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Collaborative Teaching Practices in Undergraduate Active Learning Classrooms: A Report of Faculty Team Teaching Models and Student Reflections from Two Biology Courses

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Abstract: Effectively managing active learning classrooms (ALCs), particularly large ALCs, can present a variety of challenges for instructors. There is a rapidly growing body of research literature addressing the impact of ALCs on student engagement and learning, but fewer studies have focused on investigating instructional practices and instructors in ALCs. Moreover, little to no information on best practices for multiple instructors in these learning spaces has been reported, although the presence of multiple instructors or facilitators simultaneously seems to be frequently implemented in these spaces. Many unanswered questions remain regarding optimizing the opportunities afforded by ALCs and collaborative teaching models while minimizing difficulties that may arise when multiple instructors facilitate student learning concurrently. In an effort to begin reporting faculty experiences and student perspectives of team teaching models at the college or university level, this paper provides an overview of collaborative teaching models described in the literature, describes collaborative teaching models in two undergraduate biology courses, and reports student responses to questions addressing their experience with collaborative teaching in those courses. Finally, from our experiences, we provide recommendations of helpful practices for courses with multiple facilitators acting simultaneously in ALCs.

Key words: Biology, Classroom Management, Cooperative Groups, Instructional Strategies, Teaching Strategies

INTRODUCTION

Models of co-teaching (i.e. the use of multiple instructors simultaneously engaged in instruction in one classroom) have been studied and written about mostly in the context of K-12 education (Pancsofar & Petroff, 2013; Takala & Uusitalo-Malmivaara, 2012; Conderman, 2011), particularly regarding students with special needs or disabilities (Hang & Rabren, 2009; Friend et al., 2010). Reforms in higher education have fueled the construction of active learning environments and adoption of student-centered instructional approaches, making co-teaching more common at the collegiate level. Compared to traditional lecture-based instruction in large auditorium-style rooms, instruction in ALC-style learning spaces[1] engages students in a reduced-lecture pedagogical model focused on cooperative, active learning strategies guided by facilitators (Beichner, 2008; Walker, Brooks, & Baepler, 2011). Research has been published addressing ALC design (Brown & Long, 2006; Chism, 2006; Muthyala & Wei, 2013), the impact of instruction in ALCs on students' social, affective, and cognitive domains (Prince, 2004; Dori & Belcher, 2005; Beichner et al., 2007; Dori et al., 2007; Beichner, 2008; Gaffney, Housley Gaffney, & Beichner, 2010; Walker, Brooks, and Baepler, 2011; Cotner et al., 2013) and revising curricula for instruction in ALCs (Brown & Lippincott, 2003; Nogaj, 2013). In contrast, although ALC environments and active learning strategies lend themselves well to facilitation by multiple instructors (Bradley et al., 2002; Beichner et al., 2007; Biechner, 2008; Gaffney et al., 2008), there are few reports that discuss best ways to deploy teaching teams in ALCs for college and university courses.

A review of co-teaching literature found although most educators who participate in co-teaching report increased satisfaction and positive attitudinal changes, "practitioners and researchers have not made, or cannot make, empirically based claims that their teaming efforts have been effective" (Welch, Brownell, & Sheridan, 1999, p. 46). More recent research demonstrated higher levels of teacher-

[1] Active Learning Classrooms (ALCs) are also known as "Student Centered Active Learning Environment with Upside-down Pedagogies (SCALE-UP) (North Carolina State University; Biechner et al., 2007) and Technology Enabled Active Learning (TEAL) (Massachusetts Institute of Technology; Dori et al., 2007).

to-teacher interactions - "teacher social capital" – can increase student math and reading achievement in K-5th grade settings (Leana & Pil, 2006). While other authors have reported on student perceptions of team teaching, these investigations addressed teaching teams comprised of classroom teachers and special education teachers in K-12 settings (Pugach & Wesson, 1995; Gerber & Papp, 1999). Research reporting student perceptions in ALCs have not specifically addressed the perceived impact of multiple instructors (Gaffney, Housley Gaffney, & Beichner, 2010).

