STEM STEM Center Final Report

**The Sam Houston State University
STEM Center**

Mini-Grant Award

REPORT SUBMITTED BY

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STEM course enhancement – Final report

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Executive Summary

Through the STEM center course enhancement grant, we proposed to incorporate a student mentorship program within the revamped Introductory Digital Forensics and Information Assurance course series. The proposal was effectively executed and completed by introducing a mentorship initiative which involved the pairing of experienced upper-level digital forensics students from DFSC 2316.01: Introduction to Digital Forensics and Information Assurance – II (*an ACE certified course*) with students from DFSC 1316.01: Introduction to Digital Forensics and Information Assurance – I. By integrating student mentorship as a cornerstone of the revamped course series, we aim to create an inclusive and empowering learning environment where students can thrive academically and personally.

This approach will contribute to the overall success and development of our students, further solidifying the position of the Introductory Digital Forensics and Information Assurance courses as pivotal components of the Digital Forensics major. These sequential courses, known as DF-1 and DF-2, form the core and foundational classes of the Digital Forensics major thus, they play a vital role in fostering student retention and success within our department.

To effectively execute the grant, two DF2 students were appointed as the ACE (Academic community engagement) facilitators. These students were carefully chosen based on their knowledge, dedication, and grades in the DF1 class. As part of their duties, they were responsible for maintaining the Discord server created for the Mentor Mentee program, led the mentor mentee introductions and pairings, and acted as a direct point of contact and contribute their concerns and feedback on behalf of the students. All the communication regarding the mentor mentee program was facilitated by a Discord server created for the program with dedicated channels for each lab assignment, general communication, and resources.

As part of the mentorship program, the students of the DF1 and DF2 classes were given an opportunity to meet each other through a Discord call organized by the ACE facilitators. Through that, mentors and mentees were paired up with whom they could engage in regular one-on-one meetings and collaborate study sessions. To foster this supportive learning environment outside the classroom, mentors and mentees were assigned specific labs and projects to complete together. These hands-on activities would serve as opportunities for mentees to gain practical experience under the guidance and supervision of their mentors. We aimed that this collaborative work would not only enhance the technical skills but also foster teamwork and strengthen the mentor-mentee relationship.

Throughout the semester, two labs/projects and one collaborative exercise were given with a time span of two weeks to complete each lab. Upon completion of the labs, the points would then be accounted for as extra credit on the class grade which kept students motivated. After every lab, we conducted a survey to gauge the glows (strengths) and grows (areas of improvement) of the program. The feedback from the

first lab was then used to improve the next lab assignment. Overall, both the feedback surveys helped us gauge the effectiveness of the program.

Material Sponsored by the Grant

As part of the grant sponsorship, we developed and implemented materials for student learning. We developed two comprehensive digital forensics labs on key topics. These labs served as comprehensive guidelines that outlined a tutorial of the software, objectives, tasks and learning activities for student instruction. These instructions provide clear and concise directions, ensuring that students understand the purpose of the activity and can effectively engage with the provided resources.

To gauge student progress and understanding, we developed end of lab surveys. This allowed for the evaluation of students' performance and feedback on the mentorship program. Following the surveys, the results were compiled and analyzed. These assessment results provided valuable insights into the areas for improvement, and overall effectiveness of the program. The assessment outcomes helped inform future strategies and allowed for tailored feedback and support to enhance students' learning experiences.

By providing well-structured student instructions, implementing effective assessment tools, and analyzing assessment results, the grant-sponsored learning activities aimed to promote active student engagement, facilitate learning outcomes, and foster continuous improvement in the educational process through community engagement and mentorship.

Discussion

Results

By integrating this comprehensive mentorship program, we aim to create a nurturing environment that promotes peer-to-peer learning, encourages knowledge sharing, and fosters personal and academic growth. The mentorship program not only facilitated the acquisition of essential digital forensics skills but also fostered a sense of community and camaraderie among students within the department.

Additionally, the mentorship program extended beyond the classroom, providing mentees with access to a support system and a network of individuals who share similar academic and career goals. This aspect of mentorship was instrumental in fostering personal and professional growth, boosting student morale, and increasing retention rates within the Digital Forensics major.

By leveraging the expertise and insights of more advanced students, mentees benefited from personalized attention, gaining valuable insights into the intricacies of digital forensics and information assurance. Mentors, on the other hand, developed their leadership and communication skills while solidifying their own understanding of the subject matter through teaching and guiding their peers.

