New Orleans JAZZED about Engineering Education

Paper ID #14553

Integrating a Faculty Summer Workshop with a Faculty Learning Community to Improve Introductory STEM Courses

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Dr. Jackie Greene is Assistant Director of the Lucas Center for Faculty Development at Florida Gulf Coast University. She worked in faculty development during her career with public schools, the National Board of Professional Teaching Standards, and in her current position. She is involved with the SPARCT Program as a member of the planning committee and she analyzes the qualitative data for program review and assessment purposes. Dr. Greene received her degrees from Kent State University and Florida Gulf Coast University.

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Abstract

The STEM Professional Academy for Reinvigorating the Culture of Teaching (SPARCT) Program at Florida Gulf Coast University (FGCU) combines a 36-hour May faculty workshop followed by an academic year-long faculty learning community (FLC) focused on evidence-based teaching practices. Participants teach introductory STEM courses and commit to 1) actively participating in both the May workshop and academic year FLC, 2) implementing changes in their introductory course based on one or more of the teaching practices introduced and 3) developing a scholarship of teaching and learning (SoTL) project based on experiences in their revised course. The summer academy includes multiple evidence-based teaching practices (such as POGIL, Mental-Model-Building, and Project Based Learning), an introduction to SoTL and IRB processes, and time for reflection and cross-disciplinary discussion of potential applications of each practice into participant courses. Discussion on the progress of participant SoTL projects and classroom peer observations both within and outside participant programs are the key components of the academic year FLC.

May 2014 and academic year 2014-2015 witnessed the first offering of the SPARCT Program, which engaged 16 STEM faculty members from across the University. The second offering is currently underway, with an additional 16 STEM faculty members who, over the two years, represent a broad spectrum of STEM faculty. Faculty development is chronicled through video interviews with participants. Additional data collected includes student retention, interest, and confidence in SPARCT introductory courses, and faculty feedback on programming. Qualitative data and results collected from the videos and quantitative data from the student surveys and faculty feedback will both be discussed. Advice and lessons learned for others interested in developing a similar program will also be discussed.

Background and Need

Florida Gulf Coast University is a comprehensive, public university founded in 1997 to address the educational needs of the Southwest Florida population. It is a predominately undergraduate institution with a primary focus on high quality undergraduate education. The Carnegie Foundation classifies FGCU as a full-time, 4-year, selective, very high undergraduate enrollment (VHU) institution with large Master's programming. As of the fall of 2015, undergraduate enrollment was over 14,000 students and comprised almost 90% of the campus student population. Enrollment includes 56% women and 30% racial and ethnic minorities[1]. In state students comprise over 90% of the student population with 50% of these students coming from the University's five-county service area. At last count, 26% of all undergraduate majors at FGCU were classified as STEM. Of these, 32% are minority (21% Hispanic) and 46% are female[2]. A two year tracking of 468 entering freshman at FGCU in 2009 indicated that only 41%

of freshman persist in STEM majors, 36% drop out of school, and 32% switch to majors outside of STEM after two years[3]. A six-year study (2003 – 2009) by the U.S. Department of Education examining students entering STEM degree programs at 1,600 institutions nation-wide indicates 51.7% persist in STEM, 20.2% drop out of school, and 28.1% switch to a different major outside of STEM[4]. Improving these statistics is vital to regional, state, and national economies and in keeping U.S. students competitive in the global workplace.

Our strategy to increase persistence in STEM majors is to train STEM faculty in evidence-based practices in STEM teaching and learning at the post-secondary level while improving overall course design in introductory STEM course offerings. The SPARCT program includes both a STEM summer academy followed by an academic year Faculty Learning Community (FLC). As Henderson et al. recognizes collaborative efforts between a STEM education center and a teaching and learning center as a highly productive strategy for change[5], SPARCT is coordinated by the directors of both the Whitaker Center for STEM Education and the Lucas Center for Faculty Development.

