2019 Annual Report

Faculty as Change Agents: Transforming Geoscience Education in Two-year Colleges

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Introduction

This fourth annual report summarizes selected information analyzed associated with the *Supporting and Advancing Geoscience Education in Two-year Colleges (SAGE 2YC): Faculty as Change Agents* project.[1] This NSF-Geoscience project focuses on effecting change to improve 2YC geoscience education at the course, program, department, institution, region, and professional levels. The project supports geoscience educators who are referred to as faculty "change agents" in implementing and sustaining improvements in three areas:

- Broadened student access to and participation in geoscience education
- Increased success in the academic success of students
- Improved career and transfer pathways for students

The project selected two cohorts, with cohort 1 beginning near the start of the grant in 2015 and involving 11 teams comprising 23 faculty change agents and cohort 2 beginning in 2017 involving 6 change agent teams, with 13 faculty change agents (Table 1). The project is led by two senior faculty at the four-year level, one at William and Mary and one at University of Oregon, and two senior faculty at the two-year level – University of Wisconsin-Platteville and Highline College in Seattle, Washington. Since the project's start-up, there has been some turnover of faculty change agents in both cohorts, but most participants have been involved from start to finish.

Table 1.
Summary of Faculty Change Agents, Teams, Colleges, and States

Cohort	Number of Faculty Change Agent Teams	Number of Faculty Change Agents	Number of 2YCs	Number of States
1	11	23	17	9
2	6	13	8	5
Total	17	36	24[1]	12[2]

Note: [1]One 2YC has a faculty change agent team in both cohorts. [2]Two states have faculty change agent teams in both cohorts.

Also, each change agent (CA) identified an administrator who was invited to support their involvement in the project and also possibly mentor in college leadership responsibilities. Administrators were also thought to be important to helping CAs spread lessons from the project to other faculty and staff in their colleges. Notably, at the time this grant was awarded, NSF program officers identified this aspect of involving college administrators as unique and potentially impactful in a way that has not been tested in the geoscience 2YC context. The NSF expressed interest in learning how 2YC administrators would be involved and influential, thus the SAGE 2YC research and evaluation team is gathering data to address this question.

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[1] The *Supporting and Advancing Geoscience Education in Two-year Colleges (SAGE 2YC): Faculty as Change Agents* project is funded by the NSF's Division of Undergraduate Education (DUE). The principal investigators are Heather Macdonald, William & Mary**;** Eric Baer, Highline College; Norlene Emerson, University of Wisconsin, Platteville; and Jan Hodder, Oregon Institute of Marine Biology, University of Oregon. Management and technology support is provided by Carol Ormand and John McDaris, Science Education Resource Center (SERC), Carleton College.

Project Goals

Three overarching goals stated in the project proposal that continue to guide the project are:

- Implement high-impact, evidence-based, instructional and co-curricular practices that:
  - support the academic success of all students
  - broaden participation, and
  - facilitate professional pathways into geoscience for students
- Build a national network of 2YC geoscience faculty CAs who catalyze change at multiple levels, from their courses and program/departments to their colleges and regions.
- Investigate professional development models for full-time and adjunct 2YC geoscience faculty that promote the cycle of innovation, where faculty learn from the research of others, make changes in their own practice, and share what they learn more broadly with the education community.

Research and Evaluation Design

Internal Evaluation, Research and External Evaluation Questions

The SAGE 2YC project adopted several key research and evaluation questions to guide the internal evaluation, external evaluation, and research. These questions were created by the evaluation and research team and vetted with the project leadership team of principal investigators (PIs) and project managers. Evolving over time, mostly in terms of being clarified and further detailed, these questions have also been shared with the CAs at the annual meeting so they understand the primary focus of the evaluation and research and also get an opportunity to advise on other important ways to study what is transpiring in the project.

The research and evaluation questions for SAGE 2YC are listed below, with aqua shading for questions addressed in this year's report. Questions not shaded were addressed in previous annual reports, and this entire list will be addressed in the final report to be completed and submitted in early 2020.

Internal Evaluation:

- What changes (attitudes/efficacy, practice, programmatic, institutional, regional) do faculty CAs make over the time of the SAGE 2YC grant?
- How do those adjustments align with SAGE2YC program themes and activities?
- To what extent do program participants attribute changes to SAGE2YC program elements?
- What contextual adaptations are evident?

Research:

- How do faculty CAs perceive themselves as leaders of change over the time of the SAGE 2YC grant?
  - What is the role of context in the change process? What are the differences between cohort 1 and 2, and what factors contribute to these differences?
- What influence does the community of practice developed in the project have on the CAs regarding attitudes, beliefs, knowledge, and practice?

- How is change and innovation shared in the community of practice? What contributed to the differences between cohort 1 and cohort 2 based on their individual starting points?

External Evaluation:

- What theory of change explains the professional development (PD) model for SAGE 2YC?
- How was the PD model implemented for cohorts 1 & 2?
- What factors influenced implementation for the two cohorts?
- What are the geoscience course outcomes, and how do they relate CAs actions relative to the PD model?
- How does the CA network form and change over time, and how do these changes relate to the PD model?

Methods

The project uses a mixed-methods research and evaluation design to gather qualitative and quantitative data associated with the internal evaluation, external evaluation, and research. From the time of notification of funding, qualitative and quantitative data have been gathered on grant-related activities carried out by the PIs and faculty change agents (CAs), including the evaluation/research team's conducting telephone interviews, online and in-person interviews, focus groups, observations of professional development (PD) workshops and meetings, mid-event and end of event evaluation surveys; two widely used instruments called the Reformed Teacher Observation Protocol (RTOP) and the Bolman and Deal leadership frames; two instruments designed by the evaluation/research team and PIs specifically for the SAGE 2YC project called the Educational Practice Inventory (EPI) and Departmental Practice Inventory (DPI); site visits where classroom observations and faculty and student interviews; social network analysis (SNA): and thematic content analysis of faculty journals, the SAGE 2YC webpages and musings (blog posts) hosted on the SERC website, webinars, email exchanges, and online discussion groups. In addition, the external evaluation/research team engaged all faculty CA teams in gathering data on the courses the CAs have taught and changed as a results of the grant, including documenting the types of changes made, as well as course student demographics and course completion (with a grade of C or above) as an indicator of course success.

Over the entire course of the SAGE 2YC project (four years so far) an enormous amount of data has been gathered, analyzed and reported, as noted above. In addition, the evaluation/research team has kept track of conference presentations and academic publications completed by the PIs and other project leadership team members, and to the extent possible, also the publications and presentations of faculty CAs. Appendix A gives a list of publications and presentations involving evaluation/research team members thus far, with more emerging through to the end of the grant and beyond.

The next section summarizes results for the fourth year of the SAGE 2YC grant. The findings are presented in three sections to reflect the major foci of the grant: 1) the theory of change, 2) how faculty CAs are changing their own practice, and 3) how faculty CA's are changing others' practice. Table 2 presents the three foci and evaluation/research questions and data associated with them.

Table 2.
Fourth Year of the SAGE 2YC Grant

Level of Change	Evaluation/Research Questions	Data Sources
Section 1: Theory of Change	• What theory of change explains the PD model for SAGE 2YC? • How was the PD model implemented for cohorts 1 and 2?	• NSF grant proposal, documentation and qualitative data on the theory of change • Surveys and qualitative data on the 2019 annual workshop
Section 2: How Faculty CAs Are Changing Their Own Practice	• What changes have faculty CAs made over the time of the SAGE 2YC grant?	• CA action plans, posters, website descriptions, and other documentation • RTOP scores 2016 and 2018-2019 • EPI results 2017 and 2019 • Bolman and Deal Leadership Frame results for 2016 and 2019 (cohort 1) and 2017 and 2019 (cohort 2)
Section 3: How Faculty CAs Influence Others to Change	• How do faculty CAs perceive themselves as leaders of change over the time of the SAGE 2YC grant?	• Regional workshops conducted by the faculty CAs • SAGE 2YC annual workshop results

Results

Section 1: The Theory of Change

A logic model was developed at the beginning of the project to provide a visual representation of the theory of change for the SAGE 2YC project. This first basic graphic provided a useful beginning point for the project (see Bragg & McCambly, 2016), but it did not represent the full range of goals and activities as the project unfolded. To better capture the evolving comprehensiveness of the SAGE 2YC project, a new logic model was created during year 3, led by Kristin O'Connell and Ellen Iverson (SERC), both members of the evaluation/research team. At the annual workshop in Albuquerque, New Mexico in June 2018, the new theory of change graphic was shared with the PI team and faculty CAs to gather feedback on the visual representation and consider how this graphic might be useful to scaling the most impactful changes occurring through SAGE 2YC to other 2YC contexts. Additional changes were made to the logic model during year 4 to reflect feedback gathered in June 2018 and also to depict as clearly as possible the theory of change as the project continued to advance in year 4.

Figure 1 shows the theory of change with the two major goal domains of increasing evidence-based practices and building sustainable leadership through professional development (illustrated in the top two boxes in the graph). Faculty CAs engage in what is called "anchoring practices" depicted in the circle showing reflective practice inclucing mutually strengthening time to "meet, discuss, and plan", "practice", and "reflect." By engaging in reflective practices over and over again during the grant, the faculty CAs are expected to be able to see their own practice strengthen and improve, including influencing positive student outcomes. Faculty CAs may also see the practice of others (i.e., faculty in their unit and faculty other units in the college, as well as other geoscience faculty in their geographic regions of the country) change, strengthen, and improve.

Also noteworthy is the right side of the theory of change shown in Figure 2 where we can see a set of circles depicting support structures intentionally planned and implemented in the SAGE 2YC grant, including regionally based faculty CA teams (1-3 individuals and averaging 2 per team), PD engagement strategies by face-to-face and virtual delivery with other geoscience and science educators (2YC and 4YC); evidence-based resources including the SAGE 2YC website maintained by SERC; and networking strategies that involve stakeholders associated with the overall grant, the colleges included in the grant, the larger geoscience profession. Taken together, the theory of change presents a large vision that moves from individual practice change to collective change or impact on program, organization, region, and professional endeavors.

Using this theory of change, the evaluation/research team for SAGE 2YC is gathering and analyzing data to paint a picture of implementation and impact of the grant. This theory has also been used to organize and present the remainder of this report on grant findings.

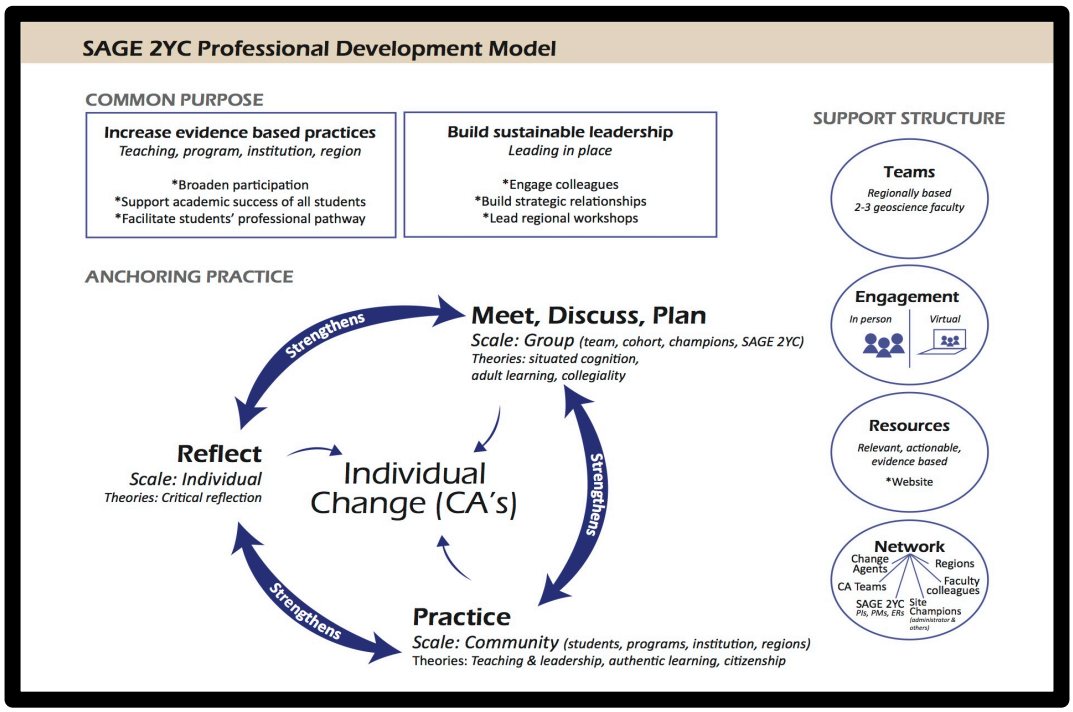


Figure 1. The SAGE 2YC professional development model.

