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Interdisciplinary STEM Peer-Mentoring and Distance-based Teams

Abstract

A Midwestern university has implemented a stepping stone, peer-mentoring approach to supporting STEM scholarship recipients. Building on the success of a National Science Foundation-sponsored scholarship program, the program has expanded to include students in a broader array of majors as well as students learning at a distant site. While the financial support is invaluable to students, the mentoring, connection and community aspects of the program are also important to their success and persistence. This paper describes the expansion of the program as well as the experience of using technology to build and maintain connections between the main and satellite campuses. Our experiences indicate that early face-to-face interactions are essential to user satisfaction and patience with technological glitches, to community building, and ultimately in establishing strong mentoring relationships. All of these have the potential to lead to a productive discussion-based seminar and to the long-term success of collaborative student project teams, although challenges need to be addressed as they arise.

Introduction

Facilitating professional development and mentoring for STEM students can be a challenge for programs but is important for students' ultimate success and satisfaction with their careers. In conjunction with a National Science Foundation-sponsored scholarship program, we have developed an interdisciplinary peer mentoring support system for STEM students. The students receive financial support and an opportunity to develop academic, professional and life skills through a weekly scholars seminar. The seminars familiarize scholars with various university support services, allow participation in interdisciplinary discussions addressing broad academic and career issues, and build relationships with other scholars from diverse STEM disciplines. The seminar coursework is centered around semester-long investigative projects designed and completed by interdisciplinary teams. A small group of math, science and engineering faculty oversees the seminar and selection of scholars.

Our approach is to provide faculty mentoring while developing stepping-stone peer-mentoring. This structure supports students and helps them develop leadership qualities. The recipients, as defined by the program criteria, are diverse: multiple majors, male, female, nontraditional students, students with different ethnicities, religious affiliations, backgrounds, and family structure. By including all eligible STEM majors at our university, we have been able to increase the number of women recipients, which creates a sense of critical mass to support the women in engineering.

There are three new aspects to this program that have been implemented in the past year. The first is expanding majors to include chemistry, biochemistry and physics along with biology, math, computer science, engineering and engineering technology. Second is the shift from the original team of four principal investigators and mentors to a transition mentoring team consisting of one of the original PIs, a new PI, and a sabbatical replacement. Finally, a distance component has been incorporated to serve the needs of our scholarship recipients learning at a remote location. The latter has brought many additional challenges not foreseen in our original proposal.

This paper briefly describes the structure of the interdisciplinary scholarship cohort, its advising program and associated seminar. We focus on the challenges and issues that have risen because of the distance component. Student feedback from anonymous end-of-term surveys is compared to past feedback. Reflections by faculty mentors will be used to highlight challenges and attempts to address them. Reflections on the process of transitioning mentoring and cohort leadership to faculty in permanent and temporary roles will also be included.

Background

Students in our program are selected on a competitive basis with an eye towards supporting a diverse working group. Here, diversity includes majors, years, gender, race, socioeconomic background and cultural experience. During the weekly seminar, students engage with each other and the faculty mentors as a large group, in smaller teams and in various affinity groups. Our program has demonstrated past successes in addressing issues important to the field and accreditation boards such as functioning on multi-disciplinary teams; understanding ethical responsibilities; developing a sense of the global and societal context of STEM work; and supporting the idea of life-long learning.[1,2] While these are clear workforce needs, students will be part of a global society and are likely to work with people on distance-based teams. With the inclusion of students learning on a campus 275 miles away, our cohort is also able to experience what works and what does not work when interacting at a distance. In planning for the program, we knew we would have access to interactive classrooms and various forms of Internet-based communication and we had a rosy, naïve vision of implementing technology-enhanced communication. While our primary goal was to engage the students on the remote campus, our secondary motivation was to teach about real world collaboration.