SPARCT Academy

Participants' first engagement with the SPARCT Program is in the SPARCT Academy, a 36-hour summer workshop hosted during the month of May. The primary goals of the summer workshop are to introduce faculty members to evidence-based practices that have been proven effective in engaging students in topical learning and increasing students' content knowledge. The workshop integrates theory and practice, providing enough theoretical background to allow participants the ability to recognize that these approaches are grounded in research, while also including practical applications and examples of each approach. Related topics, such as science of learning (research from cognitive science), course design, working with college students, assessment, and the Scholarship of Teaching and Learning (SoTL) area also included in the workshop. A summary of the schedule for both the 2014 and 2015 summer academies can be found in Table 1.

Several changes were made to the schedule from year 1 to year 2 based on feedback from the participants and the observations of the SPARCT planning team. One of the main changes involved the timing of the summer academy. While the first offering occurred over a 10-day period, the second was shortened to an 8-day period, with a slight extension of time on most days and the inclusion of a second full day of activities in lieu of solely half-days after the first full day. The daily extension allowed for the integration of additional discussion time for each topic, something identified as a potential area for improvement in the first offering. The addition of a second full day allowed for the same overall time to be committed to the workshop while reducing the number of days the workshop was run. One of the challenges of a workshop of this scope is providing a vast amount of information in a manner that allows participants to reflect and consider how they might integrate these new processes into their courses, and yet not extending the program to a length that inhibits participation in the program itself. Other changes included the shift from a general discussion of SoTL to combine assessment and SoTL, with an

explicit discussion of IRB as well. Additionally, the final presentation day was augmented in the second year with an alumni panel from year 1. At the culmination of the workshop for both summers, participants were encouraged to continue developing their lesson plans and SoTL projects with an understanding that the discussions and group activities would continue throughout the academic year in the form of a faculty learning community (FLC).

Table 1: SPARCT Academy (Summer Workshop) Schedule for 2014 and 2015

2014	**Topics**	**2015**	**Topics**
Day 1 May 12, 2014 9 a.m. – 4 p.m.	Student Engagement AM: Classroom Environment and Working with College Students PM: Real World STEM	**Day 1** May 11, 2015 9 a.m. – 4:30 p.m.	Student Engagement AM: Classroom Environment and Working with College Students PM: Real World STEM
Day 2 May 14, 2014 1 p.m.—4 p.m.	Course Design	**Day 2** May 13, 2015 1 p.m.—4:30 p.m.	Cognitive Science Research Course Design
Day 3 May 15, 2014 1 p.m.—4 p.m.	Outcomes and Assessment	**Day 3** May 14, 2015 1 p.m.—4:30 p.m.	Conceptual Change Model
Day 4 May 19, 2014 1 p.m.—4 p.m.	Process Oriented Guided Inquiry Learning (POGIL)	**Day 4** May 15, 2015 1 p.m.—4:30 p.m.	Flipping the Classroom and SCALE-UP
Day 5 May 20, 2014 1 p.m.—4 p.m.	The Flipped Classroom	**Day 5** May 18, 2015 9 a.m. —4:30 p.m.	A.M. Process Oriented Guided Inquiry Learning (POGIL) P.M. Team-Based Learning (TBL)
Day 6 May 21, 2014 1 p.m.—4 p.m.	Conceptual Change Model	**Day 6** May 19, 2015 1 p.m.—4:30 p.m.	Problem/Project Based Learning (PBL)
Day 7 May 22, 2014 1 p.m.—4 p.m.	Problem/Project Based Learning (PBL)	**Day 7** May 20, 2015 1 p.m.—4:30 p.m.	Assessment and IRB/SoTL
Day 8 May 27, 2014 1 p.m.—4 p.m.	Implementation	**Day 8** May 21, 2015 1 p.m.—4:30 p.m.	Alumni Panel and SPARCT participants present
Day 9 May 28, 2014 1 p.m.—4 p.m.	Scholarship of Teaching and Learning		
Day 10 May 29, 2014 1 p.m.—4 p.m.	Publications, Promotion, and Presentations		

Academic Year FLC

FLCs create connections for instructors from various but related disciplines to further their understanding of pedagogical issues, meet faculty expectations for establishing community, and support multidisciplinary curricula[6]. STEM teaching is more effective and student achievement increases when instructors are involved in FLCs[7-8]. The academic year FLC is scheduled to meet approximately once a month for 90 minutes. As with the summer academy, meetings include time for updates and discussions in addition to a relevant topical seminar. Seminar topics for both academic year FLCs are presented in Table 2.

