SPARCT: A STEM Professional Academy to Reinvigorate the Culture of Teaching

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Abstract

In an attempt to address declining persistence rates of university STEM majors (Science, Teaching, Engineering, and Math), concerns regarding retention rates and waning STEM faculty participation in faculty development, we report on a year-long professional development program called the STEM Professional Academy to Reinvigorate the Culture of Teaching (SPARCT) that focuses on evidence-based teaching practices. Expected SPARCT outcomes include: (1) improving evidence-based practices in the introductory STEM classroom, (2) developing professional peer-observation strategies for the STEM classroom, (3) enhancing scholarship of teaching and learning (SoTL) by SPARCT faculty, (4) developing long-term Faculty Learning Communities (FLCs) in STEM instruction, and (5) enhancing student learning in introductory STEM courses. In this article, we describe the features of SPARCT and discuss findings from our first three years as aligned with the outcomes over three cohorts of SPARCT participants (2014-2016). By engaging at least 25% of Florida Gulf Coast University's STEM faculty during the three years, SPARCT is creating a community of STEM scholars with self-efficacy in using evidence-based teaching practices, reinvigorating interdisciplinary connections, developing learning threads, and increasing the community's potential to transform the teaching culture of the university.

Key Terms: STEM Faculty, Professional Development, Evidence-Based Teaching, Faculty Learning Community, STEM teaching and learning

Introduction

One of the recommendations to transform undergraduate STEM education in the 2012 Presidential report, *Engage to Excel*, is to "catalyze widespread adoption of empirically validated teaching practices that would enhance learning and student persistence in STEM classrooms," which is especially critical in introductory STEM courses (Olson & Riordan, 2012). Engaging students through "active learning" during STEM class time has been linked to increased student performance. For example, a meta-analysis of research studies revealed failure rates increase by 55% with traditional lecturing over the rates for active learning (Freeman, et al., 2014).

In addition, a six-year study (2003-2009) by the U.S. Department of Education reveals that of students entering STEM degrees at 1,600 institutions nation-wide, 51.7% persist in STEM, 20.2% drop out of school, and 28.1% switch to a different major outside of STEM (U.S. Department of Education, 2012). Closer to home, Florida Gulf Coast University (FGCU) tracked 468 entering freshman in 2009 and found only 41% persisted in STEM majors, 36% dropped out of school, and 32% switched to majors outside of STEM after two years (FGCU Office of Planning and Institutional Performance, email communication, 2012). Improving these statistics is vital to regional, state, and national economies and in keeping U.S. students competitive in the global workplace.

Increasing the evidence-based instructional practices holds promise for improving persistence and completion, yet requires both faculty support and a reward structure (Fairweather, 2008). However, data examined over a three-year period at FGCU revealed declining participation by STEM faculty in a course design academy offered through our faculty development center, thereby limiting STEM faculty exposure to some basic evidence-based strategies. Meanwhile, STEM faculty were voicing concerns about pass rates and student retention. This context provided the motivation for designing a program with strategies customized to fill the need for professional development specifically for STEM faculty.

To identify change strategies in STEM education, Henderson, Beach, and Finkelstein (2014) analyzed 191 articles published from 1995 to 2008 with core conceptual and empirical change strategies. They determined that a successful one needs to: (1) align with or seek to change the beliefs of the individuals involved (not just top-down or with best practices handed over to faculty), (2) involve long-term interventions lasting at least one semester, and (3) be compatible with the realistic complexities of a college or university. Henderson et al. further recognize collaborative efforts between a university's STEM education center and its teaching and learning center as a highly productive strategy for change.

With these thoughts in mind, in 2014, FGCU's Whitaker Center for STEM Education in coordination with our Lucas Center for Faculty Development instituted the SPARCT program (STEM Professional Academy to Reinvigorate the Culture of Teaching for STEM faculty) (NSF-DUE #1347640). SPARCT offers a year-long faculty experience to apply evidence-based best practices in STEM teaching and learning, course design, peer observation, and scholarship of teaching and learning (SoTL) into classroom projects. The outcomes for SPARCT include:

- Improvement of evidence-based practices targeting the introductory STEM classroom.
- Development of professional peer-observation strategies for the STEM classroom.
- Enhancement of SoTL among SPARCT faculty.
- Development of long-term faculty learning communities (FLCs) in STEM instruction.
- Enhancement of student learning in introductory STEM courses.