Figure 2 shows the inquiry and reflection process that focuses on the cycle of innovation based on individual and organizational learning to amplify positive outcomes. In the top left corner of the graphic, we can see the same reflective practice cycle that appears in Figure 1, and this graphic sets this cycle into a larger context relating to scaling innovation and change. Practice is associated with CAs classrooms, but also their programs, institutions and regions. The activities that drive the scaling of change vary by group, with classroom innovation noting inclusive teaching, program change involving reflection with faculty peers and colleagues, institutional change innovation through the increased engagement of CAs with other faculty and staff on their campus, and CA involvement in planning and implementing regional workshops to both teach and disseminate what they are learning through the various grant activities to others. Again, these activities are considered to be mutually strengthening

because of the reciprocal relationships that CAs form with others. While not included in this graphic, it is noteworthy that many of the CAs have also engaged in considerable sharing of lessons learned through the grant with colleagues in national professional geoscience organizations, potentially extending the impact of the grant nationally and in a few cases internationally.

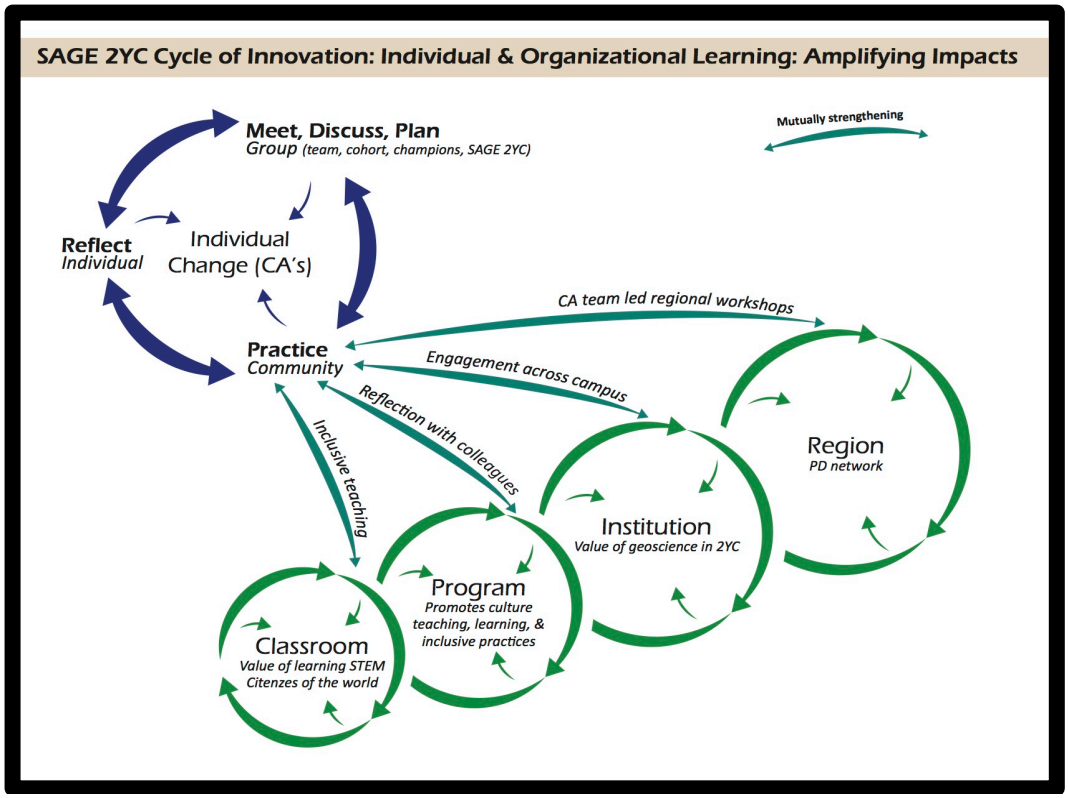


Figure 2. The SAGE 2YC cycle of innovation: Individual and organizational learning to amplify effects.

Section 2: How Faculty CAs are Changing

Faculty CA Plans and Actions to Change. An important goal of SAGE 2YC is to support changes in geoscience programs and practices through the work of faculty change agents (CAs). Table 3 provides a snapshot of how the faculty CA teams associated with cohort 1 and cohort 2 are changing their own practice, taking into account that cohort 1 began making changes in 2016 and 2017 while cohort 2 joined the project and began making changes approximately two years later. This means cohort 1 had nearly double the time to engage in activities leading to changed programs and practices compared to cohort 2, which also means cohort 1 has more familiarity with the project, the PIs and other project participants then cohort 2. Despite these differences, the data show faculty CAs in both cohorts are engaging in substantial and important changes to their own practice.

Results on how faculty CAs are changing their own practice reveal a strong focus on course level change, especially change in the faculty CAs instructional practices in their own classrooms and in some cases advocating for change in other geoscience faculty in their colleges and geographic region. Consistent with the grant, the faculty CAs associate and believe that changes in their own instructional practice will lead to improved academic success for all students. Though not all of the faculty CAs, many voice the

need to enhance what they are doing to improve the academic success of underrepresented students whose outcomes continue to lag behind racial-majority students. Many faculty CAs also express the desire to continue learning how to integrate active learning and metacognition into their teaching to improve the academic success of all students, but especially under-represented students.

In addition, the majority of faculty CA teams mentioned efforts to broaden participation. This is important to note because broadening participation is the second of three major foci of the SAGE 2YC grant. In order to enhance participation by underrepresented students, the faculty CAs planned to enhance student recruitment and new student orientation, academic advising, and various means of communications with students. Importantly, some faculty CAs also mentioned implementing improved retention and completion strategies including content-rich classroom materials, diversified field trips (e.g., urban vs. wilderness), undergraduate research, and student clubs.

With respect to the third goal of SAGE 2YC, the faculty CAs mentioned less focus on professional pathways than the other two goals, but there has been more emphasis on professional pathways toward the end of the grant than the beginning. Looking at the data for cohort 1 over the four years, there is clearly more focus on transfer, careers in the geosciences, and other aspects of professional pathways than two years earlier when similar analysis was performed by the external evaluators, Debra Bragg and Heather McCambly (2017). Some cohort 2 faculty CAs also mention professional pathways.

Overall, these results suggest the faculty CA teams have expanded their focus from primarily emphasizing improving instructional practices pertaining to their own classrooms to supporting instructional changes more broadly with other geoscience faculty in their colleges. Simultaneously, the faculty CAs have also learned through the SAGE 2YC professional development (PD) model about broadening participation and professional pathways, and these foci appear to have taken on greater importance to the CAs over time. This is apparent by tracking the evolution of the CAs' action plans for both cohort 1 and 2, revealing growth in understanding and action over time.

Table 3.
Summary of Changes Planned and Made by Faculty CA Teams (Cohort 1 & Cohort 2)

Planned Goals & Strategies (2016-2017)	**Planned Goals & Strategies (2018-2019)**
Northern California (Cohort 1)	
This team of two faculty members (1 full-time, 1 part-time) planned for "supportive pathways that lead to successful transfer outcomes to 4-year universities and colleges." The plan also included collaborative teaching, active learning and a larger network of colleagues and students to improve transfer and close the "achievement gap between targeted and non-targeted populations."	The goals and activities at the end were consistent with those mentioned earlier, including improving instruction within Earth science classes by integrating active learning and metacognition, supporting students from traditionally underrepresented groups in the geosciences in Earth science classes, and fostering greater collaboration among faculty in the ongoing development of curriculum and instructional improvement.
Southern California (Cohort 1) – this team became two teams in Year 3 of the project	
Begun with 3 faculty in 2 colleges, 2 faculty in 1 college planned to "increase student awareness of, and preparation for, academic and professional pathways attainable with a 2-year degree, 4-year degree, or certificate in geoscience." The plan also	**College 1:** The team continued to incorporate career preparation into the geoscience courses and programs and also create a Geotechnician Certificate Program. The team also devoted instructional time to discussing geoscience careers and pathways with students, and building relationships with career,

Planned Goals & Strategies (2016-2017)	Planned Goals & Strategies (2018-2019)
called for expanding engagement with college leadership and offering a CTE certificate to broaden participation. The plan of the 2nd college focused on gathering and using data from the SAGE 2YC template to accomplish numerous goals, including implementing faculty-to-faculty dissemination of instructional practices to peers.	academic and STEM advisors.
	College 2: This faculty member added a faculty member from the college and created an extensive set of goals including to broaden participation, improve students' academic success, implement a department-wide sustainability project, continue to enhance transfer, and solidify relationships in a newly formed department of geoscience and environmental science.
Southern California (Cohort 2)	
	This team planned to add an oceanography course on the coastal environment including student research. The course's goal is to provide students with a foundation and pathway to pursue a career in ocean sciences. The team also plans to form a club that will offer field trips to the coast to support various experiences. The faculty will also collaborate with chemistry and marine biology faculty to create research opportunities for students.
Florida (Cohort 1)	
This single college team of 2 faculty observed that they lacked adequate strategies to support student recruitment, enrollment, retention or completion in the geoscience pathways, and they needed sustainable strategies to implement recruitment; new student orientation for geoscience majors; advising; undergraduate research; mentoring for student supports; active learning; monitoring of job placement; formalized transfer agreements; and improved monitoring of transfer success.	The team is developing a multifaceted model that advances the initial plans that may be used by other FL 2YCs. To meet state requirements, the model's strategies are: 1) creating relationships with and opportunities for HS students and faculty; 2) increasing student sense of belonging and interaction with peers, faculty and the scientific community; 3) utilizing classroom pedagogy and challenging course content; 4) providing options for students to experience research, career practices and PD; & 5) developing supports so majors can transfer to 4Ycs colleges and the geoscience workforce.
Illinois (Cohort 1)	
Two faculty representing different colleges planned to increase student success rate of geoscience courses by strengthening diversity trainings for colleagues and creating more career opportunities for students. The plan also specified active learning and metacognition and engaging in the SAGE 2YC outcomes assessment and departmental inventory. The team also planned to develop geoscience social events, resources for other geoscience faculty and campus groups to increase student diversity, and identify and track geoscience majors and alumni.	The 2 faculty representing 2 colleges continue to work collaboratively to implement their initial plan, including reforming their courses to enhance student engagement, increasing student metacognition, and addressing implicit and cultural biases. The team also plans to integrate information about geoscience professional pathways and careers into their courses and use regional workshops to share knowledge with other geoscience educators about what they have learned, including sharing materials.
Massachusetts (Cohort 2)	
	This team of 2 faculty plans to strengthen degree and certificate programs, increase student engagement and interest in geoscience opportunities, improve transfer students' skills, increase employment for geoscience technicians, and implement online technologies and supports to reach more students and support their success.