Collaborative Teaching Models Described in the Literature

Collaborative teaching, or co-teaching, "involves two or more educators working collaboratively to deliver instruction in a heterogeneous group of students in a shared instructional space" (Conderman, 2011, p. 24) and involves three collaborative phases: co-planning, co-instructing, and co-assessing (Conderman, 2011, p. 26). Co-teaching approaches are described as six models, which differ in the extent to which each instructor contributes in the delivery of content and/or engages with students (Friend & Cook, 2010, p. 168-175). Each model is described briefly below.

(1) One lead, one observe. One instructor is the sole deliverer of content, while the other instructor observes; useful when a less experienced instructor seeks to gain familiarity with particular content or instructional approach or if an incoming co-instructor simply wishes to observe the classroom dynamics prior to participating (Friend & Cook, 2010, p.168-169).

(2) One lead, one assist. This model is also known in some literature as "one lead, one drift" (Forbes & Billet, 2012, p.61). In this model, one instructor is the primary deliverer of content, while the other instructor(s) move between individual students or student groups to answer questions, direct activities, and provide support to the lead instructor (Friend & Cook, 2010, p. 175).

(3) Station teaching. Students migrate to stations to participate in different learning activities; useful in laboratory settings, particularly when specific pieces of equipment are being used at each station. Each instructor serves as an expert guide for a different station or stations, and students rotate among all stations (Friend & Cook, 2010, p. 170-171).

(4) Parallel teaching. Instructors facilitate instruction of the same material and activities through engagement with subgroups of students within the larger teaching space or in separate classrooms (Friend & Cook, 2010, p. 171-172).

(5) Alternative teaching. Allows co-instructors to address needs of different student groups: one instructor may be working with the majority of students while a co-instructor is engaged with a smaller group of students who have a particular instructional need such as remediation (Friend & Cook, 2010, p. 172-173).

(6) Team teaching. Each instructor contributes equally, with instructors engaging in trading off or "tag-teaming" at specified signals or content breaks (Friend & Cook, 2010, p. 173-174). Team teaching is sometimes viewed as the 'goal' of co-teaching endeavors (Conderman, 2011, p. 27).

Collaborative Teaching Models Used at the University of Minnesota Rochester in Two Undergraduate Biology Classes

At the University of Minnesota Rochester, a Bachelor of Science in Health Sciences (BSHS) undergraduate degree program is delivered through the Center for Learning Innovation (CLI), a multi-disciplinary department in which faculty utilize strategies of integration (Davis, 1997; Harden, 2000) and co-teaching to deliver a health sciences-focused curriculum across humanities, quantitative, physical, life, and social sciences. Students who enter the BSHS are mostly traditional-aged college students coming from within 50 miles of campus, located in the upper Midwest. Approximately 72% identify as female and 20% identify as underrepresented minorities.

Undergraduate introductory biology courses are team-taught in technology-enhanced ALCs designed for 80 students; upper-level courses are also team taught, but generally taught in ALCs designed for 42 students.

Both BIOL2311: Integrative Biology (a first-year 5-credit course with lab) and BIOL3311: Molecular Genetics (a 3-credit upper-level elective) implement a flipped classroom model: students are expected to complete pre-class readings and respond to 4-5 targeted questions about the material provided by the instructors. Class time is devoted to a variety of teaching and learning activities including low-stakes quizzes, mini-lectures, jig-saw activities, audience response ("clicker") questions, case studies, online simulations, student drawing and writing on whiteboards, concept mapping, student investigations using online resources, and other Classroom Assessment Techniques (for examples of CATs, see Angelo & Cross, 1993).

During a single class meeting generally more than one co-teaching model is used: a 60-minute session might begin with a 10-minute mini-lecture in which one instructor presents materials facilitated through the use of lecture slides or "chalk-talk" while the other instructor(s) observe (Approach 1), followed by 30 minutes of small group activity during which students work to solve practice

problems, etc. while instructors facilitate student groups in a similar way at different locations in the learning space (Approach 4). Group work could be followed by 20 minutes of large-group discussion and debrief in which students may present details of their group discussion or activity, and instructors offer explanations, clarifications and examples (Approach 2 or 6). When using Approach 2, the role of "lead instructor" was rotated among three faculty on a daily basis, although rotating "lead instructor" on a weekly or by-unit basis is also possible. During the co-planning phase, instructors must determine the model(s) that are most appropriately suited to their teaching team, facility, course content, and student population.