Table 2: Academic Year FLC Professional Development Seminar Topics

Month	2014 – 2015 Academic Year FLC	2015 – 2016 Academic Year FLC
August	Observation Strategies and Implementation	Observation Strategies and Implementation
September	Levels of Learning: Teaching and Assessment	Levels of Learning: Teaching and Assessment
October	The Multimedia Principle	Understanding Cognitive Science: Steven Chew Video series activity
November/ December	Testing what we teach – STEM Education Seminar	Guest Speaker, Mark McDaniel, Cognitive Science Researcher
January	Using Student Evaluations as Formative and Summative Assessment	Using Student Evaluations as Formative and Summative Assessment
February	Academic Writing Workshop	Choice of Two: Writing Workshop or POGIL workshop (Advanced)
March	Using SCALE-UP Classrooms	Choice of Two: Using SCALE-UP Classrooms or PBL: Facilitation
April	Final Interviews Wrap-up event with SPARCT 2014/2015 groups	Final Interviews Wrap-up event with SPARCT 2014/2015/2016 groups

Topics for the first two meetings of the FLC remained the same for both program offerings. The first of these included a status update from each of the participants as well as an open discussion on any questions or concerns. Additionally, this first meeting is where participants are introduced to peer observations, an additional component of the academic year activities. All participants are asked to both observe and be observed by at least two different colleagues – preferably one within their department and the other outside of their department. All participants are provided a general observation protocol and the expectations associated both with being observed and conducting an observation. Observation scheduling is conducted on a one-on-one basis to ensure compatible schedules between both individuals. Observers are asked to complete an observation worksheet that not only provides feedback to the individual they are observing but also asks them to reflect on insights gained by observing and how that influenced their teaching. The Levels of Learning topic focuses in more detail on aligning outcomes, activities, and assessments and examining the cognitive levels of learning required of the students. This session was

provided by our outside evaluator while visiting. Subsequent seminar topics varied slightly from year to year and were primarily based on interests expressed by participants and integration with other campus opportunities. Several of these presentations are open to more than just SPARCT Program participants, allowing for benefits to be obtained by a wider audience.

Participants and Projects

Sixteen participants engaged in the SPARCT program in each of the two years to date. These participants include representation from the following STEM programs on campus:

- Bioengineering (1)
- Biology (4)
- Chemistry (5)
- Civil Engineering (1)
- Environmental Engineering (2)
- Environmental Studies and Marine Sciences (4)
- Geology (1)
- Mathematics (9)
- Physics (3)
- Software Engineering (2)

The participants represent all STEM departments in both the College of Engineering and the College of Arts and Sciences on campus. The 32 participants are approximately 25% of the STEM faculty on campus and roughly 6% of the total faculty on campus.

Of the 16 participants in the 2014-2015 cohort, eight presented results of their SPARCT SoTL projects at professional conferences[9-14], and two additional individuals sought further training in evidence-based practice (POGIL). Three of these faculty also presented at the University's Research Day. As of this writing, two participants from the 2014-2015 cohort are considering presenting in the next six months.

Assessment Results

The assessment plan for the SPARCT program was rigorous and comprehensive. Components of the plan included quantitative survey instruments, qualitative video interviews at checkpoints during their participation, self-report data from participants, and the services of an external evaluator. This plan provided data for program review, progress monitoring, and program improvement.

Qualitative data from faculty interviews and video presentations indicated that SPARCT participants sought to improve student learning, interest and retention in their STEM courses and that both cohorts of participants implemented, to some degree, the evidenced-based teaching practices introduced in the summer academy**.** Interviews conducted prior to the summer

academy indicated participants had limited knowledge of the targeted evidenced-based teaching practices and very few used them in their teaching. Mid-program and exit interviews found all faculty participants able to describe the practices selected from the academy, their rationale for selecting them, and their impact on student motivation to learn. Many indicated they gained deeper insights into practices with which they had some familiarity. Specific feedback about the SPARCT academy indicated participants began to think differently about their classroom practice and course design. Figure 1 shows self-reported use (all participants) of evidence-based practices by the year 1 cohort.

