

Professional Achievement and Activity Summary Phillip T. Conrad—June 30, 2017

This summary of is prepared for a career review for promotion to Senior LSOE, and covers the period from initial appointment as LPSOE, November 1, 2007 through June 30, 2017.

Highlights

- 2009-2011** **Animal Tlatoque**—co-PI on \$533K NSF Broadening Participation Demonstration Project offering summer camps for middle school students, teaching Scratch in a culturally relevant context. Publications: one paper in CCSC-SW, and three SIGCSE papers. Collaborators: Diana Franklin, Gerardo Aldana, many grad and undergrad students.
- 2009-2013** **Studio-Based Learning (SBL)**—participant in NSF sponsored multi-institution study of SBL in Computing Education—offered CMPSC 56 once in traditional format, and twice incorporating SBL and reported data to study PIs.
- 2012-2015** **Dos Pueblos Engineering Academy**—designed programming curriculum (based on C and Arduino), and coached undergraduate student mentors for engineering program at a local public high school.
- 2013-present** **Exploring Social Programming Environments**—advisory board member for NSF grant at Washington State University. Provide feedback on PIs and research team on progress, and advise on future directions.
- 2014** **AppFolio Faculty Fellowship**—took on role of an "entry level employee" at a software-as-a-service startup company, to learn about current software development practices and tools (e.g. Agile, Rails, Github, Continuous Integration) in order to better inform curriculum.
- 2015-present** **submit.cs Autograder System, and replacement system (Anacapa Grader)** Took on support and maintenance of autograder system that had become crucial to UCSB CS department course offerings, after Ph.D. student that developed it and his advisor both left UCSB. Actively developing replacement system.
- 2015-2016** **UCSD CSE Summer Program for Incoming Students (SPIS)**—instructor for summer program offered by UC San Diego's Department of Computer Science and Engineering for incoming freshman students.
- 2016-present** **Santa Barbara High School Computer Science Academy**—developing curriculum for new year long course, Designing Software for the Web. Member of Visioning Committee.
- 2016-present** **Listening to Developers Study**—outgrowth of work on CMPSC 56, a study of the barriers developers encounter in their transition from CS degree programs to work in the software industry. Collaboration with Michelle Craig and three undergraduate students.
- 2016-present** **Evaluating Test Suites in CS Education Contexts**—an outgrowth of work with submit.cs autograder—examines how to apply software engineering techniques to evaluate instructor test suites used for autograding. Collaborators: Kyle Dewey, Michelle Craig and one undergrad student. One ITICSE paper.

Details of Selected Activities

2009-2011 Animal Tlatoque

This project was a three year \$533K NSF Broadening Participation Demonstration Project. The lead PI was Diana Franklin (UCSB CS Department), with Gerardo Aldana of UCSB's Department of Chicana and Chicano Studies and I serving as co-PIs.

This project was part of an NSF effort at "Broadening Participation in Computing", i.e. increase the number of people from groups underrepresented in Computing, at every stage in the "pipeline". Our project aimed at middle school students, since the choices students make in middle school (in terms of which courses they take as they transition to high school) is crucial in determining future access to Computing, and STEM fields in general. We targeted female students, and because of the demographics of Southern California, Latina/Latino students.

We offered a summer camp around themes that, based on prior work, we believed would attract the target audience: animal conservation, and Mesoamerican history and culture. Our themes were successful in attracting students from the targeted groups and by offering a curriculum based around digital storytelling using Scratch programming, we were also successful in increasing interest in computing careers (based on pre- and post-surveys).

The full title of the grant was *A Synergy between Mesoamerican Cultural History and Endangered Species to attract and retain Latina/os and Females in Computer Science* (Award 0940491).

Results of this project were published in three papers a SIGCSE, a double-blind peer-reviewed conference for Computer Science Education, including nine undergraduate co-authors.

- Diana Franklin, Phillip Conrad, Gerardo Aldana, and Sarah Hough. 2011. Animal tlatoque: attracting middle school students to computing through culturally-relevant themes. SIGCSE '11, 453-458. DOI: <http://dx.doi.org/10.1145/1953163.1953295>

(SIGCSE '11 accepted 107 papers of 314 submissions, a 34.1% acceptance rate.)

- Diana Franklin, Phillip Conrad, Bryce Boe, Katy Nilsen, Charlotte Hill, Michelle Len, Greg Dreschler, Gerardo Aldana, Paulo Almeida-Tanaka, Brynn Kiefer, Chelsea Laird, Felicia Lopez, Christine Pham, Jessica Suarez, and Robert Waite. 2013. Assessment of computer science learning in a scratch-based outreach program. SIGCSE '13, 371-376. DOI: <http://dx.doi.org/10.1145/2445196.2445304>

(SIGCSE '13 accepted 111 papers of 293 submissions, a 37.9% acceptance rate.)

