COVID-19, administrative hurdles, cultural differences between campuses, and institutional context including lab equipment.

Two case studies representing two courses in the manufacturing engineering curriculum are examined with an emphasis placed on challenges encountered, adaptation to a changing teaching environment, and student experience of teaching and learning. The course instructors are interviewed with narratives examined through an interpretivist paradigm using inductive thematic analysis to explore themes, challenges, and the instructor's experience teaching MCI. Reflections on emerging themes and their connection to manufacturing engineering and Education 4.0 are discussed, with both opportunities and challenges for continuing program growth elucidated. Finally, understanding that multi-campus education is of growing interest to the community, some recommendations and best practices are proposed.

Introduction

Higher education has benefitted from the multi-campus system for many years by providing students with greater opportunities by expanding the physical presence of universities to different locations while maintaining the quality of education. The presence of campuses in diverse locations increases students' choices [1]. Additionally, the multi-campus system recognizes that the strengths of different campuses complement each other [2].

Conventional models for the multi-campus system treated campuses in different locations as distinct educational institutions with the same core values and regulations and/or one governing body. This type of multi-campus system is usually referred to as the satellite model [3]. However, in recent times, efforts have been made to integrate campuses not only from an educational values and regulations standpoint but also from an instructional perspective. One of these efforts is multi-campus or multi-cohort instruction, in which students attend the course in groups (cohorts) separated by physical distance (i.e., different campuses) without directed cross-cohort communication. In this method, cohorts of students are clearly defined, where groups of students are identified by the campus or classroom where they synchronously experience the course [4], [5].

Although this teaching method brings several advantages to the multi-campus system, such as leveraging the special expertise of faculty members in different campuses and bridging the cultural

boundaries [6], it poses challenges [7], specifically in its implementation. Ensuring equity and fairness in teaching between cohorts and establishing rapport between the instructor and the remote cohort are examples of these challenges [2]. Furthermore, challenges related to information and communication technology (ICT) have a critical impact on the successful implementation of multi-campus instruction [5], [6], [8]. Despite the significant innovations in ICTs and their integration into educational settings as part of Education 4.0 to enhance instructional, pedagogical, and technological processes, critical challenges persist [5], [9]. These include the lack of proper digital infrastructure and access to technology, resistance to change among instructors and administrators, and, more importantly, the absence of training opportunities for instructors [10].

Despite these challenges, recent efforts have been made to build a robust framework for the effective implementation of multi-campus instruction. Educational institutions are striving to minimize the challenges associated with multi-campus instruction by providing a structure for exploring the subject through conceptualization, design, delivery, and maintenance of multi-campus courses [11]. UBC is one such institution, with campuses in Vancouver, and the Okanagan, which are over 450 km apart from each other. The multi-campus program offered in the Faculty of Applied Sciences at UBC is the undergraduate Manufacturing Engineering program. It is the first-of-its-kind within Western Canada to be offered across two campuses, and it is a relatively new program, with the first cohort of students starting in 2019. On the Vancouver campus, the program was developed and hosted together by Mechanical Engineering and Materials Engineering. On the Okanagan campus, the program is hosted by the School of Engineering [2].

Two courses in this program, namely Production Systems Management I and II, are delivered in a multi-campus instruction format. In this format, instructors teach the course from either the Vancouver or Okanagan campus, while students on the other campus receive the teaching synchronously through videoconferencing, currently one of the attractive methods in online and multi-campus teaching [12] [13] [14]. Production Systems Management cover topics including lean manufacturing, process design, supply chain management, production efficiency, operations management, capacity planning, and quality control.

In this paper, instructors, who have been teaching these courses for multiple years, are interviewed to better understand the challenges encountered during the delivery of these courses in an MCI format and the practical methods they adapted to improve the efficacy of their teaching. In these practical efforts, the instructors not only relied on their personal experience, reflecting the instructor's viewpoint, but also sought to incorporate students' feedback to include the students' perspective in their progressive measures.

The current paper is structured as follows: firstly, the methodology employed in this study is presented. Following that, the analysis of the interview data will be conducted and outlined. Subsequently, the findings of the analysis will be discussed, leading to the derivation of key conclusions. The focus of this study is on the instructor experience of teaching, where their insights are intended to support a greater understanding of the challenges and benefits associated with multi-campus instruction in engineering.