Implementing a change from traditional approaches to evidence-based active learning is implicit in the first outcome, and this kind of change is difficult, especially for teachers who have not experienced active learning as students themselves (Anderson, 2002; Bain, 2004; Brown, Roediger, & McDaniel, 2014; Weimer, 2013). The difficulty arises because of the lack of experience which often leads to low self-efficacy, and which Bandura characterizes as a low belief in the ability to succeed with specific tasks (Bandura, 1997). Yet, self-efficacy is necessary for faculty to attain instructional competence and with high self-efficacy, they will seek out and use improved teaching methods (Henson, 2001; Rowbotham 2015). For teachers, self-efficacy concerns their beliefs in the ability to achieve student engagement and learning (Tschannen-Moran, & Hoy, 2001, p. 783). Understanding the how and why of using new methods, access to expert knowledge and skills, and opportunities to explain, try out, and receive feedback on the methods were major strategies to raise self-efficacy in the SPARCT professional development program. This approach directly aligns with the recommendation from Henderson et al. to align with or change the beliefs of those involved in STEM professional development.

In addition, design of the SPARCT Academy integrated Guskey's (2002) theoretical framework for professional development: focus on content, active engagement by all participants, collaboration between participants, duration

of development opportunities, and on-going support for participants for at least one academic year including multiple colleges and departments from within the university. These strategies align with the theory of constructivism, which drives the success of the SPARCT academy. Constructivist thinkers agree upon four central characteristics: (1) learners construct their own learning, (2) new learning depends on students' existing understanding, (3) social interaction plays a critical role, and (4) authentic learning tasks are necessary for meaningful learning and for activating change (Zimmerman & Bain, 2009; Bruning, Schraw, & Ronning, 1995; Pressley, Harris, & Marks, 1992). The developers of the SPARCT academy and the researchers of this study designed the academy and this study upon these four tenets. We also know that knowledge construction takes time, mental models change slowly, and change depends on "understanding something new in terms of some model we already have in our minds" (Zimmerman & Bain, 2009, p. 10). The inherent model in the SPARCT program for STEM educators is the evidence-based process itself through which scientists study and propose explanations about phenomena within their disciplines. With this approach, we sought to position STEM faculty as members of a community of inquiry, reflecting on their own teaching practices and generating scholarly strategies for change (Adams, 2009). This framework provided congruence between the academy design and the study design, which added precision to the analysis and the results. We report here our findings as aligned with these outcomes after the conclusion of three cycles of SPARCT.

Methodology

SPARCT Logistics

SPARCT begins with a May academy followed by an academic year of professional development through monthly meetings and activities. Figure 1 shows a timeline of the year-long SPARCT activities. Supplemental documents contain the schedules for the year-long activities.

During each May academy, SPARCT participants work together to form research questions and methodologies related to their teaching and student learning. Years 1 and 2 consisted of 36 hours of lessons and discussions on evidence-based teaching practices, course design, and SoTL. Due to funding constraints, after the second year we reduced the May academy to 16 hours. At the conclusion of each May academy, we ask faculty to formulate an initial SoTL research project that they will conduct in their introductory STEM class during at least one semester in the coming academic year.

We frame SoTL as having two parts. The first is continuous learning about teaching and the demonstration of this knowledge, including understanding and creating new teaching methodologies in STEM, integrating evidence-based perspectives from cognitive science, and stimulating others to do the same (Boyer 1990; Kreber & Cranton, 2000; Mulnix, 2016). We include the principles of inquiry focused on student learning and an ongoing commitment to the signature pedagogical practices in STEM disciplines (Perry & Smart, 2007; McKinney, 2013). The second is engagement in peer-reviewed communication of scholarly teaching practices and outcomes (Richlin & Cox, 2004).