Data Collection: Rationale

At the University of Minnesota Rochester, team teaching and high-contact faculty approaches were embraced with the rationale that these strategies would be beneficial for student learning and for the student learning experience in general. Thus, assigning multiple instructors to a course is a regular practice. We wanted to collect data that would help elucidate the impact of team teaching at our institution and qualitative analysis provides a starting point to describe the perceived impact of co-teaching in ALCs on affective domains of student learning.

METHODS

Responses included in this analysis were provided by students who consented to participation in research approved by University of Minnesota IRB (study #1008E87333 and 098S71602).

Students in a first-year biology course (BIOL2311: Integrative Biology, Spring 2013, enrollment 144) and an upper-level elective genetics course (BIOL3311: Molecular Genetics, Fall 2013, enrollment 38) were asked to provide voluntary feedback related to the collaborative teaching models they experienced in those courses at the conclusion of the course. Data were collected using an online curriculum-management platform.

Quantitative Data: Students were asked to rate their agreement with the following statement on a Likert scale of 1 (strongly agree) to 5 (strongly disagree): "Having multiple instructors in the classroom at the same time helped me learn."

Qualitative data: Students were asked the open-ended response question: "How did having multiple instructors in the classroom at the same time contribute to your learning?"

Questions were presented to students following a quiz or exam. Students were made aware through text that prefaced each question that responses were voluntary and would have no impact on their performance in the course. The voluntary nature of data collection, as well as the ability of students to opt out of participation in the research, results in a number of responses included in analysis that is less than the total enrollment in the course, although response rates for both classes were consistent (90.9% of those enrolled for BIOL2311 and 89.4% of those enrolled for BIOL3311). Data were collated, de-identified, and analyzed after the end of the semester. Qualitative analysis approaches aligned with grounded theory (Corbin & Strauss, 1990; LeCompte, 2000; Patton, 2002, p. 133), relying on descriptive themes that emerged from students' written responses: responses were iteratively read and assigned a theoretical category code (Maxwell, 2008, p. 236-238). Some responses included reference to more than one theme and were included in more than one reported category for qualitative analysis results.

RESULTS AND DISCUSSION

Overall, students reported very strong agreement with the statement "Having multiple instructors in the classroom at the same time helped me learn." (Figure 1): the average response for students in the introductory course was 1.82 (N=131) and the average response for students in the upper-level course was 1.53 (N=34).

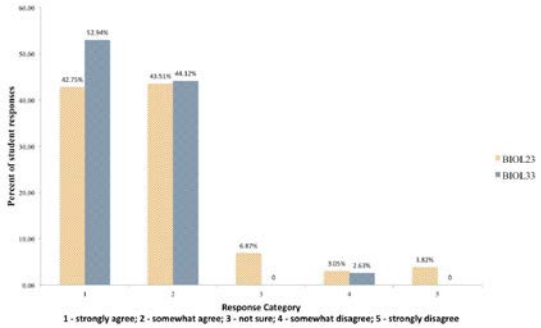

Fig. 1. Results of student responses regarding helpfulness of having multiple instructors in the learning space. Students were asked to rate their agreement with the statement "Q. Having multiple instructors in the classroom at the same time helped me learn."

Qualitative analysis of open-ended text responses to the prompt "How did having multiple instructors in the classroom at the same time contribute to your learning?" revealed four themes, summarized in Table 1 and discussed below. Themes 1, 2, and 3 are very complementary and often student responses included elements of each, yet they highlight different implications resulting from a co-teaching environment.

1. Having questions answered/getting assistance with group activities

Qualitative analysis revealed that 65% (85 of 131) of student responses from BIOL2311 and 61% (19 of

Table 1. Themes in student responses to prompt: "How did having multiple instructors in the classroom at the same time contribute to your learning?"