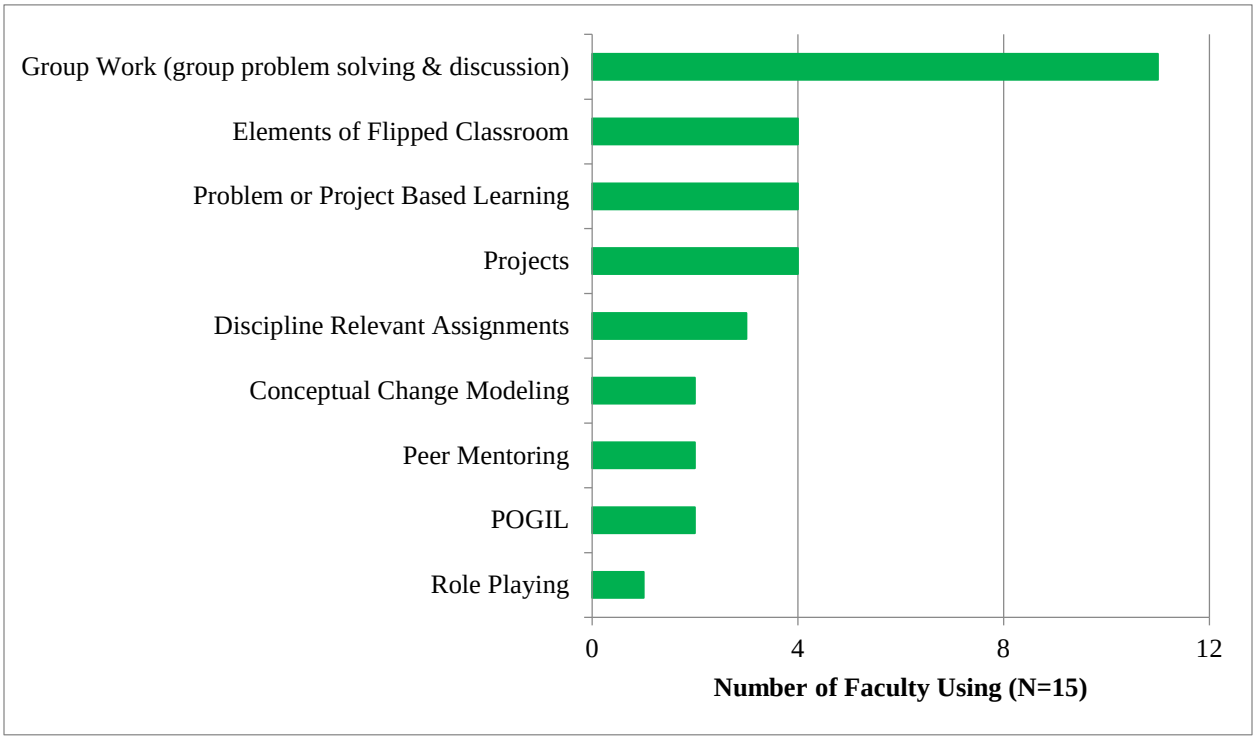

Figure 1: Evidence-Based Practices Self-Reported by SPARCT Year 1 Cohort

Self-reports in video presentations of year one participants indicated each participant gained a more thorough understanding and respect for the concept of the Scholarship of Teaching and Learning (SoTL). All participants developed a SoTL project which they implemented in one of their STEM courses and each was encouraged to present their findings at conferences. Data from participants indicates a major shift in their thinking in terms of the worth and validity of researching their teaching practices. What was once a vague curiosity about their classrooms has now taken a more formalized, research-based approach. Participants indicated they have a new sense of how rigorous this work can be and a new value for what SoTL can reveal about their practice and student learning. Three long term Faculty Learning Communities have emerged as a result of the SPARCT Year 1 academy, one which focuses on the Flipped Classroom, one on POGIL, and one which focuses on SoTL. These efforts are examples of STEM faculty's growing interest in exploring more deeply their teaching practices and their newfound sense for rigor and

value in these explorations. Year 2 participants are currently conducting their projects so final results are not available.

