

Collaborative Teaching Model: Synergy of Teaching Assistants in a First-year Engineering Course During the Pandemic

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Abstract

This complete evidence-based practice paper examines the synergy of the roles of TAs (teaching assistants) and IAs (instructional assistant interns) in the remote teaching and learning of a newly redesigned level 1 Engineering course. This study asks: *In what ways do the similarities and differences among IAs' and TAs' roles and responsibilities enhance first-year students' learning experience in an online course amid the pandemic?*

Using the lenses of collaborative teaching and community of practice (CoP), we examined how TAs and IAs perceived their roles as they worked together to mentor first-year students. An anonymous and voluntary online self-assessment survey and individual interviews were conducted, analyzed, and triangulated.

Our findings indicated that the synergy of the roles of IAs and TAs revolved around five aspects: (i) complementarity of roles, (ii) practical issues that needed to be addressed, (iii) reflective practices to enhance personal growth, (iv) professional development essential for future engineers, and (v) perceived student engagement in the course.

We argued that the use of a collaborative teaching model integrated with a CoP framework promotes learning as an inherently social and locally-situated. The synergy of the roles of IAs and TAs indicated a new collaborative teaching model between IAs and TAs. We believed that such synergy will also be applicable not only during the pandemic but also in post-pandemic setting and that would require further investigation.

Motivation and Brief Background

North American universities have cohesive frameworks for the employment of graduate teaching assistants (TAs) [1] to support course delivery. However, a few universities have also developed the concept of super TAs or as we call them at McMaster University as “instructional assistant interns” (IAs).

IAs are upper-year engineering students who are hired full-time for a period of 8-12 months while TAs (2nd and upper level undergraduate students) are hired on a part-time basis. IAs are responsible for delivery of weekly labs and design studio sessions while TAs are assigned for students' mentorship and grading.

With all university classes transitioning online from face-to-face, employing more teaching assistants is critical. More importantly, maximizing IAs and TAs' supervisory and teaching expertise might prove helpful, particularly for incoming first-year students whose needs outweigh those of students who started a year ahead of them. The seven months between March 2020 and September 2020 were trying times for thousands of young students who missed significant milestones in their final year of high school (sports championship, in-person graduations, proms, etc.). Following this, their first months at their chosen universities were

fraught with academic, social, and emotional problems [2]. To help address these problems among first-year students, an integrated and collaborative teaching approach between instructors and teaching assistants is crucial.

There are numerous successful collaborative models for teaching. While the majority of research on collaborative teaching involve faculty to faculty collaborations [3-5], there are teaching collaborations that exist between faculty and undergraduate students [6, 7] or faculty and graduate students (in their PhD programs) [8]. However, there is only limited research examining teaching collaborations that involve among undergraduate and graduate students in a course.

In this study, we examine the complementarity of roles between IAIs and TAs in the remote teaching and learning in the Faculty of Engineering at McMaster University's first-year course titled Integrated Cornerstone Design Projects in Engineering, or ENGINEER 1P13 (ENG 1P13) viewed through the lenses of collaborative teaching [8] and community of practice (CoP) [9-11]. The Faculty of Engineering hired a significant number of teaching assistants: 150 TAs and 11 IAIs to work alongside seven course instructors and four non-teaching staff to support 1,100 first-year students during the challenging times brought about by the Covid-19 pandemic.

The overarching question in this study was: *In what ways do the similarities and differences among IAIs' and TAs' roles and responsibilities enhance first-year students' learning experience in an online course amid the pandemic?*

Literature Review

Several studies have indicated that successful collaborative teaching models primarily highlighted collaborative teaching among faculty member [4, 5, 12, 13]. These studies outlined the advantages of co-teaching, like enhancing "more reflexive pedagogy as well as richer and less hierarchical relations between students and faculty, but also points to complications, dislocations and challenges in negotiating the shared classroom stage" [8].