Planned Goals & Strategies (2016-2017)	Planned Goals & Strategies (2018-2019)
Michigan (Cohort 2)	
	This team of 2 faculty recognize that students learn a small portion of what they are taught, calling for coordinating "crossover concepts" to be taught in multiple courses to help students see how the basic science applies to their lives. The plan calls for tapping into student interest in environmental issues in the Great Lakes, including developing curricular materials, developing opportunities for students to explore geoscience in the field and transfer to 4YCs, and provide access to diverse examples of geoscientists.
New York (Cohort 1)	
This team began with 2 faculty, with 1 faculty engaged in the project in years 2-4. The team's plan recognized that underrepresented minority groups were not enrolling and succeeding in geoscience courses at rates similar to other courses in the unit and the geoscience faculty had limited experience using new instructional strategies and data for student recruitment and support, and faculty PD. In year 2, transfer, mentoring and proactive supports for all majors in geoscience courses, and PD for adjunct faculty who teach proportionally more underrepresented students were added.	The strategies noted at the end of the grant include working to increase participation and success among students from underrepresented populations and first-generation college students. The efforts focus on providing the educational and social resources students need to thrive in science programs. Through in-class and extracurricular activities the faculty member plans to build students' metacognitive skills and help them build social networks to encourage persistence. The faculty member is also sharing strategies with colleagues to help them reach and inspire more students to pursue geoscience careers.
North Carolina (Cohort 1)	
The initial plan of 2 faculty in 1 college noted: "Students are not succeeding in the… geology course due to changes brought about by new placement measures, structured pathways, and advising." The team planned to support underprepared students in and out of the classroom by defining and designing a set of student learning outcomes (SLOs) and using high-impact practices, including student supports, active learning, and faculty PD. In year 2 the team added a focus on building consensus on SLOs using backwards design.	This team of 2 faculty continued its focus on supporting the academic success of all students including teaching students metacognitive strategies, fostering a growth mindset, increasing the level of active learning in geoscience courses, and balancing "depth vs. breadth" of learning. In addition, these faculty plan to continue working to broaden participation and facilitate professional pathways through local partnerships that allow students to participate in authentic research experiences, mentoring, and professional socialization.
Oregon (Cohort 1)	
Three faculty representing 3 colleges (2 in 1 system and 1 other) targeted "geoscience courses [that] underrepresent campus diversity, which leads to low diversity in the geoscience workforce." The plan called for 1 college to use mentoring, field trips, alumni activities, and data on cross-campus & cross-disciplinary collaboration to recruit & support students. The plan called for broadening participation that connects student learning to regional cases and undergraduate research.	This team continues to focus on strategies that will attract and improve the success of underrepresented students, including first-generation college students, in geoscience courses. The plan also calls for teaching societally relevant topics and career opportunities to prepare students to be "literate and involved citizens." Other strategies planned from the start that continue to be a priority include supporting student learning through regional case studies on the urban environment (rather than wilderness) and undergraduate research.

Planned Goals & Strategies (2016-2017)	Planned Goals & Strategies (2018-2019)
Oregon (Cohort 2)	
	This team has 1 faculty each from 2 colleges. The plan for college 1 supports all geoscience students' success, especially rural, first-generation and under-represented students, and increases geoscience majors transferring to universities. Strategies include training new faculty in evidence-based active learning and metacognition, assisting student study skills, and working with administrators to sustain and scale extracurricular programs on STEM transfer, cohort-building and place-based UG research. The plan for the 2nd college sets similar goals and mentions strategies such as building internal, cooperative community among students and faculty, creating shared curriculum and external relationships with local transfer 4YCs, sharing active-learning strategies, increasing outreach to underrepresented groups, and providing pathways for students to continue in 4YC geoscience programs and careers.
Texas (Cohort 1)	
This team has 2 faculty CAs who work at different colleges. Their plan recognizes, "Students are struggling to succeed on tasks in the geoscience program that require critical thinking and evaluation of scientific issues", which affects student success. Concerns were raised about underrepresentation & lower geoscience course success. The team noted disaggregated data on course completion and SLOs for curriculum and active pedagogies. The team also prioritized collaboration with administration to promote active learning among other instructors.	This team is working to support the academic success of all students by using evidence-based practices in the classroom including aligning classroom activities, labs, and assessments to scaffold the material to meet the student learning outcomes (SLO) of each course. The team is particularly attentive to improving the participation and academic success of underrepresented minority students.
Virginia (Cohort 1)	
This team has 3 faculty who represent 2 colleges that have common and distinct goals. Both planned instructional strategies (metacognition & backward design) to clarify purpose and increase course completion. One college identified recruitment and pathway issues, and the other focused on learning strategies. The plan for regional workshops also referenced professional pathway, and curriculum mapping to further clarify expectations and foster more inclusive environments.	This team was active in various SAGE 2YC initiatives prior to the grant and is utilizing their experience to make additional improvements in geoscience classrooms using evidence-based teaching practices. The new project has added outreach and new ideas about active learning strategies and inclusive classrooms that have been shared with other science colleagues to foster interdisciplinary collaboration. Additionally, the team has contributed geoscience-specific content at PD opportunities within the state system and established deeper connections with faculty at 4YCs and geoscience professionals across the state.
Washington DC Metro (Cohort 2)	
	The goal of this team of 3 Faculty CAs is to boost the efficiency and engage of geoscience programs in the college, including increasing student awareness of geoscience courses and more interaction between geoscience students, staff and college administrators. A critical goal is to increase involvement by

Planned Goals & Strategies (2016-2017)	Planned Goals & Strategies (2018-2019)
	underrepresented groups through enhancing the geoscience community on campus and increasing student awareness of careers. Strategies include working with the campus career center and academic advisors, partnering with student multicultural groups, (re)building internal geoscience faculty communications, offering field trips and a shareable database on field trips, and creating a Facebook page.
Western Washington (Cohort 2)	
	The broad goals of this team of 2 faculty CAs are to increase interest in and success of students in Earth and Space Science courses. Arresting the decline in student success and enrollment is important to the team. Strategies include enhancing sporadic geoscience-related student clubs, social activities, and academic advising, and building interest in geoscience careers and opportunities to reach a broader student audience. More departmental meetings and relationship building with student support groups are happening, along with increasing visibility of the geoscience program by publicizing information on course, program, and geoscience majors and careers.
Wisconsin (Cohort 1)	
This team of 2 faculty work at two different colleges affiliated with the university system, and this team's combined plan focuses on expanding course offerings and facilitating professional pathways by improving the transferability of classes to 4-year campuses. The team sought for students to see the geosciences as a viable academic and career path, including incorporating active learning and metacognitive skills to prepare their students for these paths. Lastly, the team planned to broaden student participation by adding numbers and diversity.	Despite major changes in the university system that have resulted in 2YC campuses ceasing to exist and being subsumed as 4-year branch campuses, the 2 faculty have continued to execute their plan. Efforts to create new courses have continued and also the plan to improve transfer pathways for geoscience majors. Strategies undertaken by these faculty include active learning and metacognition. Regional workshops and interactions with regional educational alliances emphasize changes in instructional practices as well as broadening participation in the geosciences.

Note: The data source for this section of the report comes primarily from the faculty CA team's own plans, posters, stories, and website materials, often supplied by the CAs in conjunction with activities conducted during annual workshops and other assignments pertaining to the SAGE 2YC website.

Changes in Faculty CA Instructional Practices (Analysis by Ellen Iverson). Given the importance of changing instructional practices, the evaluation/research team used the RTOP instrument to assess the extent to which faculty CAs are changing their own teaching. The Reformed Teacher Observation Protocol (RTOP) classroom instructional practices on a continuum from teacher-centered to student-centered, and we used this instrument to measure pedagogical practices used by the faculty CAs initially and at the end of the project (cohort 1 only). The RTOP instrument was chosen for use by Sage 2YC because of familiarty by grant leadership with the instrument and its history of use in the science including geoscience context. Also importantly, the project leadership at SERC administers RTOP by trained observers who conduct classrooms observations in science classrooms across the United States.

Looking at the faculty CAs (cohort 1 only) involved in SAGE 2YC, we can see that changes in instructional practices were being made. Of all cohort 1 faculty CAs who began with SAGE 2YC in 2016, 19 were observed by a trained RTOP observer near the beginning of the project in the Winter or Spring of 2016. A second observation was conducted with 14 of these CAs approzimately three years later, between Spring 2018 and Winter 2019. At the time the RTOP scores were computed initially, the scores showed eight of the CAs placed in the teacher-centered observation range equaling or below 30, 10 were placed in the transitional observation range of 31 to 49, and two were placed in the student-centered observation range of 50 or higher (Table 4).

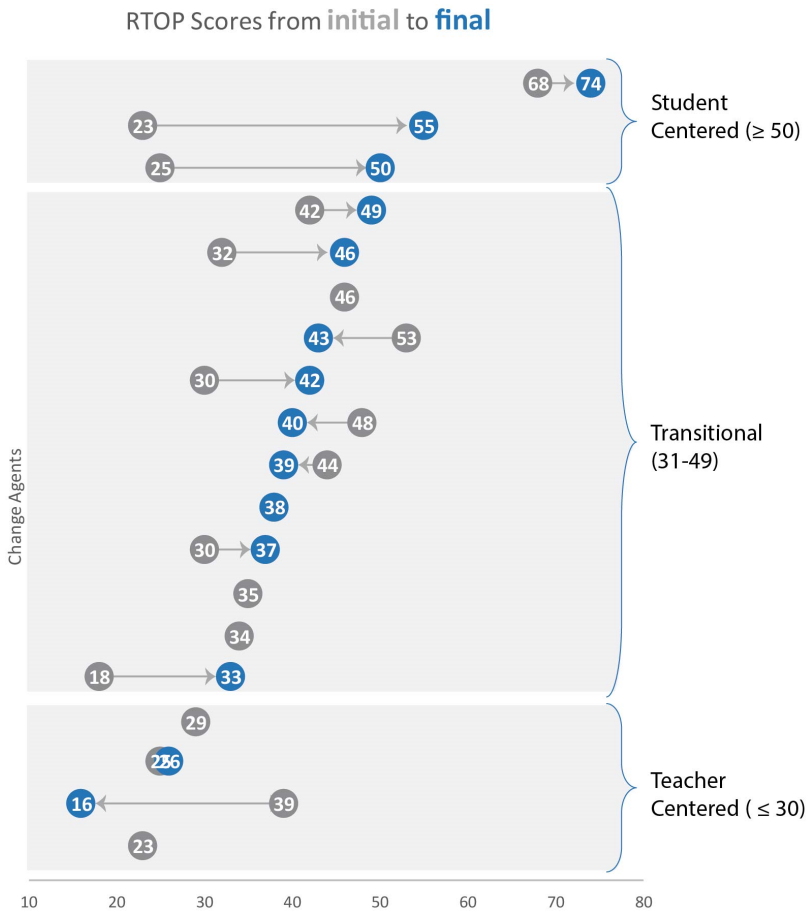
Comparing the second observation in 2018-19 to the initial score, results showed increased scores for most faculty CAs: two CAs placed in the teacher-centered observation range, nine placed in the transitional observation range, and three placed in the student-centered observation range.

The **Reformed Teaching Observation Protocol (RTOP)** was developed as an observation instrument to provide a standardized means for detecting the degree to which K-20 classroom instruction in mathematics or science is reformed, according to STELAR (STEM Learning and Research Center Twenty-five (25) items included in RTOP are divided equally into five categories: 1) Lesson Design and Implementation, 2) Content: Propositional Pedagogic Knowledge, 3) Content: Procedural Pedagogic Knowledge, 4) Classroom Culture: Communicative Interactions, and 5) Classroom Culture:). The developers of RTOP did not assume that reformed teaching is necessarily quality instruction but suggested the RTOP should be tested across various instructional settings to determine whether changes in instruction are associated with changes in quality (as measured in various ways including student learning).

Information about RTOP is available at: http://stelar.edc.org/instruments/reformed-teaching-observation-protocol-rtop).