Figures 1 and 2 show the number of students from different majors in the DF1 and DF2 classes respectively. Additionally, the graphs also depict that prior to this course, majority of the students did not engage in any sort of mentorship activity. This observation sheds light on the prevailing lack of mentorship experiences among the students, suggesting a potential gap in their academic journeys before

encountering the course material. Figures 3 and 4 show the level of interest for cybersecurity after lab 1 and lab 2 for DF1 and DF2 students respectively on a scale of 1 to 5 (1 being not interested and 5 being very interested). These graphs depict a growing interest in cybersecurity among students as the mentorship activities progress. This is a key indicator of progress that we gauged. Additionally, Figure 5 depicts the positive change felt among the students by participating in the mentorship program between 1 to 5 (1 being no positive change and 5 being considerable positive change). This feedback was gathered after lab 2 so that students could analyze and understand the personal progress they have throughout the program. It can be seen that among DF1 and DF2 students most of the responses were between 4 -5 which indicates considerable progress observed by the students.

Another aspect the survey aimed to understand from the students was their personal goals from the program and whether they achieved those goals at the end of the program. Figure 6 shows a word cloud of the key skills/goals students wanted to acquire from the mentorship program. Key concepts circled around gaining knowledge, helping others, gaining extra credit for class, developing working knowledge of the software and developing teamwork skills. After the successful completion of the program, students were asked about the skills/goals they accomplished from the program as depicted by Figure 7. Majority of the ideas in the word cloud revolved around learning digital forensics concepts, gaining experience, building teamwork skills and many more majority of which students wished to accomplish on the onset of the program.
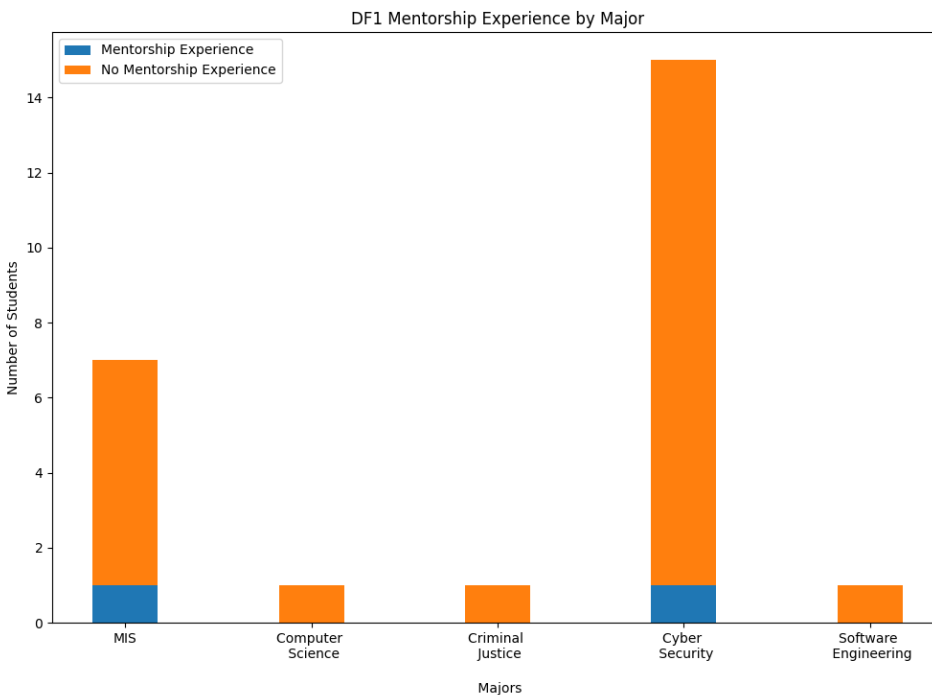