Each May academy further provides the strategic framework and guidance for implementing evidence-based teaching methods. We begin with review and philosophical grounding in a STEM-thinking framework (Reeve, 2015), followed by research and examples on effective active learning strategies in STEM (Freeman, et al, 2014) including inductive teaching (Prince & Felder, 2006); guided inquiry (POGIL; Straumanis & Simons, 2008); conceptual change and model building (Meyer, Mon, & Hibbard, 2011); and team-based learning with readiness assurance testing (Gopalan, Fox, & Gaebelein, 2013; Mcdaniel, 1970). To improve course design, SPARCT provides methods of learner analysis (Bain, 2012; Weimer, 2014), design principles from cognitive science, instructional design, and research on teaching and learning (Fink, 2003; Sweller, van Merriënboer, & Paas, 1998; Saroyan & Amundsen, 2004). Participants in Year 1 completed a SoTL project planning worksheet comparing their current teaching and assessment strategies to their SoTL project objectives. In all three years, participants reported SoTL progress in interviews and video recordings. During the summer months, they prepare their SoTL projects for the coming semester. At this time, faculty identify an evidence-based teaching practice discussed during the May academy and create a plan for implementing and assessing the effectiveness of the teaching innovation in their course. Preparation includes activities such as conducting a literature search, comparing teaching methods, and applying for IRB project approval for faculty who plan to produce public reports of their results.

In the fall semester, the SPARCT cohort meetings mainly focus on presentation of SoTL projects at various stages of their development. The cohort meetings are conducted in a group discussion format, in which faculty reflect on the project's progress, describe new developments, provide feedback, and make a plan to advance the project. During the cohort meetings and collegial discussions, some faculty decide to develop collaborative projects. Throughout the year, faculty collect quantitative and qualitative data for their projects, analyze teaching practices, and reflect on how these practices impact student learning. Some faculty develop into SoTL presenters in just one year. The SPARCT project team and facilitators continually emphasize sharing of project results and developing faculty dialogue about SoTL. As such, SPARCT provides STEM faculty at FGCU with multiple opportunities for ongoing professional development to create a mutually supportive community of fellow SoTL practitioners, which in turn fosters excellence in their research, teaching, and learning.

We ask faculty to perform two classroom observations of their fellow SPARCT participants and to have their own target classrooms observed twice during the semester—ideally, one faculty member within and one outside of their disciplines for each observation. We provide a copy of the Reformed Teaching Observation Protocol (RTOP) (Sawada et al., 2002) and point out that ten of the items focus on Content while fifteen concern Lesson Design/Implementation or Classroom Culture. We ask faculty to select one to three specific aspects that could be directly observed and evaluated during the classroom session, submit a short evaluation form to the faculty member observed, discuss observations in person, and provide a copy to the SPARCT planning group. Additionally, we video record reflections on the observation sessions during a monthly meeting where participants discuss how the observations might impact their classroom practice.

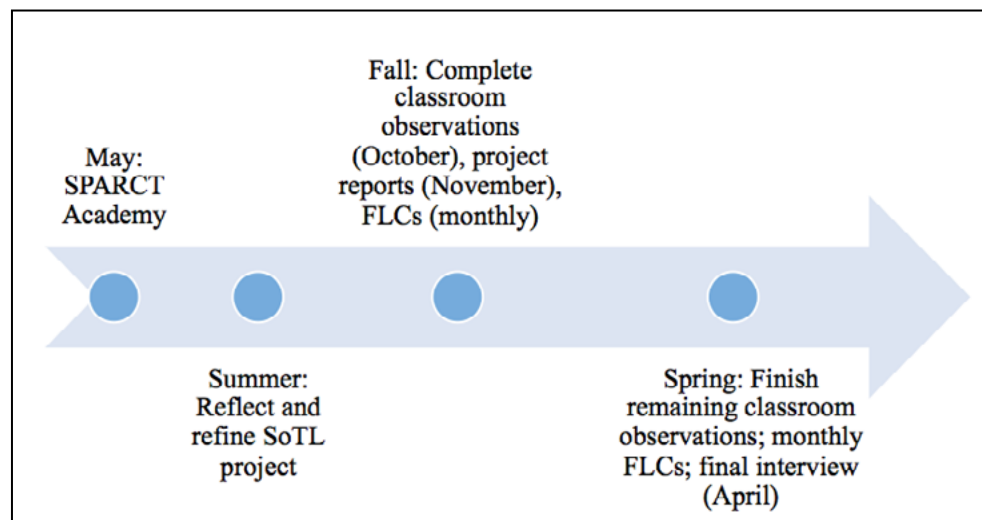During the spring semester, the SPARCT monthly fac-

Figure 1. SPARCT's year-long timeline.

ulty learning community meetings continue along with the observations. In April, we ask the SPARCT faculty to sit for a final interview where we ask them to discuss results of their SoTL projects and provide three reasons they might recommend SPARCT to a colleague.