Methodology

Two interviews were conducted of instructors engaged in multi-campus instruction, constituting the totality of instructors engaged in this format of instruction within the program. These interviews addressed their experiences in teaching in a multi-campus format, including how it contrasted against teaching in a single cohort format. Participants were selected for their experience teaching in a new multi-campus engineering program to develop themes related to early challenges in establishing effective multi-campus instruction.

The interviews were semi-structured and included questions in the following areas:

1. Establishing teaching background in both single cohort and multi-campus formats.
2. Exploring how the multi-campus course is structured and what technology is used.
3. Discussing challenges and benefits of teaching a multi-campus course.
4. Exploring specific topics such as workload, travel, equity, start-up/tear down procedure, use of technology, labs, time commitment, and teaching assistant dynamics.
5. Detailing resource discrepancies and site-specific challenges.
6. Closing with what has gone well, what can be improved, and any other comments regarding the experience of teaching in multi-campus format.

Interviews were audio recorded and transcribed, with coding conducted using NVivo [15]. Codes were first developed *a priori* with a focus on sentiment analysis and identifying emerging themes inductively through an interpretivist paradigm. As only two interviews were conducted, the purpose of the analysis was to highlight themes that may be apparent in related contexts without proposing that the themes are universally applicable to multi-campus instruction. The context includes new multi-campus programs in North America that specialize in engineering, specifically manufacturing and industrial engineering.

Analysis

Several themes emerged from the interviews with ~260 references coded across both interviews.

Background

Both instructors have over five years of experience teaching and have each taught multi-campus courses at least twice. Their experience teaching overlaps COVID-19 restrictions, meaning that classes were taught in a variety of formats with a wide range of student expectations depending on the year and institutional requirements. When teaching students remotely outside of the classroom, instructors at this institution were expected to use Zoom [16]. Both instructors continue to teach in both single cohort and MCI formats within the program.

Theme 1: There is increased hardship in teaching a multi-campus course.

In both interviews it was clear that there are additional expectations and hardships associated with teaching in a multi-campus context. Those interviewed were able to draw a direct comparison in workload between single cohort and multi-campus courses, in some cases in the same semester, with multi-campus courses identified as being significantly more work. Compared to a single cohort course, multi-campus instruction can have a greatly increased

administrative workload. This workload includes hiring of additional teaching assistants, training and technology preparation, travel to remote sites, shipping materials such as exams between campuses, coordinating exams across campuses, and managing technical difficulties.

Where possible, it is valuable for the instructor to visit the remote sites to build an in-person rapport with those students. This question of travel, whether by students or the instructor, has been explored by others as well [17]. One participant expressed that appearing in-person at a remote site increased classroom attendance substantially during the visit, despite regular, local facilitation by a teaching assistant. Travel is both time consuming and costly. One participant stated that "I covered the cost [of travel] through my research or other funding resources that I had" rather than an administrative or course-related resource, demonstrating both the importance and professional cost of maintaining a high-quality student experience. A further complexity with travel is that instructors engaged in research activities or teaching more than a single course may have to make special accommodations for being away to visit another campus at least once per semester.

Setting up a multi-campus course requires more time than other technology-enabled courses as cameras and microphones at multiple locations must be configured and checked. Coordination is required with remote facilitators, and time must be given to students at remote locations to ask questions in advance of the lesson starting. The static workload for the course is also higher, as more TAs must be hired and coordination between campuses must occur to arrange shipping of final exams and handwritten assessments. Meetings must be held with remote TAs to ensure appropriate facilitation at each location and proactively correct emergent concerns with student experience within each cohort.

In the classroom, one participant indicated a preference to combine both teleconferencing and Zoom to facilitate easier access to the instructor for remote students. This approach involves managing multiple pieces of communications technology while conducting a lecture. Addressing questions in person through a raised hand while concurrently tracking camera feeds of remote classrooms and raised hands in Zoom is mentally taxing and can slow the pace of lectures. Some students are not comfortable with asking questions during a lecture, which means more time must be allocated after the lecture to address questions from remote students who prefer to hold a discussion without such a large (multi-campus) audience. One participant indicated that teaching a multi-campus requires an additional 30 minutes before and after each scheduled lecture.