Comparing the initial observational scores to the final observational scores, nine of the 14 (64%) the CAs showed higher RTOP scores in the second observation, with three of the CAs moving from teacher-centered to the transitional range and two noteworthy shifts from the teacher-centered range to the student-centered range. These two CAs skipped the transitional range entirely, with one improving by 32 points and the other by 25 points.

Table 4.
Comparison of RTOP Scores for Cohort 1 CAs in 2016 and 2018-19



These are important results that may have relationships to other aspects of the SAGE 2YC grant, including course enrollments and outcomes. These relationships will be examined more fully in the final report.

Changes in Faculty CA Educational Practices (Cohort 1 & 2) (Analysis by Kristin O'Connell). This report describes changes in instructional practices reported by the faculty CAs in both cohort 1 and 2 using the Educational Practices Inventory (EPI). As the SAGE 2YC evaluation report reported in 2018 (Bragg et al., 2018), the EPI focuses on teaching strategies and faculty CA engagement in communities of practice (Wenger, 2011). It was developed by the SAGE 2YC evaluation/research team in collaboration with the PIs and first administered to the cohort 1 in fall 2016 and cohort 2 in Fall 2017. The EPI was administered again in January 2019 to capture information on educational practices used by both cohorts. The timing of the EPI meant there was just under 2.5 years between data collection in fall 2016 and January 2019 for cohort 1 and about 1.5 years between fall 2017 and January 2019 for cohort 2. The results compare each cohort's whole group at each point in time, meaning this analysis presents a snapshot of the entire cohort 1 and cohort 2 responses at each point in time. Each cohort was not 100% the same group of individuals at each point but they are very similar, particularly cohort 1 where there has been minimal change in cohort membership from the beginning to the end of the project. Slightly more change has occurred in cohort 2, but the majority of individuals were the same in this cohort as well. However,

because cohort 2 is smaller than cohort 1 (cohort 1 being almost twice the size of cohort 2), modest changes in the composition of cohort 2 may have had more influence on results than cohort 1.

Figure 3 shows the responses of both cohorts pertaining to educational practices thought to favorably impact student success, with the top box presenting results for cohort 1 in 2016 and 2019 and the bottom box showing results for cohort 2. The figures in this section display stacked bars representing the aggregate percentage of faculty CAs by frequency of implementing the educational practices, using the scale of no response, never, 1-2 times per term, several times per term, and every session. The figures show bars associated with educational practices most fully implemented toward the left of the graph and less frequently implemented toward the right of the graph. For example, both bar charts in Figure 3 show bars associated with lecture at the far left, then bars associated with active pedagogy, self-efficacy, relevance, and virtual availability extending to the right of the charts. The charts also show larger percentages of faculty CAs implementing active pedagogy and self-efficacy than relevance and virtual availability but these are all implemented less frequently than lecture. Interestingly, there was some decline in the percentage of cohort 2 faculty CAs on self-efficacy and relevance, but this finding may be influenced by different respondents completing the pre- to post-inventory. The small sample size for cohort 2 (n=9) means very modest changes can give the appearance of major change.

Figure 4 shows the responses of cohorts 1 and 2 on EPI items pertaining to teaching strategies introduced in the SAGE 2YC PD model. Similar to the previous figure, this figure presents stacked bars showing results on the frequency of implementation extending from the most frequently implemented teaching strategies at the left of the chart to the least frequently implemented to the right. The charts show similar patterns for both cohorts in that there was modest increase in using problem solving, data, and written and oral communications, but less up-take of research, geoscience skills in the field, primary literature, and research. Service learning was lowest on the scale in the first and second points in time of EPI for both cohorts, with the vast majority of faculty CAs saying it is never used. It is important to note that we would not expect all or most of these teaching strategies to be used in “nearly every class”, with use of some practices less frequently still having a high impact on students.

Figure 5 reveals classroom strategies associated with the SAGE 2YC PD model, with findings revealing a large number of classroom strategies associated with holistic teaching practices. To capture faculty CA use of classroom strategies, we used a different scale than the previous sections of the EPI. For this set of these questions, the instrument offered never or rarely used strategies across courses or used strategies only in some of classes versus all classes. Results show a large number of strategies are used by many faculty CAs in all classes. Multiple lines of communications is an example of a strategy used by nearly all CAs, along with setting end-of-unit and end-of-course expectations, sharing inform on tutoring, mentoring, and campus resources. However, some strategies were rarely used and these should be noted as well including making connections to geoscience careers, integrating geoscience careers into assignments, featuring diverse geoscientists, and making changes based on student feedback. We saw little take-up of these strategies from 2016-17 to 2019, which sheds light on aspects of the PD model to promote professional pathways. However, it is also important to interpret these somewhat cautiously as we would expect some of these strategies to be used less frequently (sporadically) in a class. It is also important to note that a strategy such as “featuring diverse geoscientists” is one of the least frequently used in the pre-EPI and increased the most of all the strategies but is still used less than some of the other strategies.

Figure 6 shows a range of student-focused information sharing strategies, with a scale that measures frequency of use in classes. Results show substantial increase in the use of personal stories and

information about careers by the cohort 1 faculty CAs and but interestingly these same areas appear to be reduced in use by the cohort 2 faculty CAs. In fact, most areas had grown for cohort 1 faculty CAs while we see less change and even some declines by the cohort 2 faculty CAs. Three information sharing strategies almost never used by either cohort are opportunities to give talks or posters, opportunities to interview geoscientists, and opportunities to shadow geoscientists.

Figure 7 displays student support questions with a binary scale (yes/no). For cohort 1, we see increased use of strategies such as working with the advising center, inviting geoscientists on career paths, and inviting alumni in 2019 than in 2016. For cohort 2, we see less use of connecting with K-12 schools and participation in career fairs on campus in 2019 than 2016, though, again. the sample and number of CAs in cohort 2 is so small that changes by only a few CAs can affect the distribution substantially.

Figures 3-7 appear on the following pages.

Figure 3. Cohort 1 and Cohort 2 faculty CA responses on the EPI items pertaining academic success for all students.

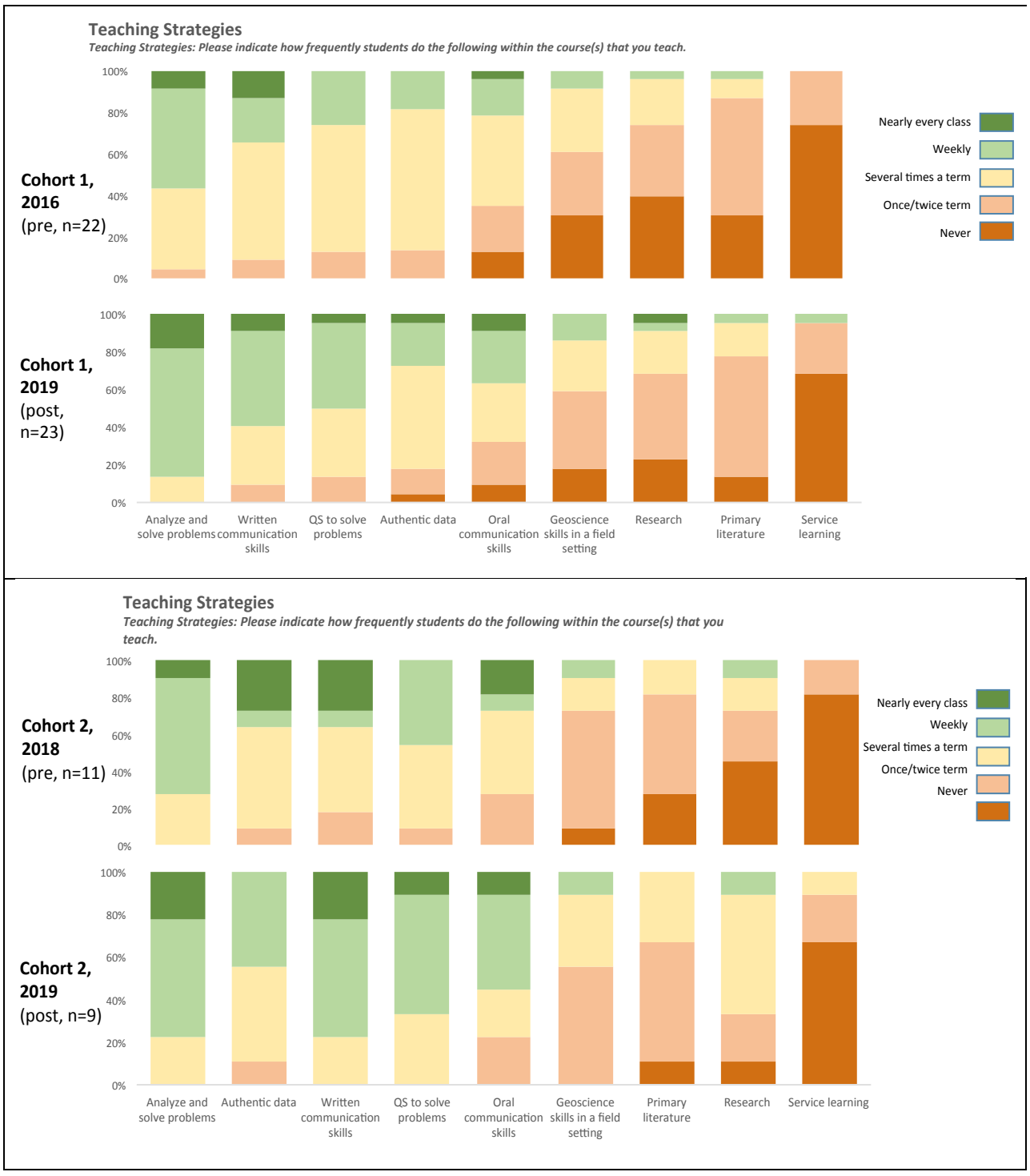


Figure 4. Cohort 1 and Cohort 2 faculty CA responses on the EPI items pertaining to teaching strategies

Figure 5. Cohort 1 and Cohort 2 faculty CA responses on the EPI items pertaining to teaching strategies