- Bryce Boe, Charlotte Hill, Michelle Len, Greg Dreschler, Phillip Conrad, and Diana Franklin. 2013. Hairball: lint-inspired static analysis of scratch projects. SIGCSE '13, 215-220. DOI: <http://dx.doi.org/10.1145/2445196.2445265>

(SIGCSE '13 accepted 111 papers of 293 submissions, a 37.9% acceptance rate.)

2009-2013 Studio-Based Learning (SBL)

After participating in a workshop on Studio Based Learning (SBL) at SIGCSE 2009, I was recruited as a participant in a multi-institution study of Studio Based Learning sponsored by a NSF CPATH II grant, *Collaborative Research: Broadening Studio-Based Learning in Computing Education*. The PIs were Chris Hundhausen (Washington State, NSF award [939017](#)), Hari Narayanan (Auburn, NSF award [939055](#)), and Marthy Crosby (University of Hawaii, NSF award [939157](#)).

The four-year study spanned collected data from 19 courses at 15 US schools, spanning a variety of campuses (public/private, 2-year/4-year, R1s and primarily undergraduate institutions, and some minority serving institutions.) I participated in a faculty development workshops at the start of the grant period to learn about SBL, how to prepare an IRB application and obtain informed consent from participants, and what kind of data would need to be collected from both a course offered in a traditional and a studio-based format.

For purposes of this study, the defining feature of SBL was the inclusion of a "design crits"—i.e. expert and peer critiques of works in progress, as has been traditionally done, for example, in Art and Architecture education. For CMPSC 56, this took the form of face-to-face peer code reviews of student solutions, as well as reviews by instructional staff, with the opportunity for revisions. I offered CMPSC 56 one in a "traditional" format as a control (i.e. without the inclusion of SBL elements), and twice in "studio-based" format. I collected pre and post test data on student mastery of important course concepts, as well as a pre and post surveys that were measures of self-efficacy and a sense of community.

A second faculty development workshop was held to discuss the interpretation of the results which failed to show that SBL made a significant difference in the outcomes measured. There was, in general, no statistically significant difference in mastery of course content between the SBL and traditional offerings. For self-efficacy and sense of community, there was also no measurable difference, though for CMPSC 56, this may have been due to "ceiling effects"—there wasn't much room for improvement from the pre-test measures, possibly due to the UCSB CS department already having very high measures on the instruments used.

In spite of the negative results, there was a sense among faculty that the SBL interventions had a positive effect on students' so-called "soft skills", i.e. the professional communication and collaboration skills that are highly valued both by employers and accrediting agencies such as ABET—but we had not collected the right kind of data to be rigorously test that hypothesis. My subsequent work in CMPSC 56, and the "Listening to Developers" survey I am currently undertaking with Michelle Craig represents two avenues of follow up work on further exploring questions about how to better prepare students in terms of their "soft skills".

For me, the key benefits of my participation were (1) the opportunity to learn from the PIs about how to conduct rigorous research in Computing Education, (2) the opportunity to interact with a community of practice—CS educators from 15 widely varying institutions across the US, and expand my professional network (3) the chance to think critically about my course design for CMPSC 56 with this community.

2015-present submit.cs and Anacapa Grader (autograder systems)

The autograder system in use at UCSB, submit.cs began as a means for a Ph.D. student to investigate a research problem as part of that student's dissertation research. As soon as it became available, many instructors found it extraordinarily useful, and over the three subsequent academic years, usage rose from 3 course (2012-2013), to 10 courses (2013-2014), to 15 courses (2014-2015).

This is the point at which both the grad student that developed the system (Bryce Boe), and his faculty advisor (Diana Franklin), left UCSB. Both out of necessity and sensing an educational opportunity—at the end of Spring 2015, I took on the support of the system, as well as undertaking the project of replacing it with something easier to support and maintain going forward. The submit.cs system was built as the work of a single programmer, with the primary goal being completion of dissertation research, rather than long-term life cycle support.

The opportunity I saw was to take on the design, and long-term maintenance of a software system with real users in collaboration with students, as part of the academic curriculum. My vision is that the replacement system will not only be used in the academic curriculum of UCSB CS as a tool, but that the design, maintenance and support of the system can become part of that curriculum. In so doing, we address the central theme of my teaching and professional activity—closing the gap between academic software development, and authentic real-world software development practices. The name we chose for the replacement system is Anacapa Grader, named for Anacapa Island (visible from the UCSB campus). Work began on Anacapa Grader in Fall 2015, with an MS project by Hunter Laux, completed under my supervision. Work continued in Winter 2016 with a CCS course organized around work on the project, and a collection of undergraduate independent studies in Spring 2016.

During the study leave I took in Winter and Spring quarters of 2017, I had the opportunity to focus on this project with MS student Nick Brown, who worked on the replacement system as his MS Project. A major theme unifying the replacement system was to avoid reinventing the wheel—that is to reuse existing off-the-shelf solutions to problems wherever possible, and minimize the amount of custom code that would have to be written, tested, and maintained.