In Year 3, in order to keep essential content in the pared down version of 16 hours over four sessions spanning two weeks, we moved some evidence-based practices, such as Team-Based Learning, into the academic year. We also condensed and shortened some of the May sessions (see supplemental information for comparisons).

To encourage sustainability of the SPARCT programming past the two-year NSF grant period, we invited participants in Years 1 and 2 (2014 and 2015) to participate with those from the Year 3 (2016) cohort in monthly activities as part of a SPARCT-FLC. The co-PIs and senior personnel of the NSF grant facilitated and coordinated these activities through the Lucas Center for Faculty Development. Although open to all STEM faculty at the university, we sent email reminders of the FLC meetings mainly to SPARCT participants and those STEM faculty who attended these meetings. To monitor ongoing SPARCT progress, we held extra meetings with the 2016 cohort (observations and SoTL projects).

Research Study

Our examination of the outcomes of SPARCT was guided by three overarching research questions: In what ways did attending SPARCT impact the participants' instructional practices in their introductory STEM courses? In what ways did SPARCT impact and sustain an evidence-based culture of teaching at FGCU? In what ways did SPARCT participants' use of targeted, evidenced-based teaching practices impact student learning, student confidence, and student interest in STEM courses?

To develop an in-depth understanding of the impact of SPARCT, we used a mixed methods, instrumental case study design following the tenets of Stake (2010), Yin, (2009), and Creswell (2013). The cases under study were the three year-long SPARCT programs, and the embedded subcases were the participants in each cohort.

Corbin and Strauss (2015) emphasize the need to embody perspectives when collecting and analyzing qualitative data. For this purpose, we gathered data at strategic times to examine participant perspectives on SoTL projects, their understanding and use of new evidence-based teaching practices, responses to reciprocal peer reviews of their teaching, and indicators of the impact on students. Over the three-year study cycle, we planned and carried out consistent data collection using multiple sources. For example, the SPARCT planning team collected daily feedback from the SPARCT academy participants in survey data, video recordings of participant interviews on their SoTL projects and teaching practices, video recordings of participant interviews on classroom observations, and
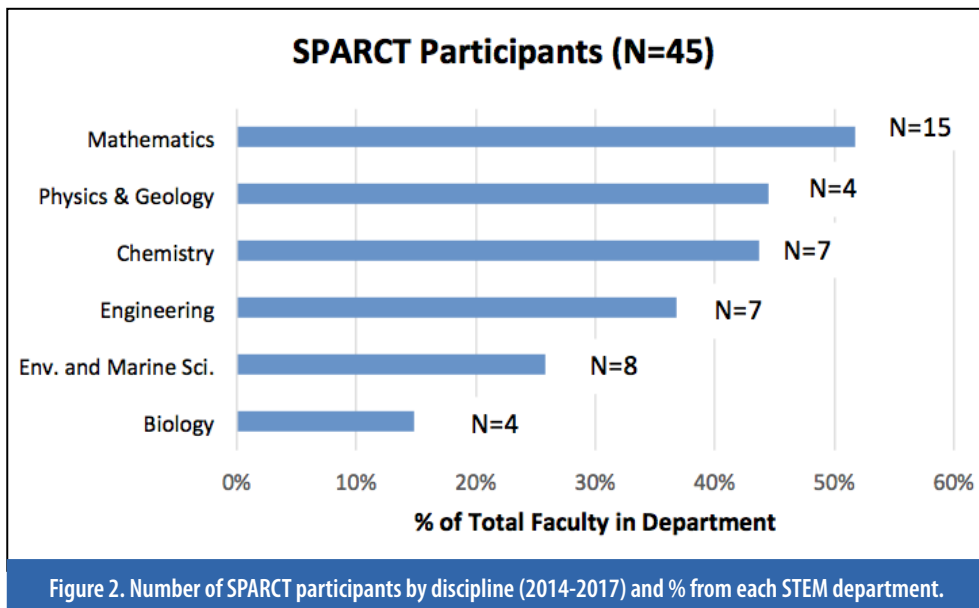