Early career instructors also suffer hardship through student evaluations of teaching in multi-campus courses. It is said that in distributed learning equity means "making all students equally miserable." It is much more difficult to assess the sentiment of a classroom remotely, and while surveys can help capture concerns from students, a lack of in-person rapport can lead to less disclosure about the student experience of learning than in single cohort classrooms. As a result, student evaluations of instruction at the end of term may be adversely affected or may diverge from instructor expectations based on local engagement. Even if the instructor solicits feedback during the course, as one participant indicated, "I'm not sure that the positive feedback will be reflected on the course evaluation."

Although context-sensitivity in teaching is essential [2], [6], similarities between the campuses explored in this study mitigate the need and commensurate complexity to adjust activities for each location. The same course material was taught in all locations, meaning that extra work was not required to tailor the courses for each learning context. Although Zoom was used in the classroom, the tool worked well and was not a major technical challenge. Engaging in activities using Zoom also permitted the instructor to get to know some students in remote cohorts, meaning that some rapport could be established remotely as well.

Theme 2: There is extensive experimentation with technology and tools to enhance engagement.

Achieving excellence in teaching a multi-campus course requires ongoing experimentation with pedagogy and class format. Study participants stressed that achieving a high-quality learning experience has prompted them to try something significantly new every year. Examples include traveling to meet with remote students, curating exams for each location to accommodate different exam schedules, incorporating or removing technology from the classroom such as Zoom, hybridizing the course, implementing group projects and case studies, adding or removing teaching assistants, and attempting a flipped classroom.

A problem consistently identified by the participants is boosting remote student engagement with the course. One participant stressed, "… if you ask me, the most challenging thing is to keep the students engaged during the lecture." Student engagement is lower when they are observing a screen, even in a classroom setting, requiring creative solutions to build engagement without relying purely on externalized incentives such as grading attendance. Although some best practices have been established in teaching a multi-campus course, they cannot always be adapted and implemented in every type of course [6]. One participant stressed that successes and failures are also situationally dependent, with purely remote teaching being much more acceptable during the COVID-19 pandemic and much less acceptable to students in a local cohort only two years later.

Theme 3: The quality, suitability, and training of remote teaching assistants has a tremendous impact on the success of the course.

Each participant had a very different experience with teaching assistants. In one case, the remote teaching assistant was knowledgeable in the subject material and had prior experience with the course. This combination of expertise and prior experience allowed the teaching assistant to facilitate the remote classroom effectively and answer technical questions with minimal interruptions for the instructor, leading to a positive experience for both the instructor and students. The instructor did keep a channel open via Zoom for the teaching assistants to communicate questions to the instructor when needed.

In the other instance, a negative teaching assistant experience had a strong impact on both student and instructor experience, as described from the instructor's perspective. The remote teaching assistant was hired shortly before the course began with minimal input from the course instructor and lacked training in both the subject material and facilitation. The instructor was often interrupted by questions from the teaching assistant, who was unable to convey a suitable

teaching presence in the classroom. The result reflected poorly on the instructor who witnessed frustration in the remote students but lacked the means to correct the problem.

A recommendation expressed by both instructors is that scheduling teaching assistants for multiple years, if possible, is very important in multi-campus instruction as they play a much more significant role as facilitators than conventional teaching assistants in single cohort course. Some institutions choose to hire faculty to facilitate remote classrooms rather than depend on teaching assistants.

Theme 4: Administrative hurdles add unnecessary complexity to delivering the course.

Aligned with themes of instructor hardship, the disproportionate administrative burden of a multi-campus course emerged as a theme. Administrative hurdles in Manufacturing Engineering courses include lab scheduling, exam scheduling, room scheduling, facilitating student feedback, cross-listing a for-credit course across institutions, accreditation, teaching assistant hiring, identifying the responsible party at each institution, and arranging shipping of student work product for review and evaluation. One participant claimed that "… the work that we are doing for multi-campus courses, I think it's double in comparison with delivering one in-person course…" while another indicated, "Well, yeah, the amount of work is, to be honest, totally different than the other courses that is in-person where we have just one cohort."

Scheduling is challenging if the associated institutions are not accustomed to consulting with each other and working together. Courses tend to be scheduled early in the morning or in the evening to avoid scheduling conflicts at all affected institutions. The rooms available to a teleconferenced course are typically limited at each institution, meaning that there are further administrative challenges in arranging course schedules to overlap at each institution. Labs and tutorial activities tend to have greater flexibility, but if there is instructor involvement then they, too, must be scheduled with availability and timing constraints applied by multiple institutions.