Walters and Misra [8] identified collaborative teaching models between faculty and students. Such collaboration on co-teaching explores teamwork in designing courses with undergraduate students enrolled [6] or not currently enrolled in the course [7]. Walters and Misra noted that this collaboration "illustrates the power of co-teaching models to engage with undergraduate students." Cordner et al. [14] offered an example on their collaborative teaching approach to graduate students and faculty co-designing and co-teaching a graduate-level ethnography course. Graduate students who had enrolled in the same course the previous year assisted a faculty member to come up with a reading reference list (books and research articles), design a course syllabus, and teach the course itself. Cordner et al. [14] reported that graduate students had positive experiences (like developing one's content and pedagogical knowledge) and allowed another faculty member to follow the co-designing and co-teaching model.

The literature on collaborative teaching, however, has limited discussion on teaching collaborations that involved among undergraduate and graduate students in a course. Since the IAIs and TAs in this ENG 1P13 course (combinations of undergraduate and graduate students) are considered a group of individuals who engage in a process of collective teaching and learning

with a motivation to contribute and improve the teaching and learning process, we viewed this current study through the lens of community of practice (CoP) ([9-11]. CoPs are groups of people who wish to meet to interact and discuss a topic to develop perspective and knowledge, practices and approaches. CoP is viewed as membership within a community that entails a learning process of becoming a member of a community, as opposed to simply acquiring knowledge. Mercieca's [15] research with groups of apprentices offered a critique of traditional learning methods that relied on "internalized knowledge transmitted from teacher to student". In this research, learners were conceptualized as being on a trajectory from the periphery towards the center of a community through adopting the group's practices, style of communication, and commitment to the domain of shared knowledge. Instead of a master-apprentice relationship, the IAs and TAs found that learning occurred through entire social networks, that included other peers and higher-ups, as learners gradually took on more responsibility in their professional settings [16] like the ENG 1P13 course where they were involved.

Methods and Design

Brief Course Context

The ENG 1P13 is a new first-year engineering course as of 2020. It is part of a wider redesign of the engineering curriculum at McMaster University across all four years of study. This new curriculum is grounded on three pillars (introducing a project-based learning approach, reimagining the manner and places of the learning delivery, and expanding work-integrated experiential learning). The new first year curriculum is an amalgamation of four foundational engineering courses (taught separately as individual courses prior to 2020; ENG 1D04: Computing, ENG 1C03: Graphic Design, MATLS 1M03: Introduction to Materials Science, and ENG 1P03: Engineering Design Practice and Profession) along with unchanged math, chemistry, and physics courses offered in the old curriculum. ENG 1P13 provides 11 hours of contact time for students on a weekly basis for both Fall and Winter semesters. The 11 hours include 3 hours of lectures, 2 hours of design studios and two 3-hour labs.

There are seven instructors involved in the course. The instructors are full-time teaching-stream professors that have been hired by the Faculty of Engineering. The instructors are responsible for designing the course components, delivering the lectures, mentoring students during design studios, and supervising the staff and IAs. The 11 full-time IAs are the best upper level undergrad students from different disciplines. Most of the 150 part-time (<10 hours/week) TAs of the course are also undergraduate engineering students, although a few are masters and PhD students. Both IAs and TAs are selected through rigid screening. For all IAs and TAs, resumes are checked by a hiring committee that includes at least 3 instructors and 1 course staff member. TAs then go through a test on four main topics of the course (Graphic Design, Computing, Materials, and Design and Profession). A weighting mechanism is in place to conduct the final selection of the TAs based on the test results and their resume. For IAs, after the first round of resume screening by hiring committee, top choices (usually 3 times the number of IAs that are intended to be hired) are asked to submit a 5 minute video responding to a series of questions related to their teaching and learning experiences. Then, the hiring committee meets to decide on the top candidates. All TAs must have successfully completed their previous first-year engineering courses (like Engineering Design & Graphics, Engineering Computation, Engineering Practice and Profession). All IAs must, in addition, have specific expertise on their

own field of engineering studies (like bio-medical, electrical, computer, chemical, mechanical, and materials).

Once hired, IAIs are trained broadly on all aspects of the delivery of ENG 1P13 weekly labs and design studio sessions prior to the start of the course as well as weekly during the course delivery. IAIs conducted numerous test-runs of course delivery and implementation under the guidance of course instructors. The four support staff include one full-time Lab Technician and three Instructional Assistants who work closely with the course instructors and IAIs to ensure everything is running smoothly behind the scenes including the coordination of team formation and peer evaluation, scheduling and student communications as well as support for technical challenges that may arise.