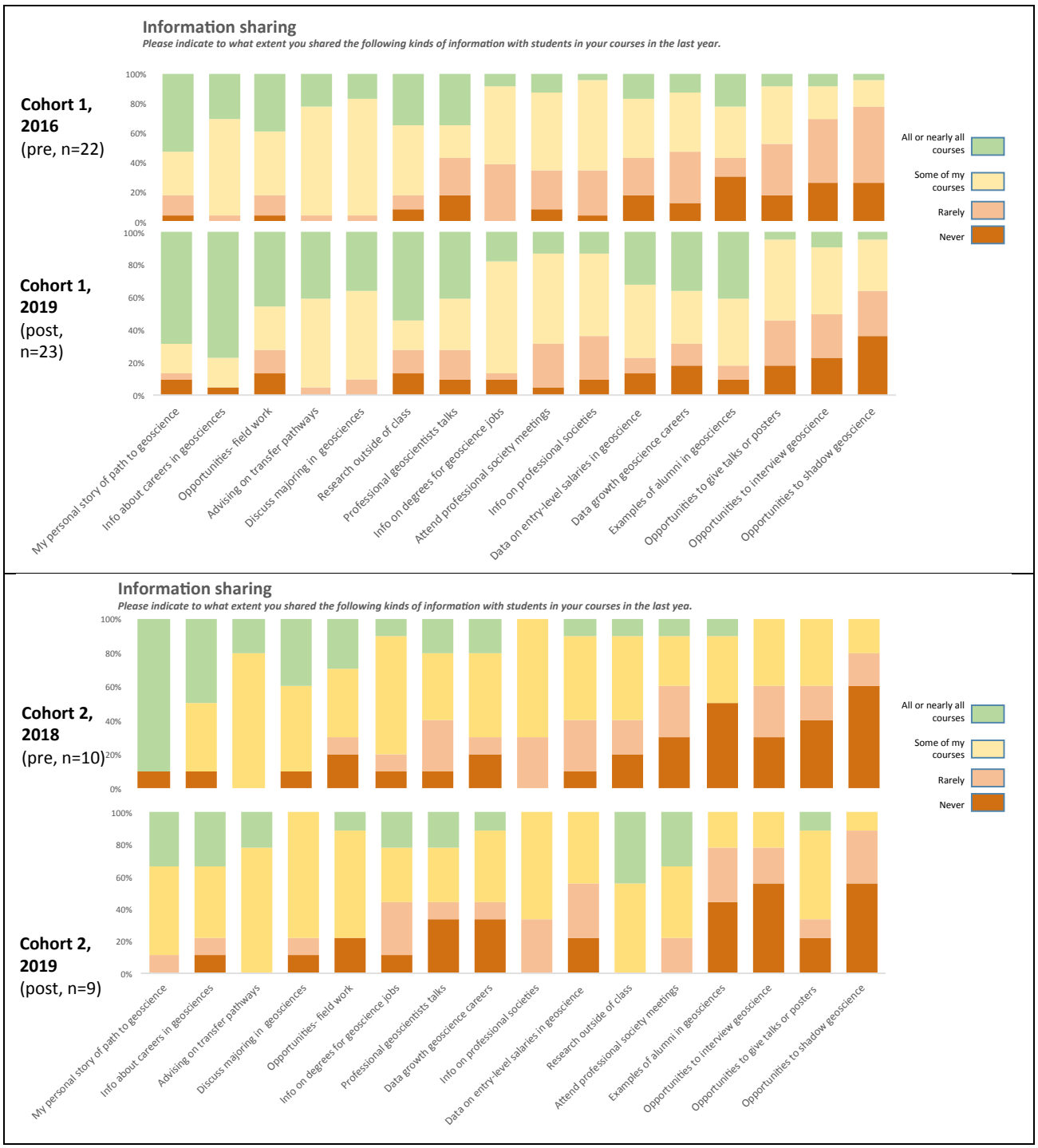


Figure 6. Cohort 1 and Cohort 2 faculty CA responses on the EPI items pertaining to information sharing.

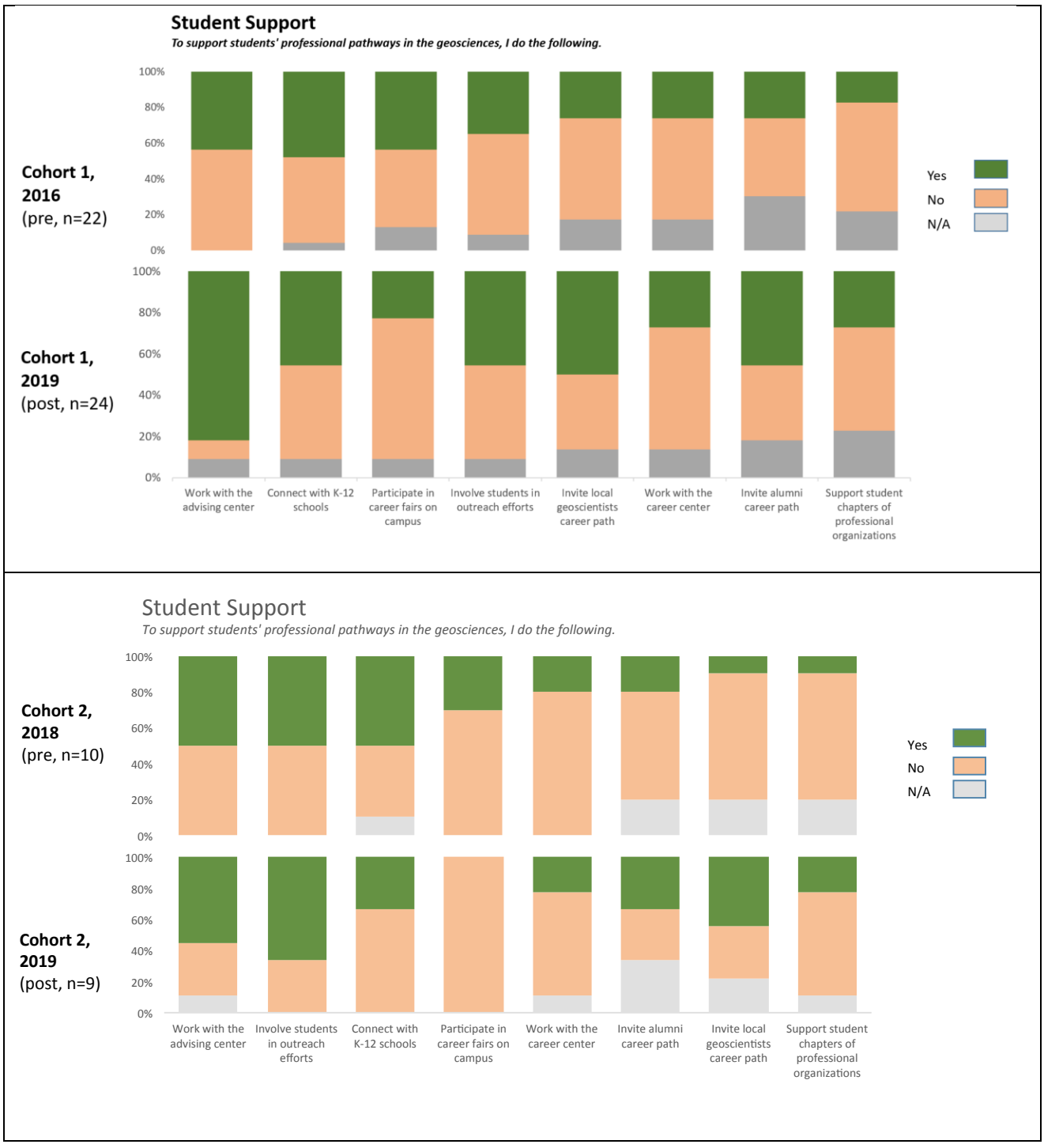


Figure 7. Cohort 1 and Cohort 2 faculty CA responses on the EPI items pertaining to student supports.

Changes to Faculty CA Leadership Frames (analysis prepared by Pamela Eddy and Yi Hao). Preparing faculty CAs to lead changes in their own practice as well as the practice of other faculty in their college and other colleges and universities in the region is an important objective of the SAGE 2YC project. To measure the leadership frames of the faculty CAs, we used the Bolman and Deal (1988) leadership questionnaire. The four types of leadership orientations conceived in Bolman and Deal's framework are:

1) **Structural** leaders emphasize rationality, analysis, logic, facts and data. They are likely to believe strongly in the importance of clear structure and well-developed management systems. A good leader is someone who sees thinks clearly, makes the right decisions, has good analytic skills, and can design structures and systems that get the job done.

2) **Human resource** leaders emphasize the importance of people. They endorse the view that the central task management is to develop a good fit between people and organizations. They believe in the importance of coaching, participation, motivation, teamwork and good interpersonal relations. A good leader is a facilitator and participative manager who supports and empower others.

3) **Political leaders** believe that managers and leaders live in a world of conflict and scarce resources. The central task of management is to mobilize the resources needed to advocate and fight for the unit's or the organization's goals and objectives. Political leaders emphasize the importance of building a power base: allies, networks, and coalitions. A good leader is an advocate and negotiator who understands politics and is comfortable with conflict.

4) **Symbolic leaders** believe that the essential task of management is to provide vision and inspiration. They rely on personal charisma and a flair for drama to get people excited and committed to the organizational mission. A good leader is a prophet and visionary, who uses symbols, tells stories and frames experiences in ways that give people hope and meaning.

We administered the Bolman and Deal question to cohort 1 at the start of Cohort 1 faculty CAs' participation in spring 2016 and to cohort 2 in fall 2017, and we repeated the measurement at the culminating workshop in Madison, WI in June 2019. Table 5 shows the scoring levels that we used for the purposes of reporting the faculty CAs' results.

Table 5.
Levels Used for Scoring the Faculty CAs Leadership Frame Orientations

Level	Bolman and Deal's Longitudinal Scoring Ranges
Strong	Only 25% of respondents rated themselves at or above the score.
Preferential	Only 50% of respondents rated themselves at or above the score.
Weak	75% of respondents rated themselves at or above the score.
Very Weak	More than 75% of respondents rated themselves at or above the score.

Cohort 1 Results. When the Bolman and Deal leadership frame instrument was administered to cohort 1 in spring 2016, the majority of the 21 faculty CAs identified a preference for two or more frames (16 showed two frames and 5 displayed three frames), with only two CAs relying predominantly on a single frame, in both cases the structural frame. (Table 6 and Figure 8 display the numerical scores and graphic representation of results for cohort 1 in spring 2016.) This finding suggests that a slightly higher number

of the cohort 1 CAs identified with more than one frame over the course of the project, and this increase may imply more flexibility in approaching their efforts to change their practice and also to change the practice of others who they encounter as CAs.

Table 6.
Bolman and Deal Leadership Frame Numerical Results for Cohort 1 at SAGE 2YC Beginning (2016)

Level	Structural	Human Resources	Political	Symbolic
Strong	13	4	8	5
Preferential	6	2	5	6
Weak	2	7	6	6
Very Weak	2	10	4	6

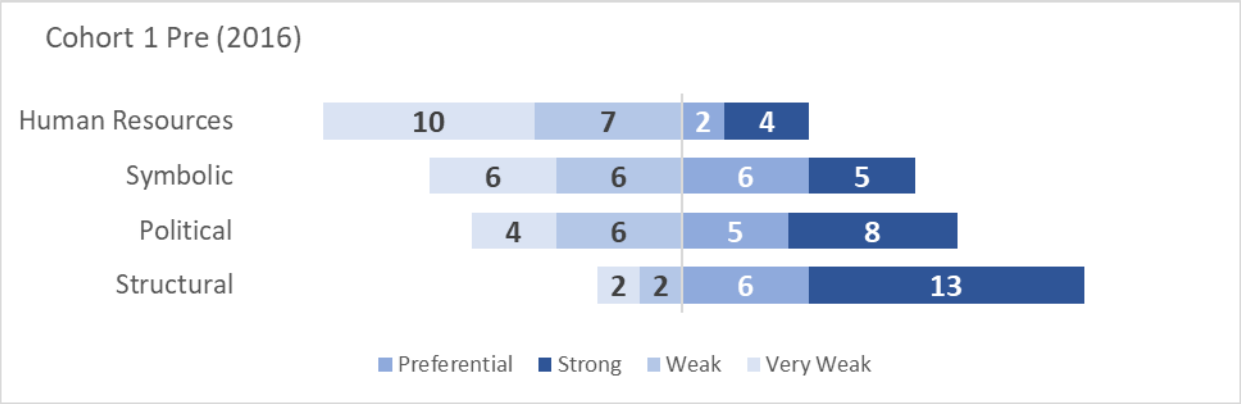


Figure 8. Bolman and Deal Leadership Frame Graphic Results for Cohort 1 at SAGE 2YC Beginning (2016)

Results for the cohort 1 faculty CAs for 2019 are shown in table 7 and figure 9 below. These results reveal a pattern that looks fairly similar in 2016 and 2019; however, upon closer inspection some variation is present in the results. By 2019, we can see some movement away from the structural frame to other leadership frames, particularly the human resources and symbolic frames. Table 8 summarizes these specific changes using a bar chart format.