Figure 2. Number of SPARCT participants by discipline (2014-2017) and % from each STEM department.

the Post-Secondary Instructional Practices (PIPS) survey (Walter, Henderson, Beach, & Williams, 2016). The PIPS survey consists of 24 statements that describe instructional practices for which participants give ratings on a scale of 1-5, with 5 being "very descriptive of my teaching" and 1 "not at all descriptive of my teaching."

In Years 1 and 2, the external evaluator also reviewed the SPARCT repository of data, interviewed participants, met with and interviewed the project team, reviewed schedules of meetings and activities, examined SPARCT academy materials, and reviewed faculty journal entries and participant evaluations. The research team further examined qualitative data from: (1) RTOP reports of peer observations; (2) videos of individual participant interviews concerning their experiences in SPARCT and reflections on SoTL projects; and (3) SoTL articles and conference posters.

Analysis of these qualitative data from program artifacts followed a systematic, structured coding procedure of reiterative readings to discover patterns and themes around the research questions. After identifying the patterns and themes, we applied a process of open coding. We broke the data down into discrete parts and compared data for similarities and differences. Then we organized the data according to two of the overarching questions: *In what ways did attending SPARCT impact the participants' instructional practices in introductory STEM courses? and In what ways did SPARCT impact and sustain an evidenced-based culture of teaching at FGCU?* To ensure validity, at least two researchers analyzed all data and we discussed and negotiated rival interpretations of data; we also used member checking of interpretations. To examine data in multiple ways and ensure verisimilitude, we recombined and triangulated quantitative and qualitative data. This process produced a description of the case created and validated by all researchers.

During Years 2 (2015) and 3 (2016), we administered

the PIPS survey (Walter et al., 2016) in a pre-post-format: immediately after a faculty member was selected for SPARCT and at the end, the following April, to further examine participants' reflection on instructional practice. For the purposes of completing the survey, we asked each faculty member to consider the STEM course selected for applying new teaching methods during SPARCT. To explore potential benefits for students, we examined course grade data from Fall 2012 through Spring 2016 in targeted STEM courses taught by SPARCT faculty and students' interest and confidence in the targeted STEM courses expressed in surveys before and after completing a course.

Participants

About one-quarter of the university's full-time faculty teach an introductory STEM course. About one-third of those participated in SPARCT. Year 1 and Year 2 cohorts had 16 faculty each year, Year 3 had five, and our current Year 4 cohort has eight for a total of 45. Figure 2 shows the discipline areas of all SPARCT participants. The data analyzed for this paper includes 36 of the 37 SPARCT participants from the first three cohorts (2014, 2015, and 2016). Note: One faculty member left the university following the May academy and thus is not included in our data analysis.

We do not include data for participants in the current Year 4 cohort beyond summarizing them in Figure 2, as they have not fully completed the program at this time. Because our focus is faculty design and implementation of evidence-based practices, we do not provide a comparison between SPARCT participants and non-participants. Instead, we examine the data indicating the STEM faculty's design and use of the new active-learning teaching practices and engagement in SoTL projects because of their participation in SPARCT. Indicators of self-efficacy, which drive the adoption of change in strategies, come

from multiple sources such as self-reports about understanding, ability, intent, and actual use of the evidence-based practices in the STEM classroom.

Results

In considering the goals of SPARCT and answers to our research questions, we discuss the outcomes in terms of changing instructional practice, sustaining a culture of evidence-based teaching, and enhancing student learning.

Changing Instructional Practices

In this section, we review the data supporting achievement of our first two project outcomes: improving evidence-based practices, and developing professional peer-observation strategies.

At the end of Year 3, 36 SPARCT participants had fully participated in the program. Based on transcripts of video recordings, all 36 reported introducing an evidence-based practice into their classroom strategies. The most common themes emerging from the transcripts indicated participant success in: (1) integrating more formative assessments into their classroom, (2) using research from the science of learning to support student learning, and (3) developing an awareness that lecture alone was not an optimal classroom practice.