Theme	Example Student Responses
1. Having questions answered/getting assistance with group activities	"It was easier to ask for help and also the student feels more comfortable asking questions since one does not necessarily have to interrupt the class"
2. Access to and relationship building with instructors	"I was able to get more one-on-one support and help when I was having difficulty"
3. Efficiency of managing an ALC with multiple instructors.	"They can all help different tables with different questions so it's a better use of our time"
4. Multiple perspectives in the classroom	"Sometimes an instructor's explanation did not make sense to me. Another instructor explained it differently... My "light bulb" lit more quickly after a different explanation"

34) of responses in BIOL3311 included commentary on having questions answered more readily with multiple instructors or being able to obtain assistance for collaborative, active group learning activities. Several students reported that it was easier to ask a question of an instructor who was in the role of observer or assistant rather than the instructor leading to avoid having to halt the large class to have a question answered.

2. Access to and relationship building with instructors

Approximately a third (31%; 41 of 131) of responses provided in BIOL2311 and close to two thirds (61%; 19 of 34) of responses provided in BIOL3311 reported a positive impact specifically with regard to perceived access to instructors. With multiple instructors present, students felt supported in their learning to a greater extent than they felt a single instructor could have provided. Some students commented on being able to establish one-on-one relationships with instructors to a greater extent.

3. Efficiency of managing an ALC with multiple instructors.

A small percent, 11% (15 of 131) of responses in BIOL2311 and 12% (4 of 34) of responses in BIOL3311, commented on the positive impact of having multiple instructors for efficiency of delivering an active, collaborative, student-centered curriculum.

4. Multiple perspectives in the classroom, alternative examples or approaches with different teaching styles

Lastly, 27% (36 of 131) of responses in BIOL2311 and 41% (13 of 34) of responses in BIOL3311 addressed the benefit of multiple perspectives or explanations that come from multiple instructors in the learning space. Students also commented that if a particular instructor's teaching style or personality was not amenable to their learning, they could seek out help from other facilitators. Such "personalized learning" would not be possible (or would be much more difficult) in a course with only one instructor.

Students in both courses clearly have embraced, and perceive benefits from, collaborative teaching models at our institution. While both populations of students report a greater ability to have their questions answered when there are multiple instructors present, responses from the upper level smaller-enrollment course emphasized access to instructors to a greater extent. It is worth noting that the student:facilitator ratio for the first-year large-enrollment course was approximately 20:1 whereas in the upper-level smaller-enrollment course the student:facilitator ratio was closer to 10:1, which likely also impacted the student experience and could be a contributing factor in differences in student responses between the two classes.

Difficulties

Although very few responses (9 in BIOL2311; 1 in BIOL3311) included concerns or negative perceptions of having multiple instructors simultaneously participate in instruction, such responses provide valuable insight into challenges that may arise with co-teaching models. Three themes emerge regarding difficulties, summarized in Table 2 and discussed below.

Difficulty 1. Management of the learning space

The first theme of difficulty regarding collaborative teaching practices refers to the physical presence of multiple instructors, which students can perceive as distracting. To ameliorate this difficulty, we recommend approaching the physical learning space as several "Zones of Engagement" that are divided among the facilitators present (Figure 2). Each instructor or teaching assistant is anchored in one of the zones, and works with students in that area to minimize facilitator movement. Further, to avoid the perception that instructors are hovering over students, instructors sit at the table with students, take part in the discussion of the group, answer questions, direct students' activities (i.e. keep students on task), or just observe. Our recommendation is contrary to the behavior described in Gaffney et al. (2008, p.19)

Table 2: Difficulties expressed in student responses to prompt: "How did having multiple instructors in the classroom at the same time contribute to your learning?"

Difficulty Expressed	Example Student Comment
1. Management of the learning space	"I thought having multiple instructors and TA's in the class at the same time was really distracting. I find it easiest to learn from one person at a time, so having like five people walking around made things a little bit difficult"
2. Consistent messaging/content delivery/learning objectives	"Having multiple instructors was sometimes confusing because they contradicted themselves sometimes" "Sometimes I found it to be annoying and sometimes I liked that we could have different viewpoints and explanations."
3. Class "housekeeping": who's in charge here?	"It was helpful during class discussions, but I never emailed a professor because I was confused as to which one to answer to. I would rather answer to one professor rather than many professors"

in which it is stated that "Instructors rarely sit, as they are continually interacting with students: answering and asking questions, distributing resources, and listening to what students are saying." We suggest that, although it is the case that instructors should move between groups to facilitate instruction and guidance of multiple groups, instructors should act to minimize the extent to which they engage in disruptive movement or hovering behavior when observing or interacting with groups.