The format of the weekly seminar varies, not only on a week-to-week basis, but during each seminar itself. The pedagogical model often involves the discussion of a problem/issue as a large group with students getting information and formulating their own perspectives, followed by small group breakout sessions where each group comes to an agreed upon solution or perspective (peer instruction model). Each group then shares their conclusion with the large group and the issue is further explored at that level. For a more detailed description of this model of instruction, often called scaffolding, see Nussbaum et al.[3] This model has recently found its way into standard classrooms, particularly the sciences[4,5] and has been found to be particularly effective for community college students and those with less prior background knowledge on a topic.[6]

Distance-based communication in the classroom has a long history, beginning with mail-based correspondence courses in the late 1800s and exploding with web-based technology in this century.[7] Reliable audio is crucial for a functioning distance classroom, while quality video has been found to increase participant satisfaction (see Sonnenwald et al.[8] for a summary of findings of the socio-technical aspects of videoconferencing). Specifically, it has been shown that the visual/auditory cues for turn taking during collaborative discussions in face-to-face interactions are often missing with videoconferencing,[8] leading to lack of the type of conflict that leads to innovative solutions as well as to lack of participation from the distance participants. Because video communication is a single channel of information, even combined with audio, it does not convey the complexity of real-time, spontaneous human interaction, especially with multiple people participating. Subtle, nonverbal communication can easily be missed or overlooked. Delays in the audio feed may lead to participants at remote locations being spoken over or not heard.

The program faculty mentors know the local students quite well as both scholars and as individuals, through participation in the seminar and often through student enrollment in a course or as an academic or research advisor. The mentors interact with the scholars often, sometimes very casually in a hallway or an office visit. For example, the student might convey to a faculty mentor the challenges with a course, team project, or other professional or personal issue while passing in a hallway. These interactions solidify the mentor-mentee relationship and build the sense of belonging to a community of scholars. Mentors are often able to connect students who can provide excellent peer mentoring because of the relationships they have with the scholars. Locally, mentors can truly mentor through listening, discussing issues, providing support, becoming familiar with the individual needs of the student, and supporting the student in identifying and obtaining goals. These interactions contribute to both student and STEM retention. Students at a remote location do not have these casual interactions with the off-site mentors, thereby losing mentoring opportunities. The faculty mentors have found that effective mentoring is strengthened by face-to-face interactions. Finding means to support the remote students in a similar way is a pressing need of the program.

The idea of the importance of face-to-face interaction has been incorporated into models of distance teamwork in industry. We can look to the agile software movement which bases their manifesto on the principle (among others) that "The most efficient and effective method of conveying information to and within a development team is face-to-face conversation."[9] This was developed in part as a reaction to requirements to always work at a distance, where teams found that they could work more efficiently when there was a foundation of in-person interactions. Built into our program are opportunities for face-to-face interactions to support the distance-based interactions. These include site visits and flexible meetings when remote students are on campus for other reasons.

Our Needs and Challenges

The needs of the weekly seminar involve connecting 4 distance students (and sometimes 1 faculty member) with the remaining 25 students participants and 3 faculty members meeting on the main campus. Some weeks, the seminar involves a guest speaker or student presentations so that the delivery of both the speaker's physical presentation as well as any media content (documents, power point, video, etc.) must be achieved. From a functional standpoint, we need all members of the cohort to feel connected to the larger group, to their teams and to any small group they may be interacting with. From a technological standpoint, our needs include having reliable quality audio-video connections. Additional technological needs include the ability to send multiple feeds for presentations and the ability to overcome large amounts of background noise during group discussions. Thus, having microphones able to pick up not just the presenters, but also audience comments during both large and small group discussions is key for our setting. Ideally, technology with auto-switching capabilities that identifies a current speaker would be of most benefit during group discussions.

As is supported in Sonnenwald et al.[8], quality audio seems to be necessary to the base function of tasks during seminar. Audio limitations and difficulties have lead to the most immediate dysfunction of tasks and source of frustration for the distance campus. We have found, as also supported in Sonnenwald et al.,[8] that quality video, on the other hand, is not as essential to short term task completion, but does lead to greater student satisfaction. Because our student groups often work on multi-week projects together and mentor relationships are essential to group dynamics, long-term task completion is highly effected by our limited video capabilities. That is, quality video seems to play a key role in community building which affects the long-term success of small group projects. Specifically, establishing the human connection among team members fosters healthier working relations. The need for an early face-to-face interaction among students and faculty is of great importance in further establishing this connection. We have found teams more willing to accept limitations of technology and have positive collaborations with people with whom they already have established relationships. For this reason, all students were present for the first meeting of the semester and there was a mid-semester social trip for the main campus students to the remote campus. These were used to establish personal connections, playing the role a conference serves in establishing such connections among professionals.