Aligning final exams to ensure that all students across institutions are conducting exams at the same time can be a challenge, where one participant stated, "I designed two types of exams. One for [the local cohort] and one for [the remote cohort]… so one of the nightmares that I have is final exams." For them, creating two exams was easier than coordinating with administration to ensure that exams occur concurrently for both cohorts.

Engineering program accreditation requires that many courses in the program submit samples of student work, assessments, and other evidence that students have met learning indicators at the set threshold. Each institution involved with a multi-campus course may have different expectations on what the course would offer their respective program for the accreditation process. Consequently, an instructor may need to provide multiple sets of data depending on the requirements detailed by each institution.

Each institution in which the course is offered may also have different procedures for academic concession, student data collection, student support systems, and administrative organization. Rather than navigating a single system with a small number of contacts, a theme of learning the institution-specific system and appropriate contacts at each location emerged, though the burden

was not great as the campuses involved in this study are closely connected with many overlapping administrative services.

Theme 5: A pure ICT solution is not best for supporting equity and encouraging engagement.

Whereas multi-campus teaching is traditionally seen as an instructor in a teleconferencing-enabled classroom with a local cohort, teaching to both local and remote cohort(s), the participants interviewed for this study stressed that they have worked with a combination of remote/distance teaching technologies such as Zoom alongside traditional teleconferenced classroom solutions.

The need for creative solutions is connected to Theme 6 and the desire to provide a high quality, positive experience for the students. One participant claimed, "… if you have multi-campus teaching without proper preparation, without proper infrastructure, that would deprive [students] of their basic things that they can get from in-person classes." The challenge in multi-campus teaching goes beyond the immediate technology available in an ICT-equipped classroom.

Three modes of teaching were shared in the interviews. One, fully remote, did not have a local cohort as the teaching took place during the COVID-19 pandemic. Attempts at persisting this mode once the pandemic had concluded was met with resistance from local students. The second mode was fully teleconferenced, where remote students were inclined to express concerns about lack of access to the instructor raising challenges in cohort equity. The third mode was using a combination of teleconference-enabled classrooms and remote communications technology such as Zoom to provide an easier pathway for students an/or teaching assistants to reach out to the instructor directly without the need to raise a hand or seek attention through the camera system. Related to Theme 2, participants stressed the need for constant experimentation and adaptation to the changing preferences of students each year.

Theme 6: Teaching a multi-campus course is rewarding and has distinct benefits.

Despite the challenges of teaching in a multi-campus context, the participants advocated for the benefits of multi-campus instruction during the interviews. Exposure to a larger group of students, particularly a higher number of deeply interested and engaged students was a strong incentive for the participants to continue teaching in this format, despite the challenges. Meaningful remote student relationships were realizable provided the remote student was interested in the course content and made an effort to engage the instructor through the technology available. One participant indicated "The students at [local cohort] and [remote cohort] could work together, and they could get to know each other, and it was really good." Teaching in a multi-campus context also exposed the participants to colleagues at other institutions and promoted other types of collaboration outside of the classroom.

Participants repeatedly stressed the importance of care and quality in their narratives, suggesting that they feel the quality of their multi-campus courses is particularly at risk. A similar appeal to the importance of quality was not made for their single cohort courses. Participants asserted that, "I did my best to satisfy the students" or "[we] all try out best to teach the students" throughout the interviews.

Discussion

Six themes were identified through the interviews conducted that highlighted some of the differences between teaching in a single-cohort and multi-campus contexts. There was a strong stress on added hardship apparent from the descriptions of workload provided, with greater uncertainty related to remote student experience and engagement. Administrative hurdles, additional teaching assistants, and protracted lecture duration lead to time commitments estimated to be double that of a conventional course. Instructors are expected to constantly experiment with pedagogy, adapt to changing student expectations, and work with administrators at multiple institutions, all while exploring methods of achieving greater student engagement and quality improvement for the course.

This study engaged a small number of participants specific to Manufacturing Engineering, meaning that the themes are limited in their scope of application. The themes identified are consistent with other institutions and programs pursuing multi-campus instruction, with slight variations specific to the context explored in this paper. Additional narratives may elucidate new themes or place those themes captured in a new context.