Table 7.
Bolman and Deal Leadership Frame Numerical Results for Cohort 1 at SAGE 2YC Beginning (2019)

Level	Structural	Human Resources	Political	Symbolic
Strong	11	3	8	6
Preferential	4	5	4	8
Weak	4	6	5	7
Very Weak	4	9	6	2

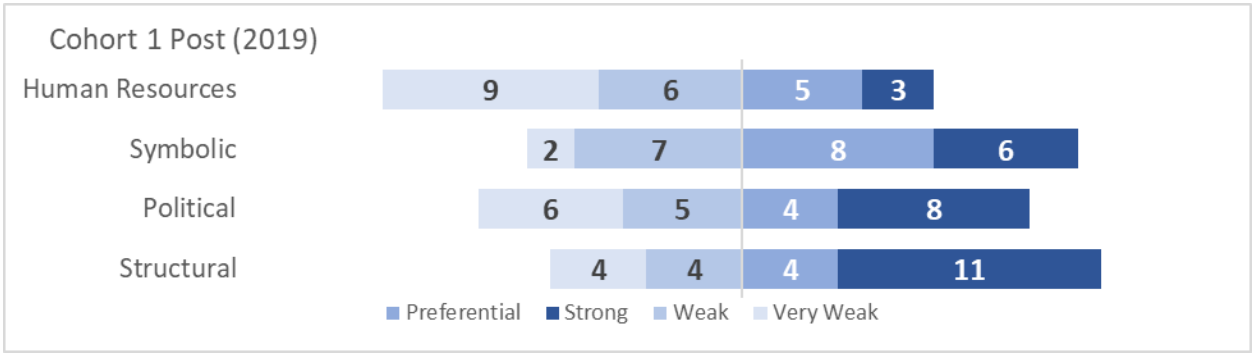


Figure 9. Bolman and Deal Leadership Frame Graphic Results for Cohort 1 at SAGE 2YC Conclusion (2019)

Table 8.
Change in Bolman and Deal Leadership Frame Results from 2016 to 2019 for Cohort 1 Faculty CAs

Level	Structural	Human Resources	Political	Symbolic
Strong	-2	-1	0	1
Preferential	-2	3	-1	2

Cohort 2 Results. The group of cohort 2 faculty CAs first took the Bolman and Deal instrument in fall 2017 near their beginning in the SAGE 2YC project. Table 9 and Figure 10 show results for these CAs in 2017, and Table 10 and Figure 11 show results for 2019. Results for the cohort 2 CAs are similar to cohort 1 in that we see a slight decrease in preference for the structural frame from the first to the second administration of the instrument. Given the shorter timeframe of involvement in SAGE 2YC for cohort 2, it is interesting that these CAs also showed movement at all. One difference between cohort 2 and cohort 1 is that the cohort 2 CAs seem to prefer multiple frames (9 scored two frames, 2 scored three frames), with only one CA relying predominately on a single frame (again, the structural frame) as compared to cohort 1. Cohort 2 CAs are more evenly spread across all four frames at the end of the project than Cohort 1 faculty CAs. Cohort 2 results are HR=45%; SY=54%; PL=54%; ST=63% compared to cohort 1 CA results (HR=35%; SY=61%; PL=52%; ST=65%).

Table 9.
Bolman and Deal Leadership Frame Numerical Results for Cohort 2 at SAGE 2YC Beginning (2017)

Level	Structural	Human Resources	Political	Symbolic
Strong	6	4	3	2
Preferential	2	4	2	2
Weak	4	0	4	4
Very Weak	0	4	3	4

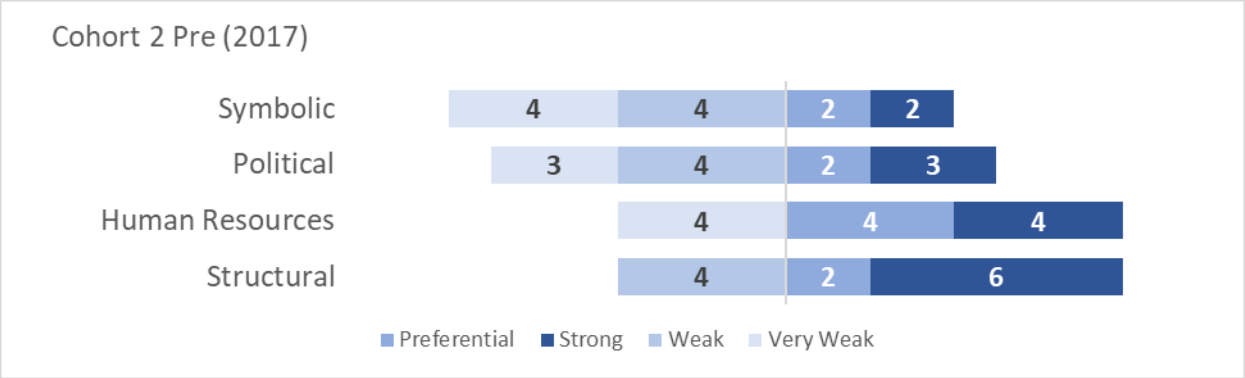


Figure 10. *Bolman and Deal leadership graphic results for cohort 2 at SAGE 2YC Beginning (2017)*

Table 10.
Bolman and Deal Leadership Frame Numerical Results for Cohort 2 at SAGE 2YC End (2019)

Level	Structural	Human Resources	Political	Symbolic
Strong	3	3	2	3
Preferential	4	3	4	2
Weak	1	2	4	4
Very Weak	3	3	1	2

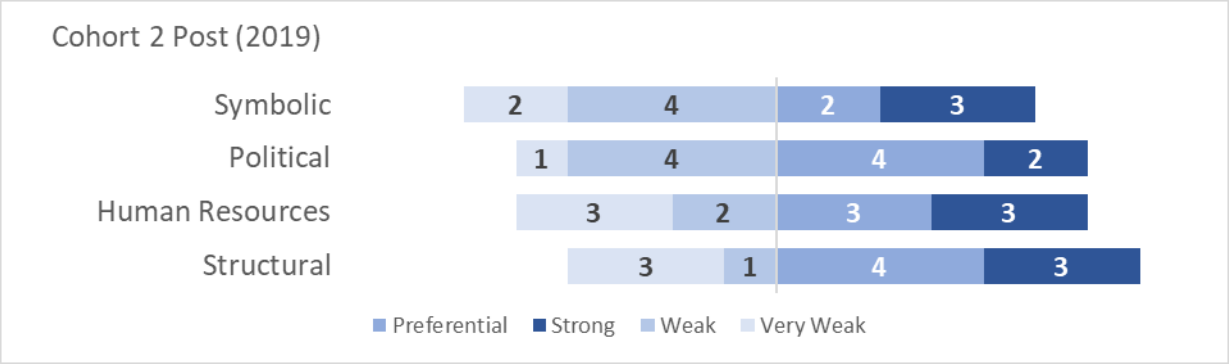


Figure 11. *Bolman and Deal leadership graphic results for cohort 2 at SAGE 2YC end (2019)*

To summarize the Bolman and Deal leadership Frame results, we note that short time frame of the SAGE 2YC project provides two glimpses into the faculty CAs leadership trajectory. Whereas precise explanations for the results are not possible given the self-reporting on the instrument, we wonder if the geoscience faculty CAs may resonate with the structural frame because of its alignment with rationality, analysis, logic, facts and data, all aspects of the scientific methods that these faculty CAs employ regularly in their work. Having cohort 1 faculty CAs showing a larger shift away from the structural frame than cohort 2 faculty CAs is not explained by the scientific method hypothesis but it is also possible the longer time period for engagement in the project of cohort 1 compared to cohort 2 offered an opportunity to learn about and try out different leadership frames in practice.

It is also important to mention that when the faculty CAs (both cohort 1 and 2) were assessed on the Bolman and Deal instrument in 2019, the majority used a multi-framed approach to leadership. Precisely 32 of 35 of the faculty CAs reported using multiple frames, with 25 CAs using two frames and 7 using three frames. By using a multi-framed approach, it is possible that the CAs could tap into different leadership perspectives to motivate others. Knowing the community college context in particular, it is possible that the community college had some influence on the CA's employing multiple leadership frames as Bensimon (1989) reported. Bensimon reported on how community college presidents are more likely to employ multiple leadership frames in their work relative to four-year university counterparts and also similar to long-serving presidents in this perspective. Having multiple leadership strategies to engage colleagues in change efforts, for example working with administrators to obtain resources to execute action plans, may benefit from using multiple leadership frames and perspectives.

Section 3: How Faculty CAs Influence Others to Change

Regional Workshop Results (Analysis prepared by Eric Baer). Consistent with the theory of change, the faculty CAs were tasked with delivering regional workshops to capitalize on their own experience and expertise to spread what they learn through SAGE 2YC to other geoscience and other 2YC faculty. The regional workshops concept was developed at the time of the NSF proposal for this project and continued to evolve as the faculty CAs engaged in implementing the PD model.

Tables 11 and 12 present the number of regional workshop, totaling 37 workshops for both cohorts, and the number of registrants by year and role type. Altogether, all workshops have enrolled 484 participants, with an average of 13 participants per workshop. Slightly over three-fourths (77%) of the total participants are employed in 2YCs as faculty, counselors, other staff, and students, with a relatively small group of representatives from industry, government agencies, high schools, and 4YCs involved. These participants come from 126 organizations, including 97 2YCs and 26 4YCUs. Thirteen of the 2YCs represented in the workshops are Minority Serving Institutions (MSIs). One-third of the faculty participants are adjunct at one or more institutions, and just over half (54%) identified as female. Thirteen participants identified with a racial or ethnic group that is underrepresented in STEM (Black, Hispanic, Native American, and Pacific Islander).

The focus of regional workshops reflects the SAGE 2YC goals to increase students' academic success, broaden participation, and improve professional pathways (see Appendix B for a detailed listing of the topics of the workshops prepared by Dr. Eric Baer, co-PI of SAGE 2YC). Success for all students is a common theme of the workshops, with a focus on changing instructional practices to be more student-centered and inclusive and impactful to the learning of under-represented students.

Table 11.
Number of Regional Workshops and Registrants by Role

Year	Number of workshops	Total Number of Registrants	Role Type			
			Adjunct	Full-Time	Non-inst.	No Response / Other
2016-17	10	147	15	90	3	5
2017-18	10	188	38	104	15	31
2018-19	17	149	28	54	4	63

Table 12.
Number of Regional Registrants by Institution Type

Workshop Year	Total Number of Registrants	Institution Type			
		2YC	4YC/U	Other	No Response
2016-17	147	126 (86%)	7	3	11
2017-18	188	136 (72%)	33	2	17
2018-19	149	113 (76%)	20	3	13

Annual Workshop Results (Analysis prepared by Ellen Iverson and the SERC staff). The last set of results pertaining to how faculty CAs influence others to change is drawn from the annual workshop survey results provided by the faculty CAs as well as administrators. With respect to influencing others, the survey results indicate one of the most satisfying aspects to the workshop for both faculty CAs and administrators was networking and sharing with others who have similar interests and aspirations. By attending the meeting with the mindset of learning and scaling change, there was a sense of shared purpose that was expressed through both quantitative and qualitative data.

To provide an example of the value that faculty CAs expressed about collective activities held at the workshop, survey results show 22 faculty CAs (61%) offered open-ended statements expressing favorable views of connecting with other participants and sharing ideas, resources, and experiences. Nearly 45% of the faculty CAs expressed positive views of working with their college administrators during the workshop, and over 20% made positive comments about time devoted to planning with their faculty CA team members and/or administrators, including planning sustainability efforts and/or regional workshops. Three quotes exemplifying some of these perspectives follow:

- "Sense of connection - with other Change Agents and with my Associate Dean. That's worth all the stress and hassle of getting people together in person."

- "Focus on planning specific tasks to accomplish. This helps in the translation of ideas to actions. Having the administrator present was super-helpful. Although she is around on campus, we rarely get good one-on-one time with her."

- "Having time to draft a sustainability plan with my administrators, and to get to know them better. The CA micropresentations provided a wealth of new material that I will implement in classes in the future. Time to network with other CAs and learn more about them and their institutions."

When asked to comment on future efforts to sustain what has been learned and accomplished through SAGE 2YC, again the faculty CAs mentioned collaborative activities that involve their work with others. Twenty faculty CAs (55%) stated that they intend to continuing working with their colleagues within the project or with other faculty CAs teams in the future. Importantly, nine CAs (25%) stated they intend to engage their students in lessons they learned from the workshop and continue attending and creating various workshops. Three quotes illustrating the importance of these experiences to the faculty CAs follow.