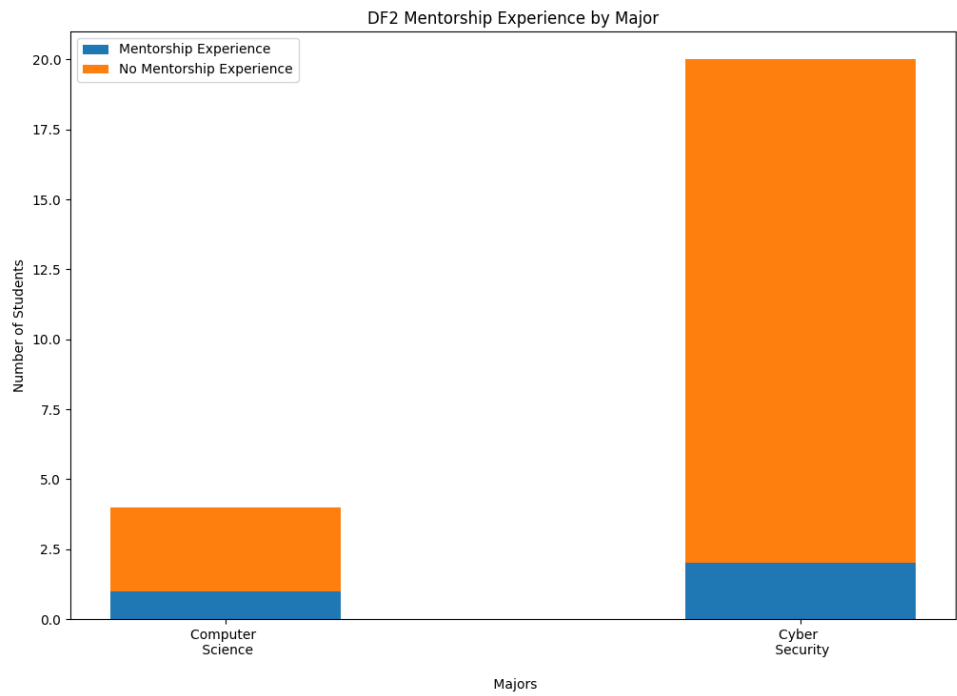*Figure 1: DF1 students mentorship experience by major*
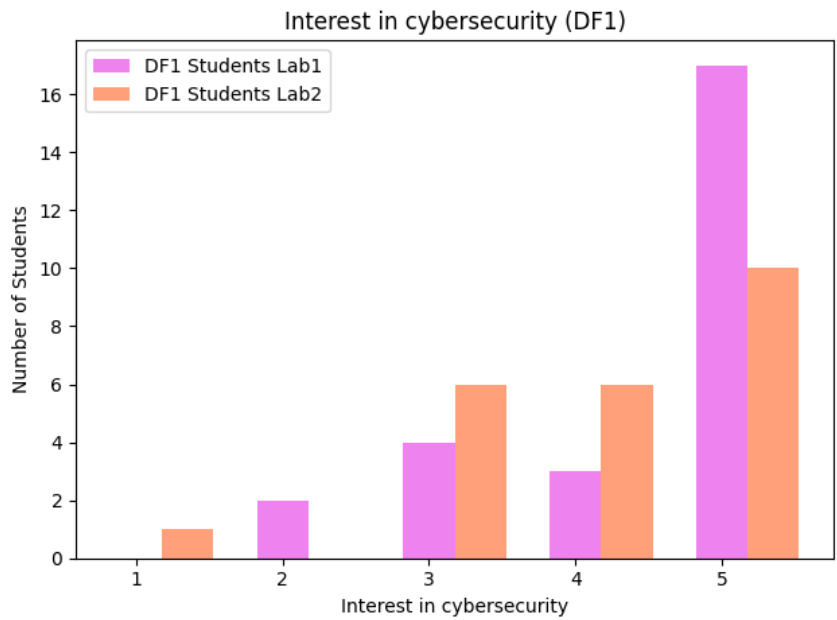
Figure 2: DF2 students mentorship experience by major