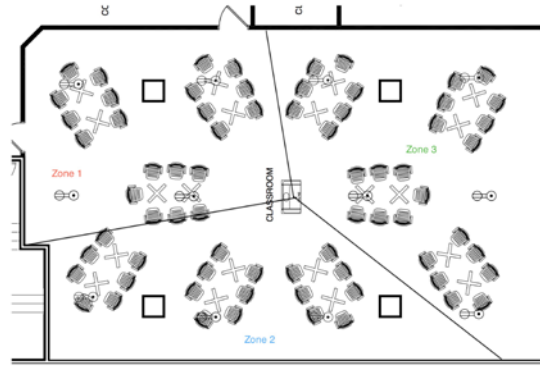

Fig. 2. "Zones of engagement" intended to help effectively manage active learning classrooms with multiple instructors. Each instructor or teaching assistant is based in one of the zones, and works with students in that area.

Difficulty 2. Consistent messaging/content delivery/learning objectives

Agreement among instructors regarding the learning objectives and instructor expectations of students can and should be addressed by co-teaching partners and teams throughout the co-teaching endeavor, but especially prior to classroom instruction during the co-planning phases. Co-teachers should work to develop clear and specific learning objectives for each classroom meeting time and activity to ensure that all instructors can provide a consistent message with regard to the important learning goals.

Difficulty 3. Class Housekeeping

Consistent messaging between instructors is also of critical importance for the third identified difficulty, class housekeeping, especially with regard to classroom policies (e.g. attendance, excused absences, make-up work, attending different sections of the class, how assignments should be submitted, etc.) to ensure students do not receive different answers depending on whom they ask. Co-instructors should also determine what methods of communication with students are preferred (i.e. should a student email all instructors of a course in advance of an absence, or should the student contact one lead instructor who will disseminate the information as necessary?) and should clearly communicate this preference to students at the outset of the class. Co-instructors should also be clear to whom students should come with questions about the course content, which may depend on the co-teaching approach used in the course.

Conclusions: Implications for Course Design and Implementation Utilizing Multiple Instructors and Recommendations from Our Experiences

Our reflection on the collaborative teaching models used in introductory and upper level university biology courses at our institution, in conjunction with analysis of student perceptions of those collaborative teaching models, has led to three overall recommendations for successfully implementing collaborative teaching models in ALCs for college courses.

First, to successfully implement collaborative team teaching models, it is crucial to have a high level of organization and effective communication among all instructors involved in the course. Many college faculty members are not experienced in teaching collaboratively and simultaneously so team teaching endeavors implementing these approaches necessarily require thought and careful planning to be successful (Conderman, 2011). Further, employing student-centered teaching techniques requires flexibility to adapt instruction day-to-day as well as

across a term as student-student and student-instructor interactions impact delivery, as others have noted (Bradley et al., 2002). Individual instructors and teams of instructors should engage in regular reflection to evaluate the effectiveness of the implementation strategies used.

Second, clear communication to students is essential. With multiple instructors for a course, students can be confused about to which instructor they should ask questions regarding assignments, grades, or attendance. If communication between students and instructors and between instructors is not managed carefully, students may adopt an "ask mom, if mom says no, ask dad" approach.

Third, gathering and reviewing feedback from students can inform revisions of course design, implementation, and assessment strategies. For us, the results of this investigation have influenced how we physically move through the ALCs and have divided the space among instructors.

Collaborative teaching can provide a valuable classroom experience for faculty and students, and potentially increase student satisfaction as a result of a perception of increased support. Being able to address more student questions in the learning space may increase positive feelings associated with the course and subject matter experience, and ultimately improve student learning. While many institutions may not employ multiple faculty members in one learning space, graduate or undergraduate teaching assistants and peer-instructors can be incorporated to achieve some of the same benefits accomplished by having multiple faculty members present in the learning space. Our experiences suggest that, in fact, having undergraduate teaching assistants in the learning space may provide additional benefits in the form of formal and informal tutoring and peer-mentoring interactions that continue outside the learning space.

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