Throughout the interviews, suggestions were also made, often as self-reflective comments, describing what can be improved in the multi-campus teaching experience to improve overall student and instructor experience. The specific recommendations are:

1. Teaching assistants that serve as remote facilitators must be hired well in advance of the course delivery to allow adequate time for training with contracts ideally lasting multiple course deliveries to help justify the added training time. The course instructor should have a strong say in teaching assistant selection and should have the option to interview candidates. This recommendation is tied closely to Theme 3.
2. Advocating for seamless scheduling and course coordination should not be the responsibility of the instructor. Prior to delivering a multi-campus course, administration should have practices in place that allow for harmonization of schedules across campuses and concurrent delivery of exams.
3. Directors and Heads must recognize the added hardship, effort, and risk associated with teaching a multi-campus course. Instructors willing to commit twice normal effort while adopting more risk should be compensated accordingly, with full acknowledgement of adjusted expectations on student feedback during any career advancement and tenure proceedings.

Synthesizing the themes listed above with information collected indirectly from students and administrators involved with the program, some recommendations can be made to reduce the burden on instructors involved in a new multi-campus manufacturing engineering program. These include:

1. Training programs specific to multi-campus education targeting administrators, staff, faculty, and teaching assistants intended to introduce best practices and strategies [6], [11].

2. Establishing protocols for synchronizing assessments and synchronous lecture periods between campuses, including the transport of exam papers and lab work between campuses.
3. Providing new instructors with teaching credit or additional compensation to acknowledge the added burden involved in ramping up a new multi-campus course.
4. Creating a special category of teaching assistant for the remote facilitation role that includes multi-year terms, additional training, and a higher expectation of experience and competency in education [18].
5. Completing a full inventory of contextual differences, including lab and learning resources, between all campuses involved to enable instructors to adapt course material for each location and provide a more equitable learning experience for all students [6].
6. Providing Accessible technology for remote collaboration including video chat (e.g. Zoom), ICT-enabled classrooms, and a learning management system (e.g. Canvas LMS) accessible to all students involved in the program.
7. Documenting quality guidelines for auditing the course and/or program at each campus and ensuring that remote factors outside the instructor's control, such as learning spaces and IT resources at each location, meet minimum acceptable standards approved by the instructor delivering the course.
8. Scheduling at least one opportunity per semester for the instructor to visit the other locations, if possible, which is best facilitated if the instructor is only teaching one course in that semester.
9. Adjusting performance expectations based on student evaluations of teaching to acknowledge the added complexity and externalized factors involved in teaching a multi-campus course that are not a direct indication of teaching competency.
10. Training students earlier in the program on expectations around multi-campus course delivery to help ensure adequate preparation for effectively learning in a such a different modality.
11. Supporting instructors with tools for evaluating student experiences of teaching presence, cognitive presence, and social presence in the classroom [11].
12. Encouraging students from all locations to provide feedback on their experience to administrators at their respective locations to ensure that students have a mechanism to communicate with a person locally that can hear and act on grievances related to the course.

Multi-campus courses are challenging not just for students but for instructors as well. Instructors need the full support of their faculty and teaching community to succeed in delivering multi-campus content at a level of quality that enables all students to benefit from the course. Open communication, advanced planning, and realistic expectations are essential to ensuring initial and ongoing success in a multi-campus environment.

Conclusion

Teaching a multi-campus course in manufacturing engineering is a rewarding, challenging, time-consuming, high-risk endeavour where the administrative support available to the instructor can

have a tremendous impact on the successful delivery of the course and satisfaction of the instructor involved. Two manufacturing engineering instructors were interviewed on their experiences teaching multi-campus courses through a variety of learning contexts, and six themes were identified using inductive thematic analysis. Teaching a multi-campus course requires care, attentiveness to detail, a willingness to experiment pedagogical, and additional resources such as time and funding. Despite the added costs and challenges, the experience enables instructors to reach many more students in different learning environments and form relationships that span great distances. It is a high risk, high reward proposition that depends tremendously on the informed support of administrators, directors, and heads.

Conflict of Interest Declaration

One of the authors was a participant in the study. To minimize influence on the analysis, that author did not contribute directly to the analysis, discussion, or conclusions sections of the study. There are no other conflicts of interest.

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