Figure 3: Level of interest in cybersecurity in DF1 students
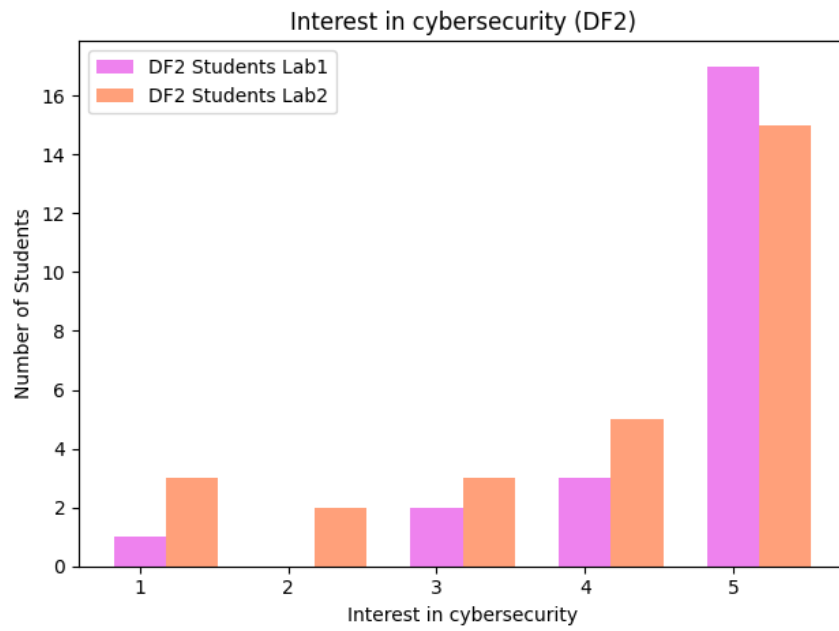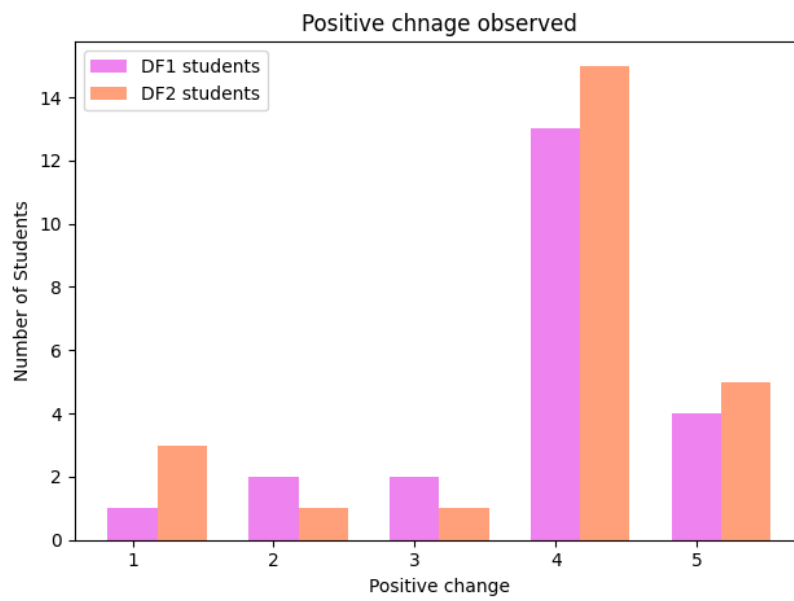
Figure 4: Level of interest in cybersecurity in DF2 students

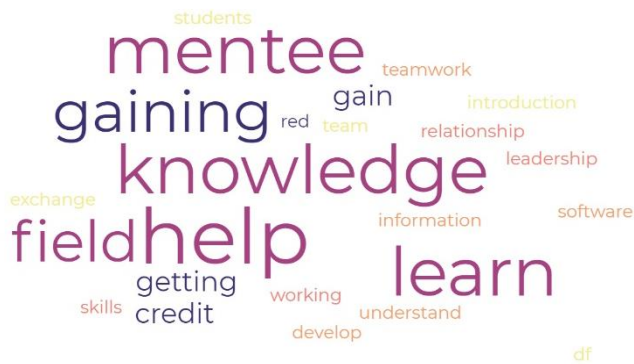*Figure 5: Positive change observed in DF1 and DF2 students*

Figure 6: Skills students aimed to get out of the program

Figure 1: Skills students gained from the program

Lessons Learned

The assessments conducted after every lab helped us gauge areas of improvement to help us effectively plan and execute the next mentorship activities as shown in Figure 8 and 9 respectively. Some of the feedback received included pointers on:

1. The mentorship activity should include dedicated time for mentorship meetings/exercises.
2. The mentorship should constitute of bi-weekly meetings with reports.
3. There should be video tutorials on downloading and using the software.

Some of the lessons learned during this preliminary mentorship exercise included:

1. Students should be able to choose whether they would like to participate in the program or not so that they can immerse themselves in the experience and reap the benefits of the program.
2. Students should be given more time to choose their mentor based on their interests and working styles.
3. There can be a better way of tracking personal progress throughout the mentorship program which can be executed with meeting reports.

Figure 8: Areas of improvement after iteration 1

Figure 9: Areas of improvement after iteration 2

Dissemination Plans

We aim to share and disseminate the findings of our study through a conference paper. This will help us reach a wider audience which would maximize the impact of our research and contribute to the knowledge base in the field.