Additionally, for Years 1 and 2, across all the interviews with the external evaluator, the faculty expressed goals to improve student learning, interest, and retention in their STEM courses and to implement the evidence-based teaching practices introduced at the SPARCT academy, which included new methods of teaching practices. These interviews, in addition to project artifacts, indicate that the STEM faculty successfully integrated the research-based teaching strategies provided through SPARCT into their own teaching practices in multiple disciplines. For example, in Year 2 the courses in which new teaching strategies were planned and being implemented included Biological Sciences, Interdisciplinary Science, Physics, Environmental Science, Applied Mathematics, Calculus and Precalculus, Geology, Chemistry, Oceanography, and Introductory Engineering courses. These new teaching practices included project-based learning, the flipped classroom, process-oriented guided inquiry learning (POGIL), the conceptual change model, challenge-based teaching, principles from cognitive science, team-based learning, assessment practices, and SCALE-UP (Student-Centered Active Learning Environment for Undergraduate Programs) activities.

In Year 2 (2015) and Year 3 (2016), 19 (90%) of the 21 faculty completed the PIPS survey before SPARCT, and 16 (76%) completed it after. This survey asks faculty to describe their teaching practices in a particular target course. For our purposes, each participant considered the course selected for SPARCT. The PIPS survey ratings pre-

PIPS Statement	PRE	POST
1. I guide students through major topics as they listen and take notes.	26%	50%
2. I design activities that connect course content to my students' lives and future work.	58%	50%
3. My syllabus contains specific topics that will be covered in every class session.	37%	38%
4. I provide students with immediate feedback on their work during class (e.g., student response systems, short quizzes).	63%	25%
5. I structure my course with the assumption that most of the students have little useful knowledge of the topics.	32%	25%
6. I use student assessment results to guide the direction of my instruction during the semester.	63%	50%
7. I ask my students to respond to questions during class time.	16%	6%
8. I use student questions and comments to determine the focus and direction of classroom discussion.	53%	50%
9. I have students use a variety of means (models, drawings, graphs, symbols, simulations, etc.) to represent phenomena.	42%	25%
10. I structure class so that students explore or discuss their understanding of new concepts before formal instruction.	84%	63%
11. My class sessions are structured to give students a good set of notes.	58%	56%
12. I structure class so that students regularly talk with one another about course concepts.	47%	19%
13. I structure class so that students constructively criticize one another's ideas.	79%	63%
14. I structure class so that students discuss the difficulties they have with this subject with other students.	79%	63%
15. I require students to work together in small groups.	16%	13%
16. I structure problems so that students consider multiple approaches to finding a solution.	63%	38%
17. I provide time for students to reflect about the processes they use to solve problems.	63%	44%
18. I give students frequent assignments worth a small portion of their grade.	16%	19%
19. I require students to make connections between related ideas or concepts when completing assignments.	32%	19%
20. I provide feedback on student assignments without assigning a formal grade.	89%	69%
21. My test questions focus on important facts and definitions form the course.	63%	56%
22. My test questions require students to apply course concepts to unfamiliar situations.	63%	50%
23. My test questions contain well-defined problems with one correct solution.	32%	31%
24. I use a grading curve as needed to adjust student scores.	95%	75%

Table 1. Pre-Post Ratings of 3, 2, or 1 (Not Descriptive of Teaching) on Post-Secondary Instructional Practices Survey (PIPS)

vs. post- showed statements that had little-to-no change, while others had large shifts. Seven of the statements had shifts greater than 20%. The shifts suggest that faculty are moving away from strictly lecturing and toward more constructivist teaching strategies (Statements 1 and 10), becoming better in-class facilitators (Statement 4), including more student discussion (Statement 12), encouraging more divergent thinking (Statement 16), and modifying their grading strategies (Statements 20 and 24).

Classroom observations also supported changes in instructional practices. During Year 1, we had 70% compliance for this task; however, for Years 2 and 3 we had over 90% compliance. We saw five themes emerge from analysis of the video-recorded reflections. The participants gained:

  (1) new insights into student engagement and motivation,
  (2) awareness of the impact of situational factors such as physical classroom space, number and seating choices of the students, and pedagogy choices instructors make,
  (3) new ways to use evidence-based approaches,
  (4) comfort being observed by peers, and
  (5) value in the observation experience.