There are four main projects or modules within this course. For each module, the regular weekly course routine is: course instructor(s) introduces a fundamental concept in one or more of the core topics (Materials Science, Graphics Design, Computing, Engineering Design, Practice & Profession) along with a corresponding activity or related milestone of a design project undertaken by all students, these happen in 3 hours of lectures each week. Then, in each 3-hour online lab, one of the 11 IAIs gathers a maximum of 80 students and breaks down the concept and lab activities for those students. Also, during the same week, one of the IAIs delivers the design project milestone(s) within the online design studios to a maximum of 40 students. All the labs and design studios have the support of at least one staff and one faculty mentor. During the labs and design studios, TAs also meet with students in small breakout groups. Generally, a TA drops into 1-2 online breakout groups made up of 3-5 students. IAIs work alongside TAs to address specific student needs or queries that may arise during and after the breakout session as well as being available throughout regular working hours.

Design

Using the lenses of collaborative teaching and community of practice (CoP), this study employed a mixed methodology [17, 18]. Using CoP, we examined how TAs and IAIs perceived their roles as they worked together to mentor first-year students, and explored how their learning and teaching approaches evolved into new sets of relations in their own sphere of community sustained by members' experience and identity in and out of engineering.

An anonymous and voluntary online self-assessment survey regarding IAIs' and TAs' roles, preparation, training, and experiences was carried out via LimeSurvey in Winter 2021. The survey could be completed within 10-15 minutes. The content of the survey was patterned from validated surveys [1, 19] combined with past surveys on pedagogical research in the Faculty of Engineering. It contained themes around IAIs and TAs roles, responsibilities, selection, preparation, and training. The questions consisted of 5-point Likert-type ratings of agreement and disagreement and 4-point ratings of significance from not significant to very significant.

Overall, 50 TAs and 5 IAIs completed the survey, representing 33% of the total TAs and 45% of the total IAIs. For the next iteration of the survey this year, we will provide a longer duration and deadlines for IAIs and TAs to respond to the survey so that we can get gather higher responses even if the survey is not compulsory. The survey responses were analyzed using general descriptive statistical analysis like percentages and tallying. Moreover, findings from a check-in

survey given to ENG 1P13 students in November 2020 to assess how they perceived their engagements with TAs and IAIs were used as supplementary data.

Individual interviews (30-45 minutes per participant) via MS Teams were conducted in Winter 2021 to enrich the findings of the self-assessment survey. The questions introduced in the individual interviews were based on the course syllabus, literature reviews on graduate teaching assistants in the context of North American universities [1], and validated teaching competencies for graduate teaching assistants [19]. A total of 15 TAs and 5 IAIs joined the audio interview, each receiving an honorarium for their participation. Interview transcripts generated from MS Teams were transferred to Excel spreadsheets. The contents of the transcripts were double checked against the MS Teams audio recordings by the first author. Afterwards, both the first author and a research assistant (upper-year undergraduate engineering student), coded the transcripts independently. The two agreed that the codes would include the following themes relating to how individual TAs and IAIs: (i) complemented one another's roles and tasks and their perception of first-year students' learning engagement; and (ii) reflected on how TAs and IAIs addressed practical issues (like managing conflict), personal issues (like reflective practices), and professional development issues (like pedagogical training). After independent coding sessions spread over two months, both coders synthesized the themes and a number of IAIs and TAs were requested to do a member check - also termed as participant validation to make sure that the interview responses were accurate and resonated with the participants' experience. Finally, the coded themes were matched with the results of the online survey to come up with a final analysis.

Quantitative and qualitative analysis were triangulated. Triangulation was focused on how IAIs and TAs roles and responsibilities supported the implementation of the redesigned curriculum and promoted performance skills crucial for future engineers such as communication abilities, interpersonal interaction, conflict mediation, team performance, understanding of technical culture, and sensitivity toward diversity [20-23]. To promote trustworthiness in the mixed methods study, both the survey and individual interviews were conducted by the first author and an upper-year undergraduate engineering student. Both are not part of the course's teaching team.

