DEPAUL UNIVERSITY
CENTER FOR TEACHING AND LEARNING

SoTL Grant Proposal Form

To be considered for funding, your research proposal must align with the following definition of the Scholarship of Teaching and Learning, SoTL, endorsed by the University Faculty Council (January 2014):

"*The rigorous investigation of student learning, with the purpose of developing novel teaching methodologies and practices that can lead to the measurable enhancement of student learning. The results of the investigation are made public through quality scholarly outlets and widely-accepted conferences and general or discipline-specific journals.*"

I. Basic Information

Title of Project: Obstacles to Remote Cooperative Learning in Computer Programming Courses
Date of Application: September 18, 2020

Investigator(s) Information

Principal Investigator:

Name: Craig Miller
College: CDM
Department: School of Computing
Phone Number: 312-362-5085
Email Address: craig.miller@depaul.edu

Other Investigators (Co-Pi):

The proposal does not have other faculty or staff as Co-PIs. However, the proposal includes a team of 5 graduate students. Their names and majors are provided in the proposal narrative.

Will your project involve human subjects? ■ Yes ☐ No

The interview protocol has been submitted to the IRB and received approval (Protocol #JL060120CDM).

Requested Funds

Amount Requested (up to $2,500): $2400

II. Project Abstract (250 words or less)

This proposed study explores practices and obstacles of students remotely collaborating to learn computer programming. Working with a team of graduate students, we propose to interview students in an introductory programming course about their efforts to interact with peers for learning the course content. Drawing upon prior research on effective practices for collaborative learning, the goal of the interviews and their analysis is to determine what practices appear to be working and identify obstacles that remain. These findings are expected to lead to teaching guidelines for improving collaborative learning, particularly for, but not limited to, computer programming.

III. Project Description (1000 words or less)

Purpose

Given the context of student learning in introductory computer programming courses, the proposed research seeks to answer the following questions:

- Do students engage in effective practices for remote cooperative learning in computer science?
- What obstacles do students encounter that prevent them from engaging in effective collaboration?

Theoretical Framework

This study draws upon prior research and theoretical underpinning in two ways. First it considers established practices for effective cooperative learning in the context of programming (e.g., see Salguero, McAuley, Simon, & Porter, 2020). These practices include pair programming, where two students interactively construct a working computer program, and peer reviews, where students work on a question together and explain their answers to each other. As Salguero et al. (2020) explain, both of these practices provide a social context for synthesizing disciplinary content to construct explicit verbal summaries. Both practices elicit explanations from students, activities that have both theoretical and empirical support for student learning (e.g., Chi, De Leeuw, Chiu, & LaVancher, 1994). Theoretical models suggest that explaining how an example (e.g., a segment of a computer program) rederives a solution not only reinforces understanding but also induces the construction of new mental rules (VanLehn, Jones, & Chi, 1992).

Second, we consider well-reported obstacles that detract from learning, particularly identified in computer-supported cooperative learning (CSCL) and the computing education literature. Computer-supported communication often incurs mental costs that are not intrinsic to learning. Viewed as extrinsic cognitive load (Sweller, 2010), usability problems with computer software and other overhead for maintaining a collaborative dialog may be identified as possible obstacles to learning. Another potential obstacle may involve student inhibitions to contributing because they lack confidence in their ideas. Often framed as the “impostor phenomenon,” computing education scholars (Rosenstein, Raghu, & Porter, 2020) report that a majority of students question whether they are qualified to study computer science. While the phenomenon appears in majorities of students across all demographic groups, even higher rates have been reported among females and under-represented minorities. An open research question is whether (or how) computer-supported collaboration supports (or detracts from) student confidence and willingness to collaborate with their peers.

Research Methodology

In addressing the research questions on identifying collaborative practices and obstacles, the study seeks qualitative descriptions of student experiences as collected by interviews of students. The interviews will be conducted by a research team of graduate students, using a semi-structured protocol that includes prompts, as they are needed, for identifying when best practices (e.g., self-explanations) occur and for inquiring on obstacles that students encounter. In order to obtain detailed accounts, the interviews rely on a common method practiced in human-computer interaction (HCI), namely the contextual inquiry (Wixon, Holtzblatt, & Knox, 1990). For this method, the interviewer encourages participants to refer to artifacts (e.g., collaborative software), prompts them to recall recent instances of their use, and asks them to walk through a recent activity.

A team of graduate students will conduct up to 20 interviews from introductory programming courses (e.g., CSC 241). The team includes Jenny Chang (HCI), Katie Domines (HCI), Benjamin Green (HCI), Brandon Johnson (HCI), and John Lynch (computer science). Interview sessions will be recorded and transcribed. We then plan to conduct a bottom-up qualitative analysis akin to the approach presented by Oleson, Solomon, and Ko (2020). The resulting analysis should provide detailed descriptions of collaborative learning (when and if they occur) and difficulties students encounter.