- "I need to stay connected and continue to push myself out of my comfort zone. New faculty brings a refreshing new opportunity to reach out and make more connections and share SAGE 2YC initiatives."

- "I want to continue my network that I'm creating with my students (both former and current students). My hope is that with time, I will not be the only hub."

- "Keep on hosting and attending workshops and professional development events. Keeping up with what others are doing in their courses to find possible ways to improve my courses."

Administrators were also invited to share their impressions of the annual workshop strategies to encourage networking and collaborative work that can impact their own colleges. Results of these end-of-workshop survey items revealed administrators thought the brainstorming session gave them an opportunity to consider ways to continue post-SAGE work (n=7), dedicate time to interacting with their faculty CA(s) (n=6), and learn about ideas from the larger group (n=6). Three quotes supporting these administrator perspectives follow:

- "The brainstorming session (post-its) with both faculty and administrators, project team micro-presentations and time for sustainability planning with my change agent. Great idea sharing to take away for potential implementation from hearing of others' work. Faculty perspective in what's needed to support change. Sustainability and continued development specific to our CA's work."

- "I enjoyed all the aspects of the workshops, but having the time to meet with my faculty and hear what they need most to continue their momentum was really valuable to me. This

afternoon I meet with my change agents and got to hear what they were most excited about working on moving forward. I feel like we have a very good sense of how to keep a positive attitude as we move forward together."

- "I appreciated hearing from folks at other institutions and what changes they are implementing. With the culture of sharing, I know we can reach out to others and share ideas instead of having to reinvent the wheel. I also appreciated having time to talk about what we want to do in the future with my CA. We had ideas going into this workshop, but I feel we were able to flush them out and have a stronger plan moving forward."

Summary of Major Year Four Results

Evaluation of the fourth year of the SAGE 2YC provided valuable insights into what's changing in the work of two cohorts of faculty CAs. The theory of change for the project is rooted in a professional development (PD) model emphasizing the two major goal domains of increasing evidence-based practices and building sustainable leadership. The PD model also stresses improving instructional practices, broadening participation of under-represented students, and enhancing professional pathways. By changing faculty practices and engaging faculty CAs in reflecting on those changes independently and in collaboration with others over time, the PD model theorizes that CAs will learn how to continue to strengthen and improve their practices in ways to lead to more equitable student outcomes. Faculty CAs may also positively influence the practice of other faculty and staff in their colleges and in their geographic regions to be more student-centered. Through intentional inquiry and reflection, the CAs and their 2YCs will engage in a cycle of innovation that will continue to scale and amplify positive student outcomes.

Summarizing major findings for this fourth year, we present the following points:

- Efforts of the faculty CAs reveal a strong focus on course-level change of instructional practices in their own classrooms. These personal experiences lead to sharing about how to change instructional practices within their 2YCs as well as through their regional workshops and other professional development opportunities. In the CAs' work with their 2YC administrators some CAs experience support for making larger, systemic changes in instructional practices on their campuses.

- Through formal assessments and qualitative interview data, results show faculty CAs believe that changes in their own instructional practice will lead to improved student success, and they rely on these beliefs to ground their efforts to make current and future changes in instructional practices. Though the CAs appear to vary in the intentionality of the strategies they adopt to improve the learning outcomes of under-represented students, many voice a commitment to improving the academic success of underrepresented students whose outcomes continue to lag behind their racial-majority students (this finding is consistent with course-level outcomes data collected to be reported in the final SAGE 2YC report). The vast majority of faculty CAs in both cohorts express the desire to continue learning how to integrate active learning and metacognition into their teaching to improve the academic success of all students, and they see these strategies as especially important to the under-represented students in their classrooms and colleges.

- Data gathered by trained observers on the Reformed Teaching Observation Protocol (RTOP) found 9 of 14 cohort 1 faculty CAs (64%) who were observed in 2016 and again in 2018-19 showed higher RTOP scores at the second observation than the first (some RTOP data is not yet available but will be completed and integrated the final SAGE 2YC report). Notably, three CAs moved from teacher-centered to the transitional range and another two CAs shifted two levels from the teacher-centered range to the student-centered range, skipping the transitional range entirely. One of these CAs made a remarkable jump of 32 points, and the other by nearly as much, at 25 points.

- The Educational Practices Inventory (EPI) was completed by the faculty CAs near the beginning of their involvement in the project in either 2016 (cohort 1) or 2017 (cohort 2) and in early 2019. The instrument uses scaled items associated with strategies on success-for-all-students, teaching, classroom, information sharing, and student supports. Using the EPI to do pre- and post-project assessment provided rich data to triangulate with other data points in this study, two of which follow:

    - The faculty CAs reported continuing to use lecture-led instructional approaches but by 2019 their lecture-led instruction was more integrated with other student-focused instructional strategies, such as student-to-student interactions, inquiry methods, cooperative learning, active learning, as well as metacognition. These findings are corroborated by RTOP results showing the majority of CAs who were observed pre- and post-project showed positive change toward student-centered teaching.

    - The faculty CAs reported less use of strategies associated with geoscience careers, engagement of geoscience experts, and other career-focused areas advocated by the SAGE 2YC project goal of advancing professional pathways than the goal of enhancing the academic success of all students or broadening participation. This finding is consistent with the CAs action plans (see Table 3 again) wherein the plans show intentional efforts to enhance student success including by closing equity gaps but comparatively less focus on professional pathways (although it is clear that some CA teams did purposefully address this goal).

- Data gathered on the Bolman and Deal Leadership Frame instrument near the beginning and end of the project reveal changes in the ways in which the faculty CAs (cohort 1 and 2) perceive of their own leadership frames. For cohort 1, we see some movement toward the identification of more than one frame in 2019 compared to 2016, and we also see some movement away from the structural frame to other leadership frames, particularly the human resources and symbolic frames. These results may suggest more flexibility in engaging in change strategies in the CAs work to change their own practices in their work with others. Similarly, we saw some movement of cohort 2 CAs from the structural frame to more of a multi-frame leadership perspective although as a group, the CAs in cohort 2, showed preference for a multi-frame leadership approach from the start of the project. The results for cohort 2 CAs results were distributed more evenly across the four frames than the cohort 2 CAs' results. For both groups, the shift to multiple leadership frames may position the CAs to be more adept at using these frames to motivate others to change. Having multiple leadership strategies to engage colleagues in change efforts, for example working with administrators to obtain resources to execute action plans, may benefit from using the CAs' using multiple leadership frames and perspectives.

- The faculty CAs delivery of regional workshops has been an important component of the SAGE 2YC project. To date, 37 workshops enrolling 484 participants have occurred, with a common focus being on the SAGE 2YC goal of enhancing the success for all students. Numerous workshops have replicated aspects of the SAGE 2YC PD model to change instructional practice in geoscience classrooms to be more student-centered for all learners as well as to be more inclusive and positively impactful for under-represented students.

- Finally, results from the annual workshop show the faculty CAs appreciate opportunities to convene and collaborate with each other, including sharing with other faculty how they are experiencing changes to their instructional practices, how they are reforming recruitment and engagement strategies for under-represented students, how they are encouraging other geoscience faculty in their colleges to change their instructional practices, and how they are engaging in other professional development to grow their networks on the regional and national levels. The faculty CAs also recognize the involvement of their campus administrators in favorable ways, and in turn, the administrators express appreciation for the value of the SAGE 2YC project. Many acknowledge the difficulties they experience in finding time to engage with faculty in such a deep way as the SAGE 2YC project has provided. Without SAGE 2YC it is difficult to imagine how these relationships could have developed, but it is easy to see how important they are to creating and sustaining meaningful change.

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Appendix A

Publications, Presentations, Posters & Abstracts by the SAGE 2YC Evaluation and Research Team

Eddy, P., Hao, Y., & Bragg, D. (2019, April). *Exploring theoretical perspectives on change agent roles enacted by two-year college geoscience faculty.* Research paper presented at the 2019 Annual Meeting of the American Educational Research Association, Toronto, Canada.

Eddy, P., Iverson, E., Hao, Y., Bragg, D., & O'Connell, K. (2019, April). *Faculty as leaders: Building innovative and sustainable change in community colleges.* Research symposium at the 61st Annual Council for the Study of Community Colleges Conference, San Diego, CA (equal contribution among the presenters).

Eddy, P. L., Hao, Y., Markiewicz, C., & Iverson, E. (2018). Faculty change agents as adult learners: The power of situated learning. *Community College Journal of Research and Practice. https://www.tandfonline.com/doi/full/10.1080/10668926.2018.1507848*

Eddy, P. L., Hao, Y. H., Bragg, D., & Iverson, E. (2018, April). *The influence of mental maps on engagement in transformative change efforts.* Peer reviewed paper at the Annual Conference of the Council for the Study of Community Colleges, Dallas, TX.

Eddy, P. L., (2018, April). *Supporting and advancing geoscience education at two-year colleges (SAGE 2YC): Faculty as agents of change.* Peer reviewed symposium at the American Association for Educational Research Annual Meeting, New York, NY.

Eddy, P., Iverson, E., & Hao, Y. (2018, April). *Fostering communities of practice among community college STEM faculty: Connecting the dots.* Roundtable session at the 2018 Annual Meeting of the American Educational Research Association, New York, NY.

Eddy, P. L., Iverson, E., Hao, Y., & Markiewicz, C. (2017, November). *Change agents as adult learners: The power of situated learning.* Peer reviewed research paper at the Annual meeting of the Association for the Study of Higher Education, Houston, TX.

Ormand, C.J., Baer, E.M.D., Bragg, D., Eddy, P., Emerson, N.R., Hao, Y., Hodder, J., Iverson, E. and Macdonald, R.H., (2017, October). The Inventory Of Educational Practices And The Inventory Of Geoscience Department And Program Practices: Two New Instruments In Development From The SAGE 2YC Project. Geological Society of America Abstracts with Programs, 49(6). doi: 10.1130/abs/2017AM-304154 Poster

Eddy, P. L., Hao, Y., Iverson, E., & Bragg, D. (2017, April). *Changing teaching practices to support student success: The role of communities of practice*. Peer reviewed research paper at the Annual Conference of the Council for the Study of Community Colleges, Fort Worth, TX.

Hao, Y., Eddy, P. L., Bragg, D., & Iverson, E. (2017, April). *Becoming change agents: Geoscience faculty at two-year institutions.* Peer reviewed research paper at the Annual Conference of the Council for the Study of Community Colleges, Fort Worth, TX.

Eddy, P. L., Hao, Y., Markiewicz, C., Iverson, E., & Bragg, D. (2017, February). *Building good teaching practices in STEM: Exemplar portraits*. Peer reviewed poster at the Conference on Higher Education Pedagogy, Blacksburg, VA.

Eddy, P. L., Iverson, E., Hao, Y., & Bragg, D. (2016, November). *Focusing on teaching to promote student success: Faculty change agent roles in SAGE 2YC.* Peer reviewed roundtable at the Annual meeting of the Association for the Study of Higher Education, Columbus, OH.