Implementation and Further Challenges

In choosing the appropriate technology for our setting, we have found that the interaction assumptions of technology designers are not congruent with our needs. There is substantial technology for delivering pure presentation content to audiences at multiple locations and separate technology for the collaboration of small groups. The former is particularly good at sending multiple feeds and establishing quality audio/video for a single performer. The latter generally excels in providing audio and visuals cues for turn-taking and isolates the group from distraction. Because our use is a mixture of these two settings, we have found some challenges in implementing the seminar to distance participants.

The main campus has substantial access to distance technology for the traditional settings. Several small rooms are available for video conferencing, one of which contains high quality video monitors for each distance participant, but most rooms host under 8 participants and these rooms are not clustered in a common area. For these small settings, new Cisco TelePresence Rooms on the main campus do an extraordinary job of creating the illusion that two sites are a single space. But, the equipment for this technology and that of other small spaces is expensive and not always available at the distance locations. For lecture style classes, the university maintains several Interactive Television (ITV) classrooms. These classrooms have separate cameras on the front of the room (presenter view) and the students (classroom view). Control of the camera is sometimes possible by the remote audience in order that they may zoom in on board-work or switch views depending on speakers. We currently use an ITV room for our seminar, but the remote campus is not able to implement this aspect, so camera control is on the main campus side, as is most presenting. A challenge for the presenter is to be aware of the experience for the remote participants at all times and conscience of the information being sent, without limiting the interaction with the local students. We often found that we were spending as much as ¼ of the seminar time establishing connections with the remote location and engaging with the students there. This was to the detriment of the students at the local classroom. Local students grew frustrated with the challenges of technology and the division of the mentor attention to the 4 remote students. In other words, 26 local students waited, often impatiently, while the mentors dealt with unforeseen technology issues such as remote students changing classrooms without notice, telecommunication being disrupted or timed out, or lack of audio on one side of the communication.

Our ITV technology is limited in its ability to send multiple feeds. We cannot send a view of information being projected (powerpoint, documents, etc) at the same time as video. The presenter must switch back and forth or stay with the one view or the other. Many inexperienced with this setup stay with presentation slides creating a less than ideal experience to the distance participant, who is left watching only slides and hearing audio. We therefore must plan ahead and send many presentation slides and documents ahead of time for distance participants to display on laptops while the ITV is used for video/audio. Unfortunately, speakers are often not fully prepared until moments before the seminar, thus confounding this solution.

The dynamic of a large student group, more than 30 students, frequently causes noise that challenges the telecommunication system, losing the ability to discern distinct voices. During small group break out sessions, we use netbooks, tablets or laptops for videoconferencing (i.e., Skype), but have found the background noise prevents sufficient audio performance to allow several groups to work in the same classroom. We therefore have needed to send groups to separate conference rooms in the area during this time. Bringing groups back together for large group discussion is time consuming and hurts the flow of our model. Faculty mentors were unable to join each group for discussion effectively. The availability of nearby spaces is an additional challenge. Our ITV rooms and small group conference rooms are not clustered to provide the option of eliminating the need for student laptops.

Because connection, audio and visual problems often arise, technology support staff is crucial. Our campus is fortunate to have strong resources in this area. However, the evening timing of the seminar (chosen to conflict with the fewest major classes) causes support staff to not necessarily be available at the moment of any problems. We have found it helpful to have a lead student among the distance participants (or occasionally a faculty member attend on the distance side) to be a point of contact should problems arise and to test new ideas. Most helpful has been the use of backup connections. Specifically, in addition to the ITV connection, we establish messenger chat connections with the lead distance student and a (non-presenting) faculty member at the main campus. This connection allows the distance students to communicate any technological issues, poor camera choices and difficulties in hearing comments. However, it is also helpful in providing students the opportunity to provide real-time written contributions to the discussion, with the point of contact on the main campus acting as an "interrupter" for the remote students so that they can more actively participate in the discussion. This has the additional benefit of establishing a personal connection between the distance student and their faculty mentor.