Results and Discussion

Five emergent themes were extracted from the combination of results of the survey and individual interviews. These themes were: (i) complementarity of roles, (ii) practical issues, (iii) reflective practices, (iv) professional development, and (v) perceived student engagement.

Complementarity of Roles

IAIs and TAs strongly agreed that they have the competency to teach content or learning materials suited to the background, ability level, and interests of students at 92% and 100%, respectively. In a remote teaching setting due to the Covid-19 pandemic, 98% of TAs and 100% of IAIs believed that: 1) having the competencies to manage and assist with the learning needs of students in teams and groups; 2) enhancing students' motivation and learning engagement with

the course; and 3) communicating effectively with course instructors and fellow TAs and IAIs were very significant.

However, since TAs were not working full-time, they faced gaps regarding information communicated between IAIs and students during the week. Thus, during their scheduled breakout group mentoring sessions with the students, TAs could not fully facilitate activities and deliverables that had been discussed between IAIs and instructors during labs and design studio sessions. This is one of the hurdles seen during the early stages of the course that resulted in a limited coherence and consistency in the teaching and learning of students.

To address the issue, IAIs and TAs themselves agreed to conduct weekly updates regarding the course. Weekly updates were led by IAIs and repeated twice in a day to accommodate all 150 TAs with different schedules. Moreover, during the week, TAs were encouraged to join their breakout group sessions with students 15 minutes earlier so that IAIs could provide last minute briefings and debriefings if necessary.

Practical Issues

All 15 TAs (interviews) unanimously expressed high regard for the expertise and efficiency of their IAIs, while the 5 IAIs complimented the TAs as very responsible when it came to marking students' work, responsive to student needs, effective at channeling concerns and communication, and receptive to new ideas and approaches. Equally importantly, these TAs and IAIs gladly described their own workload as very manageable and satisfying, and stated they are well-paid.

While both IAIs and TAs exchanged positive regard for each other, there were existing practical issues that both should be aware of to consistently achieve the course learning outcomes. To establish efficient and effective dissemination of information to the right person, for instance, TAs suggested that each IAI should provide their own brief profile (e.g., expertise, engineering discipline, strengths, etc.) at the start of the term. That way, when TAs in breakout group sessions encountered student questions that only IAIs could address, these questions could be sent directly to the right IAIs. TAs described instances where questions were directed to an IAI whose expertise did not allow them to answer, in which case the TA had look for another IAI. Between crafting the question, sending it to the IAI, receiving the initial reply back, and continuing to search until the right answer was found, significant instructional time was lost.

For their part, IAIs stressed that TAs should feel free to provide them with the latest information on any teaching and learning issues at any time rather than waiting to report them during the scheduled weekly updates. TAs should also not hesitate to inform IAIs regarding any discrepancy in marking rubrics within the soonest time possible.

Reflective Practices

Working as a teaching assistant (TA or IAI) during the pandemic was an immense challenge when it came to achieving course learning outcomes, but it was also a significant opportunity to grow into a teacher and mentor. IAIs and TAs were able to reflect on the value of developing empathy skills to understand students' and instructors' points of view and circumstances, particularly amid a pandemic. Moreover, by engaging with their fellow IAIs and TAs through a

community of practice, they were able to harness the art of effective communication, which is one of the more important performance skills future engineers should develop.

Professional Development

Experiences in mentoring students, delivering labs and studio design sessions, and marking students' deliverables over the duration of the course allowed IAs and TAs to dive deeper on the best pedagogical practices to improve teaching and learning in engineering education. TAs and IAs have identified these experiences as forms of professional development. TAs and IAs have also mentioned examples of pedagogical practices that helped them grow as future engineers and educators such as: (a) showing extra understanding of first-year students' situations as impacted by the pandemic (e.g., different time zones, social and emotional issues, technical and technological issues); (b) providing constructive feedback to students while remaining consistent in addressing matters related to course content and delivery; (c) exhibiting respect and fairness for the class during breakout group sessions; and (d) enhancing students' motivation by sharing personal learning experiences to demonstrate the relevance of the course to future goals.