Sustaining a Culture of Evidence-Based Teaching

In this section, we review data, not only about sustainability, but also about achievement of our next two project outcomes: enhancing SoTL, and developing long-term Faculty Learning Communities.

To evaluate the sustainability and culture of evidence-based teaching, we examined each SPARCT cohort's final interview comments, the number of SPARCT faculty participating in the FLC this past year, and their SoTL output. At the April conclusion of SPARCT, we invited all faculty to conduct a final interview with one of the project team members in response to this question: "If you were going to recommend SPARCT to a colleague, what are your top three reasons you would give a colleague to attend SPARCT?" Responses converged on four main themes. Participants liked: (1) meeting STEM faculty outside of their disciplines, (2) seeing what their colleagues were doing in their classrooms teaching-wise, (3) learning about evidence-based teaching practices, and (4) actually being able to make progress on a classroom SoTL project. Several faculty also commented that progress on these items would not have been possible without the structure of the SPARCT program and their initial commitment.

Although we invited all SPARCT participants to attend the SPARCT FLC in 2016, we did not provide incentives in any way for former SPARCT faculty to participate. Nonetheless, 16 of 31 (52%) from the previous cohorts attended at least one FLC event during the 2016-2017 academic year. The Lucas Center for Faculty Development also hosts a POGIL FLC initiated in 2014 by one of the authors (Frost) prior to the SPARCT project. During SPARCT Years 1, 2, and 3 (2014-2016), 28 different STEM faculty participated in the POGIL FLC, 13 (46%) of whom were SPARCT participants.

In addition to the SPARCT academy and faculty development activities, five SPARCT faculty have attended workshops off-campus that provided additional training in evidence-based teaching. Beyond this, even though developing and implementing a classroom SoTL project can take multiple semesters, we know that 14 of 35 SPARCT faculty from Years 1, 2, and 3 (2014-2016) have made 16 SoTL presentations at professional STEM conferences.

Enhancing Student Learning

In this section, we focus on our third research question: In what ways did SPARCT participants' use of targeted evidence-based teaching practices impact student learning, student confidence, and student interest in STEM courses? The answer to this question also addresses our last project outcome: to enhance student learning in introductory STEM courses.

We examined course grade data from Fall 2012-Spring 2016 from SPARCT faculty vs. non-SPARCT faculty in core STEM introductory courses. We examined 449 sections of the following introductory courses: Biology I (98 sections), Chemistry I (46 sections), Physics I (30 sections), Business Calculus (64 sections), and Statistics (211 sections). These courses enrolled 22,969 students. We looked at the numbers of D and F grades and Withdrawals (DFW) as one indicator of student success and learning. We examined this data set for trends in DFW rates for:

  • individual SPARCT faculty sections, pre- vs. post-SPARCT training, and
  • non-SPARCT vs. the SPARCT faculty sections post-SPARCT.

We found no correlations between DFW rates and SPARCT training during the period under examination.

We also considered the student perspective in identifying the possible impact on learning. For this reason, SPARCT faculty administered a short pre- and post-survey to students enrolled in their targeted course during the semester(s) in which the faculty were implementing a change in instruction. The pre-survey asked students their major, interest in the course, and confidence with course content. The post-survey asked whether students were considering changing majors as a result of taking the course, their interest in the course, and their confidence levels before vs. after taking the course. All SPARCT faculty participated in at least one semester in administering the surveys.

We examined a subset of these surveys at the beginning of SPARCT to see if there was any shift of students into or out of STEM majors as a result of students enrolling in introductory courses taught by SPARCT faculty participants. This analysis included surveys completed between the Fall 2014 and Summer 2015 (37 sections, 14 courses, 1136 surveys). We did not see a significant shift in or out of STEM majors as a result of students enrolling in introductory courses taught by SPARCT faculty participants.