Although a classroom screen based video provided a means for communication, the technology does not yet satisfy the needs of the mentoring program. First, mentoring, both peer-to-peer, and faculty-to-student requires strong verbal and nonverbal communication. Expressing the needs of discipline specific programs of study often takes on nonverbal forms of communication such as demonstrable movements, animated gestures, and facial expression. Nonverbal communication is not always effectively communicated via video. In addition, in a successful mentoring program, a sense of trust and community must be established. We found that conferencing approaches alone offered a reduced interface that was severely limited in its ability to provide fulfilling engagement, both between students and faculty and between student groups. It was challenging to build trust as well as convey and interpret human needs and emotions via a screen. Combining face-to-face time with personal connections through phone calls and text messenger programs does seem to help.

What could be more ideal? A combination of room set-up and technology. A newly created space in our university is a modular style classroom that seats 45 students in computer clusters. The seating is arranged in clusters of 5 laptop stations around a shared plasma monitor (in u-shaped configuration) and serves the purpose of allowing student groups to collaborate on a variety of projects such as paper creating, programing, etc. Any group member can send their screen to the shared monitor and the instructor can share the screen of any laptop on one of two monitors at the front of the room. Such a setup might be ideal for our purposes due to a relatively low number of distance participants. Each distance participant could be displayed on one of the 9 plasma monitors "seated" with their group. Small group break-out session could be achieved quickly, although headphones would likely be necessary for background noise. However, this classroom does not currently have ITV capabilities, nor does each monitor have the ability to display a distance participant connected via a videoconferencing program such as Skype.

Student Feedback

Anonymous feedback from students was solicited using an online survey. Questions included one demographic question (year in school), 19 Likert-scale questions and 4 open ended questions. The Likert questions and their responses are shown in Table 1. Reverse coding was not used in order to be consistent with past uses of the survey. The survey was voluntary so out of 31 possible students, 14 responded.

The responses to Q1 – Q5 presented in Table 1 indicate the student's feelings of being connected to peers and faculty. Overall the student responses indicate a more secure feeling of connection with the S-STEM program faculty than within their individual academic programs (Q1 - Q2). The positive change in Q1 and negative change in Q2 shows that students are feeling even more connected with the S-STEM faculty and less connected with their academic program faculty this year compared to last spring. Although they may spend more hours each week in lecture or office hours with an academic program faculty, the interaction with faculty in the S-STEM program is more open and personal. One student commented,

> "This was my first semester in the MAX program and I was VERY pleased with it. The faculty mentors and students were inspirational and intriguing. I made a number of new

friends and learned more in this 1 credit class than most 4 credit exam-oriented classes I've had. Thank you for a wonderful semester."

Table 1: Likert-scale survey questions and responses by percentage of responses for fall 2011, N=14. Numbers in parentheses indicate change from spring 2011 responses (N=20). Responses are grouped into [Strongly Disagree/Disagree], [Neutral], and [Agree/Strongly Agree].

Question	SD/D	Neutral	A/SA
1. I have improved my connections to faculty members in the S-STEM program.	0(0)	7.1(-12.9)	92.9(+12.9)
2. I have improved my connections to faculty members in my academic program.	0(0)	21.4(+6.4)	78.6(-6.4)
3. I have improved my connections to other students inside the S-STEM program.	0(0)	0(0)	100(0)
4. I have improved my connections to other students inside my major.	0(0)	7.7(+2.7)	92.3(-2.7)
5. I have improved my connections to other students outside my major.	0(0)	21.4(-3.6)	78.6(+3.6)
6. I have outlined goals for my academic year that will move me towards my ultimate career goals.	0(0)	8.3(+3.3)	91.7(-3.3)
7. I have outlined goals for my academic year that will move me towards my ultimate personal goals.	0(0)	0(-5)	100(+5)
8. I have met the goals I outlined for this semester.	0(0)	35.7(-0.7)	64.3(+0.7)
9. I feel I will meet the goals I outlined for the academic year.	0(0)	7.1(-7.9)	92.9(+7.9)
10. I have experienced being mentored by a faculty member in the S-STEM program.	7.1(+2.1)	14.3(+4.3	78.6(-6.4)
11. I have experienced being mentored by a faculty member in my academic program.	0(-5.0)	28.6(+13.6)	71.4(-8.6)
12. I have experienced being mentored by a student in the S-STEM program.	7.1(-17.9)	42.9(+12.9)	50(+5.0)
13. I have experienced being mentored by a student in my academic program.	7.1(-12.9)	42.9(+17.9)	50(-5.0)
14. I have experienced being a mentor to other students in the S-STEM program.	7.1(-12.9)	42.9(+27.9)	50(-15.0)
15. I have experienced being a mentor to other students in my academic program.	7.1(+7.1)	35.7(+20.7)	57.2(-27.8)
16. In the S-STEM program I have developed my resume writing skills.	0	0(-10.0)	100(+10.0)
17. In the S-STEM program I have developed my skills in interviewing.	0	35.7(+0.7)	64.3(-0.7)
18. In the S-STEM program I have developed my skills in organizing information.	0	14.3(-20.7)	85.7(+20.7)
19. In the S-STEM program I have developed my skills in presenting information.	0	14.3(-5.7)	85.7(+5.7)

