# THE POWER OF DIGITAL PLATFORMS: FACILITATING THE COLLABORATION OF UNDERGRADUATE COMPUTER SCIENCE PROJECT TEAMS

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## ABSTRACT

A required undergraduate computer science 15-week project course at North Carolina State University, Department of Computer Science, USA, has grown rapidly in 29 years from serving 3 student teams to up to 39 teams. To maintain the integrity of the award-winning program and to facilitate the collaboration of hundreds of students in an academic year, the use of digital platforms to augment the face-to-face experience has become necessary. The use of commercial tools (Slack, Zoom, Google Workspace, and Panopto) are described. Customized digital tools to facilitate a feedback loop for student team assignments and to monitor student participation are also outlined. Balancing face-to-face advising with the creative and consistent use of appropriate digital platforms is a necessity for teaching and monitoring effective student collaboration.

## KEYWORDS

Computer Science Capstone, Digital Team Collaboration

## 1. APPROACH TO CAPSTONE PROJECT EXPERIENCE

The North Carolina State University, USA, Computer Science Senior Design Center (SDC) was formed in 1994. The SDC's mission is to educate undergraduate computer science students by providing a real-world software development problem (with industrial partners) and by teaching and integrating the principles of software engineering, teamwork, and professional communication in the solution of that problem. Student teams are expected to collaborate and develop software to solve a problem posed by industrial sponsors.

The SDC offers a 15-week capstone senior design project course taught by instructors with different areas of expertise. The course is team taught by the Director, a technical communicator and teaming specialist (on staff since 1996), and computer science teaching professors who serve as technical advisors to the student teams. Currently 30-40 individual teams (4-5 students/team) are formed each semester. Industrial sponsors provide problem statements and mentors to work with the student teams throughout the semester.

In the beginning, the instructors of the SDC worked with only 3-5 student project teams and senior design was designated as an elective course. By the early 2000s, the course became required for all undergraduate computer science students because it provided a robust communication and teaming experience. In a recent semester, the SDC faculty and staff were required to teach 5 sections; 194 students were placed on 39 teams collaborating on unique problems. Since the inception of the SDC, the teaching team has taught ~800+ teams of students and worked with ~225 different industrial sponsors. The pedagogical approach used in the SDC has been previously described (Carter et al. 2012, Fornaro et al. 2007, Scaturro Heil and Domínguez 2022).

As this experience evolved and grew over the decades, the teaching team was faced with the challenge of managing daily communication with dozens of teams and sponsors as well as hundreds of students. It has been necessary for the teaching team to augment face-to-face student interaction with the use of multiple digital platforms to facilitate collaboration between students, instructors and sponsors. These platforms include email, Slack, Zoom, Google Meet, Panopto, Google Calendar, and a custom-designed document submission system integrated into the course website. While digital tools allow us to accommodate our growing program in many ways, we continue to emphasize the importance of face-to-face communication.

## 2.  FACILITATION OF PROJECT EXPERIENCE WITH DIGITAL TOOLS

### 2.1 Commercial Tools

Normally, the SDC teaching team meets with students in person twice per week during class time; however, outside communication with teams necessarily occurs on a daily basis. The Pandemic required 100% virtual instruction. This required the use of Panopto, Zoom, Google Workspace, and Slack to replace face-to-face interaction with students. Since the University reopened for in-person instruction and as our enrollment has increased, these tools are being used on a regular basis as a part of the course experience (in addition to face-to-face interaction).

#### 2.1.1 Weekly Industrial Sponsor Meetings

The success of the student project teams is highly correlated to collaborating with industrial sponsors (or mentors) on a regular basis, so the mentors meet with student teams weekly. Many of these weekly meetings are conducted via Zoom or Google Meet; in our case, in one semester, this could total hundreds of meetings. There are many advantages to this method of meeting – it saves travel time to campus for sponsors and allows them to meet with students even if they are out of town, and participants can join when circumstances prevent them from meeting in person. Using digital platforms also allows faculty advisors to more easily join meetings when their expertise is needed. When compared to other semesters when these tools were not used, student teams often ended up not meeting with sponsoring mentors or faculty advisors as often as needed; this created lags in project understanding and progress.

#### 2.1.2 Faculty Advising Sessions with Student Teams & Class Lectures

This senior design experience is most successful if the students attend all class sessions and are actively engaged with the teaching team and each other. Effectively advising dozens of project teams in a 15-week semester is an overwhelming task; the students need assistance with technical details as well as guidance with communication assignments given throughout the semester (i.e., formal presentations and documentation). Recently, the teaching team has relied heavily on digital tools to facilitate such collaboration.

Slack, an instant messaging platform, has proven to be extremely useful when supporting students. For example, in the most recent semester, the Director and Assistant Director each monitored over 90 Slack team channels plus numerous individual channels on a daily basis. Via Slack, the teaching team can quickly answer student questions; in many cases, the instructors collaborate extensively for several hours with student teams, giving them technical tutorials and advice. Slack allows us to create dedicated workspaces for the course and for each team; when compared to using just email (which was the only digital platform used in previous years), Slack is more pointed and efficient. The teaching team is also more readily available to students outside of face-to-face class meetings via Slack; this remote interaction allows productive communication (and usually, improved project progress) in a timelier manner than if only meeting twice/week during class (as in years past).