Perceived Student Engagement

Near the halfway mark of the semester, a check-in survey was given to first-year students in November 2020. A total of 657 students responded to the survey. It showed that while first-year students had started to acknowledge the increase in their course workload, most students (85%) were feeling engaged (combinations of engaged, engaged most of the time, and always engaged) in lectures, labs, and design studios. This level of engagement aligns with their perceived engagement with their TAs, IAs, and instructors, with an average of 86% (with TAs at 84%, IAs at 89%, and instructors at 86%, respectively). Students mentioned that IAs and TAs provided a larger support network considering the immense diversity of student needs and realities during the pandemic for both local and international students. Students were much freer and more comfortable interacting with IAs and TAs than the course instructors as they saw the IAs and TAs as students like them. IAs and TAs also mentioned that students enjoyed having different ways and approaches to learning because the concepts and activities in labs and design studios were discussed in different perspectives and nuances - combinations of ideas from TAs, IAs, and instructors.

While IAs and TAs saw that students were engaged actively in smaller groups and exposed to different perspectives and approaches to understanding content, IAs and TAs agreed that there were some organizational and administrative aspects of the course that must be consistently observed. For one, they suggested to establish consistency in the interpretation and implementation of marking rubrics for every deliverable. They also mentioned a need to organize all communication with students. As well, IAs and TAs suggested to arrange weekly updates, changes, etc. related to the lab and design studio sessions properly (for example, arranging updates by weekly folder). For some TAs who are not available throughout the whole week, they emphasized that such organization would help them in following, monitoring, reviewing, and preparing for their weekly mentoring sessions with students. All IAs and TAs believed that organization is critical because any TAs who is uninformed about weekly updates and changes related to the lab and studio sessions will create a chain of confusion among TAs and students.

Conclusion

Examining the synergy of IAs' and TAs' roles, responsibilities, etc. in ENG 1P13 through the lens of a CoP allowed us to see how “new-comers” to a practice (a term that could be applied to both IAs and TAs) develop knowledge that leads to the mastery of becoming “old-timers”[24]. The synergy of the roles of IAs and TAs in a large integrated online engineering course for first-year students amid the pandemic was seen to revolve around five aspects: (i) complementarity of roles, (ii) practical issues that needed to be addressed, (iii) reflective practices to enhance personal growth, (iv) professional development essential for future engineers, and (v) perceived student engagement in the course.

The synergy between IAs and TAs allowed them to work together to help achieve the learning outcomes set by the course instructors. They streamlined and divided workloads which allowed them to attend to students' needs individually or in smaller groups. The use of both IAs and TAs provided students with multiple scaffolds to access learning resources and different perspectives of doing and thinking, to break down difficult concepts and their applications in labs and design studios, to establish a feeling of belonging to a team and community (particularly during the pandemic), and to potentially achieve the course learning outcomes set by the instructors.

To further promote the synergy between IAs and TAs, the following key suggestions should be considered: (1) establish consistency and coherence across all instructional aspects communicated to students by requiring all TAs to attend weekly update meetings organized by IAs and instructors and to share and brainstorm best teaching and learning practices. In this way, communication gaps (like schedules, markings, rubrics) are likely to be minimized among IAs, TAs, and students during labs and design studio sessions; (2) provide clear organization of all teaching and learning updates by organizing the minutes of the weekly updates on SharePoint folder and be made accessible to both IAs and TAs; and (3) disseminate any instruction-related issues to the specific individual(s) or to the teaching team efficiently and effectively. The IAs and TAs helped one another develop performance skills crucial for them as future engineers, such as communication abilities, interpersonal interaction, conflict mediation, team performance, understanding of a technical culture, and sensitivity toward diversity [20-23]. In return, these performance skills allowed IAs and TAs to enhance first-year students' learning experience in the course.

The collaborative teaching and learning engagement between IAs and TAs as a community of practitioners allowed them to de-center what is in their individual's mind, and instead centers teaching and learning in the middle of social and collegial interaction [25]. The use of a collaborative teaching model integrated with a CoP framework promotes learning as an inherently social and locally-situated, and pushes back on traditional education methods that focuses on individuals learning abstract concepts. The synergy of the roles of IAs and TAs indicated a new collaborative teaching model between IAs and TAs. We believed that such synergy will also be applicable not only during the pandemic but also in post-pandemic setting and that would require further investigation.

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