Peer to peer classroom observations were a component of each SPARCT group. All participants, Year 1 & 2, developed observation dyads; one observation partner shared the same discipline, and the other partner did not. Each participant was observed twice: once by a peer in their discipline and once by a peer outside their discipline. Participants used sections of the RTOP (Reformed Teaching Observation Protocol) as a guide to providing feedback to their partners. Three strong themes emerged from the video interview data: new insights into students and their engagement, the impact of situational factors on learning, and new ways to use evidenced based practices to enhance their teaching. Insights gained from being observed coalesced around the theme of confidence including confidence in their current practice and confidence that small changes make a big difference in student engagement. Peer-to-peer observation began as an anxiety ridden experience; however, the self-report video data indicates all participants shared a newfound comfort with and respect for peer observations.

A major goal of the SPARCT academy was to introduce STEM faculty to evidenced-based teaching practices that have been proven effective in engaging students in their learning and in increasing students' content knowledge. Preliminary findings from student surveys from Year 1 indicate student interest levels did increase. Specifically, results suggest that when students take a course taught by an instructor in the SPARCT program, students increased their interest in the course content and their confidence in their ability to learn the content. (Student interest ($n=557$) Confidence ($N=554$) $p<0.005$ increased). From this preliminary data, the percent of students surveyed who changed majors out of STEM was only 5% which we consider a low number.

Findings from the External Evaluator validated the data and findings to emerge from the internal assessment processes and procedures. The External Evaluator conducted on-site interviews of faculty participants and the project team annually. She viewed video recordings of faculty presentations about teaching strategies and Scholarship of Teaching and Learning (SoTL) projects for their courses, reviewed online materials used during the academy, observed an actual academy session and perused periodic electronic communications. Her findings indicated that faculty videos and interviews aligned well with the expected outcomes of enhancing SoTL, using evidenced-based practices in introductory STEM classrooms, engaging peer-observations strategies for STEM classrooms, and using strategies to enhance student learning. One notable strength was the formative survey assessment used at the end of the SPARCT year. Data from these surveys indicated the top three benefits of attending the academy were interacting with colleagues, learning how to flip a classroom, and becoming familiar with different types of formative and summative assessments and ways to assess learning. Suggestions for program improvement were also included in her report of Year 1; many of these suggestions were implemented in Year 2.

Broader Impacts

The impacts of SPARCT reach across both the university and society in general.

Regarding STEM faculty, SPARCT participants were distributed across two colleges: the College of Arts and Sciences and the College of Engineering. Because we have directly impacted 25% of the STEM faculty through SPARCT, according to Roger's Diffusion of Innovation[15], at the end of year 2, SPARCT will have reached well into the Early Majority of the model making the goals of SPARCT likely to bring further change to FGCU (See Figure 2). This diffusion may represent a significant culture change among STEM faculty at the university.

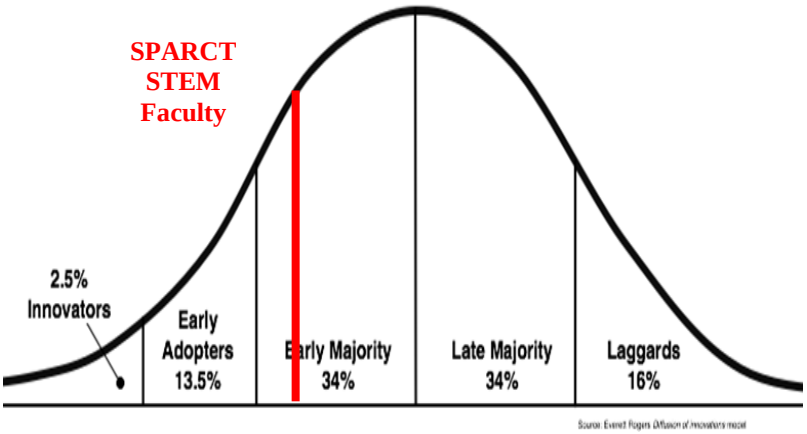

Figure 2. By the end of the funded program, SPARCT will have trained 25% of the STEM faculty at FGCU in evidence-based teaching practices.

Regarding the university students, our current data suggests that students enrolled in STEM introductory courses taught by SPARCT faculty members (STEM and non-STEM majors) show increases in student confidence, interest, and retention (pre- vs. post-course).