Responses to anonymous student feedback indicate there is a strong need for students to not only learn from faculty but to also feel connected with them. Despite the high agree / strongly agree response to Q1, student comments indicate that they would like even more connection with the S-STEM faculty:

"I would love to hear more about the academic work of the S-STEM advisors, as well as hearing about their experiences in Grad school...I know many of the S-STEM scholars will go on to grad school, and any knowledge passed on about how to succeed in as a grad student would be priceless..."

"The course provides a lot of interaction for student with different majors, but I would like to get to know the S-STEM faculty on a more personal level. Every monday when we meet, it seems like another class. From what I have heard, previous years were more interactive with the faculty. The S-STEM faculty is doing a great job as is, but I would love to get to know you all on a more personal stance."

The student's progress towards setting and achieving goals are captured in survey questions Q6 – Q9. The results presented in Table 1 show that the students have learned how to set goals and access their progress towards meeting their goals. Q16 – Q19 address other aspects of developing professional skills in the S-STEM scholars. The students expressed that the S-STEM program has strongly helped them develop their resume writing skills (Q16). Their development of interviewing skills (Q17) was less strong, however note that his topic is typically covered during the spring semester of the seminar course. The responses to Q18 and Q19 indicate that the S-STEM program is helping the scholars develop skills in organizing and presenting information.

The survey questions Q10 – Q15 are focused on mentoring relationships with their peers and faculty. Q10 compared to Q11 indicate a slight increase of faculty mentoring within the S-STEM program compared to their academic program. In examining the differences in questions 10, 12 and 14, students at the end of spring 2011 had spent an entire academic year with the faculty mentors and the scholarship cohort so are more likely to have experienced being mentored and mentoring.

Aspects of the distance communication with the remote campus were discussed by several of the students in the anonymous feedback. Their responses indicate an understanding of both the benefits and challenges of distance communication with a remote team:

"I think the overall idea of the students in both places interacting is a good one, but it is very hard to implement. Talking over skype and the ITV camera can make conversations difficult when it is hard to hear."

"As is, I think the way we communicate won't get any better without breaking the bank. Skype seems the best way to contact them. Without actually traveling there every week and seeing them in person, I don't think we can get any better."

Their understanding of the need for occasional face-to-face communication with a remote team was also expressed:

"I believe it would have been beneficial if there was more interaction between the remote campus and local campus scholars on their first visit. I know they were introduced on day 1, but I didn't feel like I knew them at all until we visited them at the remote campus, which was an excellent experience."

"Perhaps more visits?"

"There is little to improve the class, but I feel that interacting with remote campus more would help. This semester, when we went to the remote campus, it was nice to get to know them on a more personal side besides seeing them on a projector once a week. I would suggest planning at least one time per semester where we visit them or they visit us in person. This would provide networking as well as a way to interact with student that have a completely different learning system."

The need for face-to-face communication was simply expressed by one students through their comment on suggestions to improve the course:

"Sit in a circle....It's amazing how different communication is when everyone can see everyone else...."

Conclusions

Our lofty goals of simply expanding our peer mentoring network to include students at a remote site were not met as we had expected or hoped, although community was built across the student cohort. Many solutions were tried and some even worked to an extent. Our dream technology is still to be developed, perhaps by students who have had experiences they would like to improve. We would like to see one monitor per remote student, better streaming of information with multiple streams to carry multiple information channels, and noise-adjusting microphones to capture nuance and excitement of the entire group while carrying understandable words. Our experience shows that face-to-face experience supports the community and helps to overcome technology failures. We believe this approach is possible, but definitely improvable, especially if we keep the focus on supporting the student community.

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