Zoom or Google Meet are also used for technical advising sessions when face-to-face meetings are not possible. These tools allow instructors to meet with students more easily outside of class time. When needed, instructors also use Zoom or Google Meet to conduct a required teaming project management activity with each team every semester (Heil 2019). As our enrollment numbers have increased, student absenteeism is also on the rise. These digitals tools help to keep students included in activities when they would otherwise not be engaged. This digital inclusiveness has improved the accountability for each team member and hence, in most cases, has increased project productivity.

Lectures included in this course are recorded using Panopto, a video platform that allows the teaching team to securely share on-demand recordings. To encourage collaboration, attendance is required and students who miss lectures are expected to use Panopto to watch any unattended lecture. Panopto monitors whether or not absentee students have downloaded lectures. This tool facilitates students' review of lecture material.

### 2.2 Custom-Designed Tools

In this project-based course, student teams are expected to provide successively refined versions of a written software development project report and oral progress report presentations. These written and oral reports include extensive details related to Requirements Definition, Design, Implementation and Testing, and they

are expected to be completed collaboratively. Electronic and oral feedback from instructors is carefully scheduled and coordinated around due dates of these written and oral deliverables; students are expected to collaborate and respond appropriately to feedback at the next deliverable checkpoint. Each member of the student team is also required to keep an individual log of their personal contribution to the project as well as their activity as a team. Peer evaluations are also required four times during the semester.

### 2.2.1 Formal Communication Checkpoints

The Assistant Director of the SDC has created an electronic Submission System that allows feedback from multiple instructors to be given to the entire student team on written and oral deliverables. This system allows one instructor to download a document, for example, review, comment, and upload the commented document. The system notifies other instructors on the teaching team who then in turn can download that commented document, review, add additional feedback, and upload for the next instructor. The final reviewer can then electronically open the fully commented document for the student team to review. Before this submission tool was created, students were given handwritten feedback or multiple copies of electronic feedback from various instructors; this sometimes led to inconsistent or untimely feedback and confusion among students, which interrupted the development process. Maintaining the integrity of the SDC while enrollment has increased would not have been realized without this custom-designed digital tool.

### 2.2.2 Detailed Course Information & Student Logs/Peer Evaluations

The increased enrollment in this robust project course has created challenges related to the consistency of information dissemination. The Assistant Director has created and maintains a course website that is always updated with project listings, information for sponsors, and extensive course guidelines for students (Domínguez 2023). The student tab of the website includes syllabus and assignment rubrics (which are cross-referenced to course pack). Students also use this website to access customized Google calendars/section; the Submission System; class notes and lectures; as well as lab, technology, and testing resources.

Students use the course website to log time and to submit peer evaluations. This facilitates the monitoring of student collaboration and individual accountability, especially with hundreds of students (and enrollment on the rise).

## 3. CONCLUSION

University enrollments in computer science and information technology disciplines are increasing. The power of using digital tools to facilitate and monitor collaboration among student teams is apparent to those of us who manage 30-40 teams at one given time. There is a concern, however, that these tools could potentially be overused. Digital tools were used exclusively during the Pandemic; when the doors were open again for in-person learning, the SDC teaching team observed that students seemed unusually awkward, uncomfortable, and ineffective when interacting face-to-face. It became apparent that it was essential for our capstone experience to provide young, about-to-become computer science professionals with as many face-to-face learning opportunities as possible. As undergraduate enrollments increase in this discipline, educators must maintain the balance between the convenience of using digital tools and the need to teach foundational skills needed for effective face-to-face communication and collaboration.

## REFERENCES

Carter, M. et al., 2012. Creating a Progression of Writing, Speaking, and Teaming Learning Outcomes in Undergraduate CS/SE Curricula. *Proceedings of the World Engineering Education Forum (WEEF), Engineering Education for Sustainable Development and Social Inclusion,* Buenos Aires, Argentina, Abstract p. 262.

Domínguez, I., 2023. NC State University Computer Science Senior Design Center. https://sdc.csc.ncsu.edu/.

Fornaro, R. et al., 2007. Reflections on Ten Years of Sponsored Senior Design Projects: Students Win – Clients Win! *Journal of Systems and Software,* Vol. 80, No. 8, pp. 1209-1216.

Heil, M., 2019. A Project Management Activity for Student Teams in a Computer Science Undergraduate Capstone Project Course: Task Planning. *Proceedings of EduLearn19 Conference,* Palma de Mallorca, Spain, pp. 9072-9077.

Scaturro Heil, M. and Domínguez, I., 2022. A Practical Approach to an Undergraduate Computer Science Senior Design Project Experience: Partnering with Industry to Create an Effective Transition from Academia to the Next Chapter. *Proceedings of International Conference on Interactive Collaborative Learning Conference,* Vienna, Austria, pp. 921-929.