Hunter Laux's MS project had already shown how much of submit.cs could be replaced with features available in a version control system known as Github. During the study leave period, Nick Brown and I took this a step further, and showed how to replace a significant portion of what remained with an off-the-shelf automation server known as Jenkins. Nick and I worked alone throughout Winter 2017, and then brought three additional undergraduates into the project in Spring 2017—Gareth George, Carson Holoien, and Connor Armbrust Mulcahey. By the end of the study leave period, we not only had a working system, but had also shown that we could automatically convert assignment specifications from the legacy submit.cs into equivalent specifications for the new system.

There are some additional steps that need to be taken before the replacement system is ready to go live, including working out logistics of support with the College of Engineering Computing Infrastructure (ECI) staff, additional testing, some work on the user interfaces. I anticipate this work to be completed within academic year 2017-2018. The construction of "yet another autograder" in and of itself, may or may not be publishable—however, as indicated below, there is the possibility of using the data in the system as a basis for many areas of CS Education research.

2016-present Santa Barbara High School Computer Science Academy

Santa Barbara High School, a local public high school, provides space for a Computer Science Academy, supported jointly by the school district, and donations to a non-profit foundation.

In Fall 2016, I was invited by Richard Johnston, the director of the academy, to join the Visioning Committee, an advisory board comprised mostly of local tech industry leaders.

Later, I was invited to design a curriculum for a new year-long course in full-stack web development.

The course I designed for the academy, titled *Designing Software for the Web*, is intended as a second or third year course in Computer Science, in which students will learn programming, design patterns, data management, scalable cloud computing, and principles of collaborative software development for full stack web application development, including both front-end (browser side) and back-end (server side) code.

Students will demonstrate mastery of these skills by constructing web applications using HTML, CSS, JavaScript for the front-end, and Python for the back end.

The goals of of this course are:

- to develop students' critical thinking skills via the application of computational thinking practices in solving problems and developing algorithms, in an academically challenging way,
- to develop students' written and oral communication skills via team-oriented software engineering practices.
- to develop students' ability to take responsibility for their own learning, by scaffolding them towards independence in learning new skills and technologies
- to develop students' interest in further study of Computer Science by offering engaging problem solving experiences in a relevant, modern context, i.e. web applications.

I collaborated with Sky Adams, the high school teacher scheduled to deliver the course in the 2017-2018 academic year, on an outline of the learning objectives and key assignments for each unit of the course as part of preparing a submission to the UC A-G Course Approval Process (the process by which high school courses in California are approved as acceptable preparation for admission to the UC system).

I also offered a three-day professional development training to Ms. Adams (June 26-28, 2017) to help her prepare to teach the course.

I plan to continue supporting the SBHS CSA academy and Ms. Adams as this course is delivered this coming academic year.

2016-present Evaluating Test Suites in CS Education Contexts

Together with UCSB Ph.D. Candidate Kyle Dewey and a CS undergraduate student, Elena Morozova, we completed a study on the evaluation of instructor test suites (as used, for example, by the submit.cs autograder) using a technique known as Constraint Logic Programming.

This led to a conference publication at ITICSE 2017 (a double-blind peer reviewed conference in Computer Science Education with a 32% acceptance rate—56 of 175 submissions.)

- Kyle Dewey, Phillip Conrad, Michelle Craig, and Elena Morozova. 2017. Evaluating Test Suite Effectiveness and Assessing Student Code via Constraint Logic Programming. In *Proceedings of the 2017 ACM Conference on Innovation and Technology in Computer Science Education* (ITiCSE '17). ACM, New York, NY, USA, 317-322. DOI: <https://doi.org/10.1145/3059009.3059051>

I have discussed possible follow up collaborations with Kyle Dewey—while there are no specific or concrete plans for those as of now, once the Anacapa Grader system is complete, there is the potential for synergy between these two projects—that is, the Anacapa Grader system provides a laboratory in which many hypotheses about instructor and student generated test-cases can be investigated.

2016-present Listening to Developers Study

Throughout the academic year, 2016-2017, I hosted a visitor, Michelle Craig, an Associate Professor (teaching-stream) on sabbatical leave from the Computer Science department of the University of Toronto. During her visit, Michelle and I began a collaboration on a qualitative study based on interviews with early career developers, along with three CS undergraduate students, Dylan Lynch, Natasha Lee and Laura Anthony.

This work is based on an analysis of twenty interviews with graduates of 4-year degree programs in CS that have been in the workforce between one and five years. We are investigating what barriers developers encounter in their transition from CS degree programs to work in the software industry.

The motivation is to provide a basis for further study of whether the innovations I have been making in CMPSC 56 are helpful in addressing real needs. While I believe that the innovations in CMPSC 56 are valuable, my basis for that belief is anecdotal. Our work is trying to establish a more rigorous foundation for that work, through direct investigation, and through an examination of the prior work in the field.

During the study leave period, we made significant progress on a draft paper, and we anticipate submitting it to a peer reviewed conference during academic year 2017-2018.