The team of students has already developed the interview protocol. John Lynch (one of the students) has submitted the protocol to the IRB and received approval (Protocol #JL060120CDM). Pending funding of this proposal, the protocol will be modified to include $20 gift cards as incentives for students to participate in the study.

Impact of Project

At the immediate, practical level, the study will yield examples of best practices and guidance to instructors on facilitating collaborative learning in introductory programming courses. Recommendations may take the form of preferred communication tools and advice for how students may best work with each other. While some recommendations may be specific to programming practices, some practices, such as peer review, may apply more broadly to science, technology, engineering and mathematics (STEM) courses. As a longer-term goal, we seek to draw upon the qualitative analysis to design survey questions, which would provide better estimates of frequency and perceived effectiveness of the collaborative practices and tools. Theoretically, our observations may suggest possible relationships, such as a potential connection between anonymous communication and willingness to contribute, which may be further explored in future studies.

Dissemination of Results

We propose disseminating results at multiple levels of scope and formality:

- **Course level.** We plan to present and discuss findings from the analysis with course instructors, particularly for CSC 241.
- **College and institutional level.** The college and university offer diverse forums for presenting and discussing results. These include informal seminars, student-oriented symposia and the DePaul Teaching and Learning Conference. We plan to present our findings at one or more of these venues.
- **International research community**. We seek publication in leading peer-reviewed conferences and journals in computing education. These venues include the International Computing Education Research (ICER) conference, ACM Transactions on Computing Education (TOCE), Computer Science Education, and the ACM

Technical Symposium on Computer Science Education (SIGCSE). The principal investigator of this proposal has already published in and reviewed for all of these venues.

References

Chi, M. T., De Leeuw, N., Chiu, M.-H., & LaVancher, C. (1994). Eliciting self-explanations improves understanding. *Cognitive science*, *18*(3), 439–477.

Oleson, A., Solomon, M., & Ko, A. J. (2020). Computing students' learning difficulties in HCI education. In *Proceedings of the 2020 CHI conference on human factors in computing systems* (p. 1–14). New York, NY, USA: Association for Computing Machinery. Retrieved from https://doi.org/10.1145/3313831.3376149 doi: 10.1145/3313831.3376149

Rosenstein, A., Raghu, A., & Porter, L. (2020). Identifying the prevalence of the impostor phenomenon among computer science students. In *Proceedings of the 51st ACM technical symposium on computer science education* (p. 30–36). New York, NY, USA: Association for Computing Machinery. Retrieved from https://doi.org/10.1145/3328778.3366815 doi: 10.1145/3328778.3366815

Salguero, A., McAuley, J., Simon, B., & Porter, L. (2020). A longitudinal evaluation of a best practices CS1. In *Proceedings of the 2020 acm conference on international computing education research* (p. 182–193). New York, NY, USA: Association for Computing Machinery. Retrieved from https://doi.org/10.1145/3372782.3406274 doi: 10.1145/3372782.3406274

Sweller, J. (2010). Element interactivity and intrinsic, extraneous, and germane cognitive load. *Educational psychology review*, *22*(2), 123–138.

VanLehn, K., Jones, R. M., & Chi, M. T. (1992). A model of the self-explanation effect. *The journal of the learning sciences*, *2*(1), 1–59.

Wixon, D., Holtzblatt, K., & Knox, S. (1990). Contextual design: an emergent view of system design. In *Proceedings of the SIGCHI conference on human factors in computing systems* (pp. 329–336).

IV. Project Plan and Timeline

Describe the proposed project plan and timeline. *Please note grant funds need to be used by the end of the fiscal year.

Completed. The research team has already completed an interview protocol. John Lynch submitted the protocol for IRB review, which has been reviewed and approved (Protocol #JL060120CDM).

October 16. Submitted updated protocol (includes funding information and participant incentives) to the IRB for approval.

Week of November 9. Conduct 20 interviews with students.

January 2021. Complete analysis of interview protocols.

March 2021. Complete summary report and target it towards various venues (see Dissemination of Results).

V. Budget

The proposed budget provides support for conducting 20 interviews in the form of participant incentives ($20 gift cards) and stipends for students conducting interviews ($100 per interview). The student work includes time preparing and conducting interviews, analyzing interviews, reviewing all interviews and summarizing the results.

Description of Expense	**Cost Per Participant**	**Total Cost (20 participants)**
Gift cards as incentives to participate	$20	$400
Stipends for students on the research team who interview computing students and analyze the protocols	$100	$2000
Total Expenses	$120	$2400