To this end, we submitted the abstract attached below to the conference "IAFOR International Conference on Education in Hawaii (IICE) 2024" and it was accepted. We have now started working on the final paper for the submission.

Abstract

The impact of peer- and cooperative learning is two-fold: Not only do the mentees benefit, but the mentor also has a lot to gain. This forms the basis for our research. We seek to imbue active-learning and community-engagement pedagogical techniques into the introductory digital forensics course series, DF1 and DF2, at our institution. These courses are required by the Digital Forensics major and seek to transform

the freshman student into a digital forensic analyst by their junior year. Many students find this course series challenging. This leads to several issues: failure in subsequent courses, change of major, and a general degradation of student morale. An oft-repeated request from students is the availability of tutors/mentors for guidance. Lack of funding has been a primary impediment to alleviating this concern. Our research entails enlisting the DF2 students as mentors and pairing them up with specific mentees in the DF1 course, effectively creating a peer-learning community. The mechanics of our peer-learning implementation lends itself to making the classroom more responsive to diversity. It is well-known that instructors tend to orient themselves, in terms of both effort and positive affect, towards students whom they consider 'teachable' and steer away from students who they perceive to be difficult-to-teach. By pairing mentors and mentees with diverse backgrounds, and ethnicities, we are attempting to mitigate this issue and promote a robust and vibrant, diverse learning community. We request the opportunity to present our methods and processes involved in our research at the upcoming IICE 2024 conference.

Directions for future development

The DFSC2316 is ACE certified hence, we aim to keep holding the mentorship session between the students in the courses for effective learning. From the feedback received, we intend to make the following changes.

The mentorship program will commence at the beginning of each semester, with careful consideration given to matching mentors and mentees based on their academic interests, strengths, and compatibility. Mentors will be selected from a pool of accomplished and dedicated upper-level students who have demonstrated exceptional proficiency in the field of digital forensics.

To support the mentorship program, we will organize regular workshops and training sessions for mentors, equipping them with effective mentoring techniques, communication skills, and strategies for guiding their mentees through the digital forensics' curriculum. This investment in mentor development will ensure the program's success and provide mentors with the necessary tools to provide meaningful support and mentorship to their assigned mentees.

Artefacts of the project

We thank the STEM center for their support in helping this project come alive. Attached is an exercise document submitted by one of the mentor mentee pairs. In this document, they worked on a lab using a key digital forensic software to find insights and clues of the perpetrator.

Adobe Acrobat
Document

Original Proposal

A copy of the original proposal is pasted verbatim below.

STEM Course Enhancement
An Overhaul of the Introductory Digital Forensics, Cyber Security Course Series
Department of Computer Science

Grant Participants:

Drs. Narasimha Shashidhar, Cihan Varol. Professors in the Dept. of Computer Science.
Ms. Khushi Gupta, and Mr. Ishan Perera, Doctoral students in the Dept. of Computer Science.
Email: {karpoor, cvarol, kxg095, wdp006}@shsu.edu

Budget:

The total budget requested is $2000. (Less than $1,500 towards faculty stipends)

Participant	Stipend
Dr. Narasimha Shashidhar	$500
Dr. Cihan Varol	$500
Ms. Khushi Gupta	$500
Mr. Ishan Perera	$500
Grand Total	$2,000

STEM Courses targeted in the proposal:

This proposal constitutes an effort to overhaul the Introductory Digital Forensics and Information Assurance course series in the Department of Computer Science. The courses being targeted are:

- DFSC 1316.01: Introduction to Digital Forensics and Information Assurance – I, and
- DFSC 2316.01. Introduction to Digital Forensics and Information Assurance – II.

These DF-1 and DF-2 sequential courses serve as core and foundational classes in the Digital Forensics major and are instrumental in ensuring retention and success of students in this major for our department. These courses are offered in the Fall and Spring semesters and enrolls about 50 to 55 students each term. Our effort outlined in this proposal will be implemented in Spring 2023. There is only one section of each course being offered this Spring 2023.