We used this same pre-post survey to gauge student interest and confidence in the targeted introductory courses of the SPARCT faculty. Over a longer time, from Fall 2014 through Spring 2016, 72 sections of a variety of introductory STEM courses administered the surveys representing 1840 student surveys. We did not make between-group comparisons (SPARCT vs. before SPARCT)

For student interest levels, from a paired-samples t-test, we found a significant difference in the scores for before (x=2.97 s=1.266) and after (x=3.38, s=1.205); t(1840) =-15262, $p<0.0001$. These results suggest that student interest levels increased, 95 % CI [-0.471, -0.363] when students took a course taught by an instructor in the SPARCT program.

For student confidence levels, from a paired-samples t-test, we found a significant difference in the scores for before (x=2.83 s=1.217) and after (x=3.579, s=1.051); t(1840)=-22.774, $p<0.0001$. These results suggest that student confidence levels increased, 95 % CI [-0.811, -0.683] when students took a course taught by an instructor in the SPARCT program. We saw an overall increase in student self-assessments of confidence and interest for students in courses taught by faculty who participated in the SPARCT program. We cannot claim that this increase is solely due to SPARCT participation since we did not collect baseline data on these factors prior to faculty participation in SPARCT.

Discussion

The reinvigorated culture of teaching emerging from the SPARCT program embraces a growth mindset among the faculty for continual development of SoTL, wherein faculty integrate scholarship of teaching and learning with their course design and teaching practices. However, what accounts for this success beyond the SPARCT materials and specific activities? To answer this question, we note that strong inquiry emerges from a theoretical perspective by which we can improve the quality of results and conclusions (Wilson-Doenges, Troisi, & Bartsch, 2016). The theoretical perspective driving the success of the SPARCT academy and this case study is constructivism.

While we might attribute much of the success to the thoughtful evidence-based design of the curriculum of the SPARCT program, access to expert knowledge and skills, and its year-long programming, we should not overlook the strength of its collaborative design process. Faculty created this program for faculty in a way that brought together many existing resources and stakeholders from multiple colleges and departments. Major stakeholders include the Whitaker Center for STEM Education and the Lucas Center for Faculty Development. The planning team had representatives from both centers, the College of Education, the College of Arts and Sciences, the College of Engineering, and an instructional design expert.

To return to constructivism, we understand that students must construct their own understanding of the material in our courses if we expect significant learning to occur. In much the same way, faculty—and their institutions—must actively engage in their own professional development if we expect significant changes in

culture and pedagogy. Just as constructivism does not lead to a one-size-fits-all pedagogy for all students in all classrooms, success with SPARCT does not provide a one-size-fits-all model for faculty development. Rather, it underscores the need for bringing together a diverse set of resources and stakeholders in STEM and the university system to work toward a common goal. The constellation of outcomes—participation in FLC activities, ongoing additional workshop experiences, and faculty progress in carrying out and reporting on their SoTL projects—suggests that STEM faculty find ongoing value in their collegial sharing and demonstrates the sustainability of evidence-based STEM teaching cultivated among participating faculty at FGCU.

Concluding Remarks

While we see change in our faculty, at this time we have not sought to objectively measure SPARCT faculty teaching (Ebert-May et al., 2011) or assess student performance in the participants' classrooms (Laverty et al., 2016). As suggested by Laverty et al. (2016), an examination of test questions using a tool such as the 3D-Learning Assessment Protocol would provide a better way to examine student learning than course grade data.

In summary, our analysis of three annual cycles of SPARCT shows that a professional development program can have a positive effect on STEM faculty participants' use of evidence-based teaching practices in the classroom as reflected in faculty self-reports (interviews, journals and surveys), self-reflection (video transcripts), observations, and a formal survey of faculty teaching practices (PIPS). The SPARCT program began with a workshop designed with constructivist strategies and provided evidence-based practices, expert knowledge, expert examples, and authentic learning with a focus on the faculty's STEM courses and SoTL practice. However, instead of a one-shot seminar or a longer academy without follow-up activities, participants in the SPARCT program continued engaging in professional development, ongoing peer observations, and mentoring. The faculty who participated in this SPARCT program increased their SoTL output, and while we were not able to measure increased student learning (see limitations), we did see an increase in student self-reports of their levels of interest and confidence in the courses taught by the SPARCT faculty.

Acknowledgements

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