SPARCT also impacted non-STEM faculty and K-12 educators and others in our community. When scheduling outside speakers, we were able to offer separate or sometimes concurrent sessions for non-STEM faculty and to the community. Some examples include 1) the Flipped Classroom session in year 2014 where we offered a session attended by approximately 100 K-12 teachers and community members, 2) Team-Based Learning where we offered separate sessions for faculty attending a course design academy and health professions faculty engaging an estimated 50 more FGCU faculty, 3) academic writing workshops offered in both years engaging an additional 80 non-SPARCT faculty.

SPARCT also impacted institutional and information resources at the university. It is our intent to continue offering a May session examining evidence-based practices followed by a STEM FLC open to all STEM faculty with support from the university. Our use of video reflections for horizontal and vertical assessment represents a unique model for faculty reflection and has recently been used in the justification for university purchase of a video repository that can be incorporated into the university's learning management system[16].

Future Direction

Our experience organizing SPARCT and our engagement with the participants revealed several areas for future improvement and research in delivering effective instruction to students in introductory STEM classrooms. One of the areas that we are currently pursuing through grant agencies involves the appropriate use of the university's fourteen SCALE-UP (Student-Centered Active Learning Environment with Upside-down Pedagogies) classrooms. We seek to improve the level of instruction in these classrooms through faculty training in SCALE-UP classroom use and the incorporation of Learning Assistants. If funded, implementation would begin in fall of 2016.

References

1. FGCU (2015). Board of Trustees Information System Quarterly Briefing. Retrieved October 28, 2015 from http://www.fgcu.edu/trustees/Agenda.asp
2. FGCU Office of Planning and Institutional Performance (2015). *Email communication.*
3. FGCU Office of Planning and Institutional Performance (2012). *Email communication.*
4. Web Tables U.S. Department of Education (2012). *STEM Postsecondary Education: Entrance, Attrition, and Coursetaking Among 2003-20-Beginning Postsecondary Students.* NCES 2013-152. Retrieved June 24, 2013 from http://nces.ed.gov/pubs2013/2013152.pdf
5. Henderson, C., Beach, A., and Finkelstein, N. (2011). Facilitating Change in Undergraduate STEM Instructional Practice: An Analytic Review of Literature. *J. Coll. Sci. Teach.* 48 (8), 952 – 984.
6. Cox, M.D. (2004). Introduction to faculty learning communities. New Directions for Teaching and Learning, 2004: 5-23. doi 10.1002/t1.129
7. Ahyun, K., Papa, R., and Stoner, M. Disseminating STEM Teaching Practices: The Role of Centers for Teaching and Learning. California State University, Sacramento. Unpublished paper.
8. Fulton, K. and Britton, T. (2001). STEM Teachers in Professional Learning Communities: From Good Teachers to Great Teaching. *National Commission on Teaching and America's Future*. Washington, D.C.
9. Brooks, C.D.; Huffman, T. (2015). *Changing Teaching Practices to Influence Attitudes and Success in Mathematics.* SoTL Commons Conference. Savannah, GA.
10. Geiger, C.; Kunberger, T. (2015). *From Catch-all to Clarity: Revising a First-Year, Multidisciplinary Introductory Course*. ASEE 122nd National Conference. Seattle, WA.
11. Gonzalez, F.; Zalewski, J. (2015). *FAST Learning: Follow Accomplishments of Senior Teams*. ASEE 122nd National Conference. Seattle, WA.
12. Lura, D.J.; Badir, A.; O'Neill, R. (2015). *Homework Methods in Engineering Mechanics*. ASEE 122nd Annual Conference. Seattle, WA.
13. Zalewski, J.; Gonzalez, F. (2015). *FAST Learning: A New Didactic Method in Software Engineering.* EDUCON 2015, IEEE Global Engineering Education Conference. Tallinn, Estonia.
14. Cassani, M.K.; Wilkinson, A. (2016). *Role Play in Large Enrollment STEM*. SoTL Commons Conference. Savannah, GA.
15. Rogers, E.M. (2003). Diffusion of Innovations, 5e, Free Press, New York, NY.
16. FGCU Director of Web, e-Learning, and Publication services (2016). *Personal communication*.