Current and Pending Support Related to this Project: None

Project Narrative

Executive Summary (250 words): In this project, we seek to imbue active-learning and community-engagement pedagogical techniques into the introductory digital forensics and cyber security course series, DFSC 1316, and DFSC 2316. More specifically, the PI, Dr. Narasimha Shashidhar, has recently applied for and secured the ACE (*Academic Community Engagement*) approval for DFSC 2316 for Spring 2023 and subsequent semesters going forward. The Co-PI of the proposal, Dr. Cihan Varol, is a departmental representative for the Center for Community Engagement and a strong proponent of community engagement. Furthermore, both PIs are active participants in Cohort G, ACUE Fellows 2022-2023, facilitated by Dr. Todd Primm. Both the above-mentioned courses are core and required by the DF major and seek to transform the freshman student into a competitive forensic and cyber analyst as they enter their yearling phase of the program. It is unfortunate that many students find this introductory series needlessly challenging. This yields several deleterious issues: failure and dejection in subsequent courses, change of major resulting in program attrition, and a general degradation of morale at the inception of a student's career in the DF program. A common and oft-repeated request from students is the availability of tutors and mentors who can guide them through this initial stage. Lack of funding has been a primary impediment in our ability to alleviate this concern thus far. To this end, our proposal entails enlisting the DFSC 2316 students as mentors and pairing them up with specific mentees in the DFSC 1316 course, effectively creating a peer-learning community.

Rationale (sound pedagogical practices and current learning theories)

In a survey on peer- and cooperative-learning, Topping [1] notes that the impacts of peer-learning are two-fold: Not only are the mentees benefiting (obviously), but the mentor also has a lot to gain from the process. In addition, it is not only cognitive gains that are to be reaped, but there are also social and emotional gains to be enjoyed as well. It is this observation that forms the rationale for our current proposal. Lastly, the mechanics and procedural elements of our peer-learning implementation lends itself to making the classroom more responsive to diversity. It is well-known that instructors (and high-achieving peers) have a tendency to orient themselves, in terms of both effort and positive affect, towards students whom they consider 'teachable' and try to steer away from students who they perceive to be difficult-to-teach [2]. By pairing mentors and mentees with diverse backgrounds, and ethnicities, we are attempting to mitigate this issue and promote a robust and vibrant, diverse learning community. We discuss the methods, and processes involved in our proposal in the section below.

Materials and Methods

All students in the second course of the sequence, DFSC 2316, are required to serve as mentors by virtue of the fact that the course is designated as *ACE*. This necessitates at least a minimum of 13 hours of community and civic engagement outside the classroom (about an hour per week of

the semester). Both DFSC 2316 and DFSC 1316, meet on MWF. Fridays have been designated as *peer-learning ACE* days. Ms. Khushi Gupta, and Mr. Ishan Perera serve as instructor and graduate assistant for DFSC 1316/DFSC 2316 while Drs. Narasimha Shashidhar, and Cihan Varol serve as instructor and course/activity developer for DFSC 1316/2316. The first Friday of the semester, the proposal participants will identify and pair mentors and mentees from the two courses. Having established the framework, we then proceed to design course materials and hands-on activities that serve to intellectually stimulate students from both courses as discussed below.

Expected Results and Dissemination Plan

We are quite positive about our proposed approach and are confident that the benefits of this proposal, if funded, will boost morale among the freshman DF students, reduce attrition, and develop a scaffold structure that students can rely upon for their growth and development in-and out- of the classroom. We plan to collect data on our teaching and scholarly progress in this regard and based on the results, plan to attend and present our findings at the ACM (Association for Computing Machinery) Conference on International Computing Education Research (ICER) between 8th and 10th of August 2023, in Chicago, Illinois.

Budget and Budget Justification

We request a total budget of $2,000. This pays a $500 stipend for each of the grant participants while adhering to the constraint of being less than $1,500 towards faculty stipend. The two faculty members in the grant are being paid $500 for a total of $1,000. This budget is essential to defray the effort of the participants to develop lab activities that serve propitiously to both the course students. Also, we intend to draw heavily from the ACUE resources on ACUE's "*Effective Teaching Practices course*" for some of the active-learning techniques. Some techniques that we plan to implement in our hands-on peer-learning activities include *Jigsaw, Think-Pair-Share, Peer Teaching, Peer Editing, Problem-based learning, and role-playing*. The hope is that our approach can be repeatable in other areas such as the CS-1/CS-2 series as well (COSC 1436 and COSC 1437) where a similar ACE initiative is underway and taking shape.

References

1. Topping, Keith J. "Trends in peer learning." *Educational psychology* 25.6 (2005): 631-645.
2. Fuchs, Douglas, et al. "Peer-assisted learning strategies: Making classrooms more responsive to diversity." *American Educational Research Journal* 34.1 (1997): 174-206.