Appendix B

Regional Workshops Offered by Cohorts 1 and 2 Faculty Change Agent Teams

Team	Regional Workshop in 2016-17	Regional Workshop in 2017-18	Regional Workshop in 2018-19
Cohort 1			
Southern California 1	Supporting Academic Success In The Geosciences At Two-year Colleges In Southern California*	Geoscience Retreat For Southern California 2YC Geology, Geography, And Environmental Science Faculty	Strong Starts And Transitions: Supporting Present And Future Geoscience Educators At 2YCs In Southern California
Southern California 3 *(Single team with So. Cal. 1 in 2016 and 2017)*	Supporting Academic Success In The Geosciences At Two-year Colleges In Southern California	Geoscience Retreat For Southern California 2YC Geology, Geography, And Environmental Science Faculty	Welcome To Geosciences: Removing Barriers To Engagement, Success, And Persistence
Florida	Passage To Student Success In Florida 2YCs	Passage To Student Success In Florida 2ycs: Developing Strategies To Increase Student Recruitment And Retention In Geoscience Courses, Majors, And Programs	Passage To Student Success In Florida 2YCs: Welcome To The 21st Century: Developing Successful Strategies For Online/Hybrid Geoscience Courses
Illinois	Cultivating Geoscience Students	Diversity Is More Than Ethnicity	Geoscience Connections: Helping Students Connect To Their Science Identity
New York	Student Success In The Geosciences: Why Can't They Do That? Overcoming Learned Helplessness, Change Mindset And Teach For Mastery	Collaborating For Success: Building Communities To Increase Success And Participation Within Our Programs	From Design To Assessment: Developing Successful Science Courses And Programs
North Carolina	Empowering 2YC Geoscience Faculty To Improve Student Learning: If You Can't Have The Student With Skills You Want, Then Engage The Ones You Have.	Pathways To Success: Course Design, Improving Diversity, And Transfer Opportunities In Geoscience	Take The Leap From Studying Best Practices To Action: Propelling Our 2YC Geoscience Students To Success
Oregon (Portland)	Active Learning: Hood To Coast	Floods Of Change: The Vanport Floods, Stereotype Threat, And 2YC-4YC Transfer	CASCADES "Creating Academic Success & Cognitive Awareness Developing Exemplar Students"
Texas	Supporting Geoscience Student Success Through Active Learning, Metacognition, And GRIT	Improving Student Success And Broadening Participation Of Underrepresented Minorities In The Geosciences	Unseen Barriers In Our Geology Classes And Helping Our Students Prepare For Transfer
Virginia	Revitalizing Connections With Geoscientists Within The VCCS Through The Science Peer Group: Sharing Best Practices For Engaging Our Students	Fostering A Network Of Virginia Geoscientists	Geoscience Career Mentoring

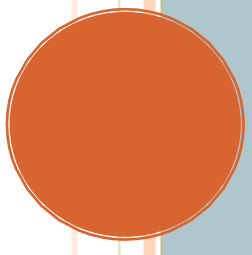
Team	Regional Workshop in 2016-17	Regional Workshop in 2017-18	Regional Workshop in 2018-19
Wisconsin	Not Just Rocks! We Know Other Stuff, Too! Geosciences In The Modern World	What Does The Geoscience Landscape Look Like In The Badger State?	Re-imagining Geoscience Education In Wisconsin
Northern California	Improving Instruction And Supporting Transfer Opportunities In The Geosciences In The San Francisco Bay Area	Exploring The Geoscience Landscape 2018: Opportunities For Undergraduate Education In The Geosciences	Improving Instruction, Broadening Participation And Supporting Transfer Opportunities In The Earth Sciences Within The S.F. Bay Area
Cohort 2			
Southern California 2			PathWaves To success: Building bridges between 2YC And 4YC ocean sciences programs
Massachusetts			Science by the Sea
Michigan			Building community and supporting student success in environmentally-related science courses at 2YCs
Oregon (Willamette Valley)			Supporting the success of all students in introductory 2YC geoscience courses
DC Metro area			Field trips to engage students in science
Western Washington			Build community for student success

Appendix C

Annual Workshop Results

SERC the Science Education Resource Center at Carleton College

SAGE 2YC 2019 Faculty as Agents of Change



The Science Education Resource Center at Carleton College

Findings

General Information

The end of workshop survey included questions related to the workshop and to participants' experience with the project as a whole. This report summarizes the responses from the questions related to the workshop. The appendices include verbatim comments and how the comments were coded into sub-themes. Participants were asked general questions about the workshop. These included questions about what they found most and least valuable, and how they planned to sustain their efforts as Change Agents. (Appendices are removed from this document to ensure anonymity of respondents in this annual report.)

When asked what aspects of the workshop they found most valuable participants responded that they liked connecting with other participants and sharing ideas, resources, and experiences (n=22), working with the site administrator (n=16), and planning time for next steps including sustainability efforts and/or regional workshop with either team or administrator (n=8). These quotes exemplify some of these comments:

- "Sense of connection - with other Change Agents and with my Associate Dean. That's worth all the stress and hassle of getting people together in person."
- "Focus on planning specific tasks to accomplish. This helps in the translation of ideas to actions. Having the administrator present was super-helpful. Although she is around on campus, we rarely get good one-on-one time with her."
- "Having time to draft a sustainability plan with my administrators, and to get to know them better. The CA micropresentations provided a wealth of new material that I will implement in classes in the future. Time to network with other CAs and learn more about them and their institutions."

Other valuable aspects noted included the micro-presentations (n=7), synthesis work developing project themes helped put own work in perspective and helped understand other Change Agent's work (n=5) research team interactions including coaching and/or leadership development (n=4), and equity session (n=3).

When asked what aspects of the workshop they found least valuable participants responded with various issues related to time (n=7), the use of the website (n=6), or other aspects such as reporting that parts of the workshop seemed redundant (n=3) or less value in equity session (n=3).

- "The lack of time to reflect this time around. Everything seemed a lot more rushed than usual."
- "Not so much less valuable but writing the websites was challenging...it's hard to synthesize so much!"
- "Some parts near the end seemed a bit redundant--in particular I am thinking of the gallery walk activity right after the evaluation that were essentially covering the same thing. It wasn't that bad, because it is good to be reminded of important concepts and questions, but I felt I had to put something here."
- "Although I find I usually get something out of everything I experience, there were parts that I did feel were somewhat minimal in what I did get out of it. [NAME] Equity presentation was

more of a reminder than getting a lot out of it. I kinda felt the same way about the Momentum presentation. Sorry."

Participants were asked how they planned to sustain their Change Agent efforts post-grant. Many participants stated that they intended to work with their colleagues within the project or their Change Agent teams (n=20). Additionally, they stated that they intended to engage their students with lessons from the workshop (n=9) and continue attending and creating various workshops (n=9).

- "I need to stay connected and continue to push myself out of my comfort zone. New faculty brings a refreshing new opportunity to reach out and make more connections and share SAGE 2YC initiatives."
- "I want to continue my network that I'm creating with my students (both former and current students). My hope is that with time, I will not be the only hub."
- "Keep on hosting and attending workshops and professional development events. Keeping up with what others are doing in their courses to find possible ways to improve my courses."

Other strategies that participants reported included promoting active learning (n=6) or pursuing regional or institutional engagement activities (n=5). In addition, participants described a desire to maintain leadership development or take on specific roles (n=6) with many additional responses inferring leadership as a role for how they would promote the strategies described.

Workshop Design

Participants were asked to rate the extent to which they agreed with a set of statements about the design of the workshop. Overall, responses to all questions about workshop design were positive.

a. The pre-workshop communications gave me the information I needed to learn about and prepare for the workshop. (n=32)

	Disagree	Tend to Disagree	Tend to Agree	Agree
Number OR Percent of participants	0	0	25% (8)	75% (24)

b. Materials on the website were useful in preparing for the workshop. (n=32)

	Disagree	Tend to Disagree	Tend to Agree	Agree
Number OR Percent of participants	0	0	22% (7)	78% (25)

c. The design of the workshop facilitated exchange of expertise among participants. (n=31)

	Disagree	Tend to Disagree	Tend to Agree	Agree
Number OR Percent of	0	0	10% (3)	90% (28)

participants				

d. The workshop events engaged me in active learning related to its goals. (n=31)

	Disagree	Tend to Disagree	Tend to Agree	Agree
Number OR Percent of participants	0	0	16% (5)	84% (26)

e. The workshop sessions were well facilitated. (n=32)

	Disagree	Tend to Disagree	Tend to Agree	Agree
Number OR Percent of participants	0	3% (1)	6% (2)	91% (29)

f. The logistics for the workshop were well executed. (n=32)

	Disagree	Tend to Disagree	Tend to Agree	Agree
Number OR Percent of participants	0	0	12% (4)	88% (28)

Goals

Workshop facilitators were asked to provide goals for the workshops prior to the day of the actual workshop.

a. Learn about the work of other Change Agents and teams (n=32)

	Disagree	Tend to Disagree	Tend to Agree	Agree
Number OR Percent of participants	0	0	6% (2)	94% (30)

b. Learn more about aspects of the three major strands of the project (n=32)

	Disagree	Tend to Disagree	Tend to Agree	Agree
Number OR Percent of participants	0	3% (1)	19% (6)	78% (25)

c. Codify the work of the SAGE 2YC: Faculty as Change Agents project (n=32)

	Disagree	Tend to Disagree	Tend to Agree	Agree
Number OR Percent of participants	0	3% (1)	19% (6)	78% (25)

d. Discuss and plan for project sustainability (n=32)

	Disagree	Tend to Disagree	Tend to Agree	Agree
Number OR Percent of participants	0	3% (1)	22% (7)	75% (24)

Participants were then given the opportunity to respond to how well they felt the workshops met the stated goals. Nearly all participants agreed or tended to agree that the stated goals were met. On three of the goals (learn about three strands, codify work of project, and plan for sustainability), one respondent (different for each question) tended to disagree.

Participants were given space to provide open-ended comments on the goals. Among the 12 responses, some felt goals were successfully met (n=6), a few felt goals were still met but not as much as they could have been (n=2), while few more felt the stated goals were unsuccessfully met (n=4). These quotes exemplify the type of comments provided by participants:

- "This workshop was incredibly helpful to see the scope and context of the entire grant and how our work fit into that."
- "On the whole, the workshop included valuable information, but it was, at times, stretched over too long a session -- some sessions could have been combined. The content of the workshop could have just as effectively been covered in 2 days."
- "I did not understand the codification process."

Overall Satisfaction

Workshop participants were asked to rate their overall satisfaction on a scale of 1-10 with 10 being "very satisfied" and 1 being "very dissatisfied." The average overall satisfaction was 9.6.
The number of respondents giving the workshop each number ranking is listed below.

Participant Overall Satisfaction (n = 32)

	1 "Very dissatisfied"	2	3	4	5	6	7	8	9	10 "Very satisfied"
Percent of Participants	0	0	0	0	3% (1)	0	0	6% (2)	13% (4)	78% (25)

Participants were also asked to explain the reasons behind their overall ratings. From the 26 participants who provided comments, many participants expressed satisfaction with the workshop and gratitude for the experience (n=17). Some participants noted particular feelings of engagement either positive (n=4) or negative (n=1).

- “Another great workshop with a bunch of awesome folks! I'm going to miss these!”
- “Great workshop, I felt like I actually accomplished something instead of sitting in a room and passively taking it all in.”

These comments were provided from the three lowest satisfaction ratings by way of explanation:

- “Some of the sessions were a waste of time, and the lack of time to complete items. There were constant interruptions which were difficult to deal with.”
- “Good content, great interaction, but the overt favoritism displayed by some project leaders really destroyed any pleasure I gained from the workshop. It has been a painful experience.”
- “Overall the workshop was very effective. This workshop felt different regarding engagement. I did not feel as engaged. It also felt a bit isolated, but that could just be my personal baggage and not workshop related. That being said- I am grateful for the chance to be part of this group and am thankful the PIs allowed me to be part of the grant.”

SERC the Science Education Resource Center at Carleton College

Administrators only

The Science Education Resource Center at Carleton College

FINDINGS

General Information

Administrators responded to questions about what they found most and least valuable about the workshop, how they would apply what they learned, and how if at all they planned on continuing to learn about the topic.

Most Valuable

When asked **what aspects of the workshop they found most valuable** administrators responded that the brainstorming session gave an opportunity to consider ways of continuing post-SAGE work (n=7), dedicated time to interact with their CA(s) (n=6), and learning about ideas from the larger group (n=6).

- "The brainstorming session (post-its) with both faculty and administrators, project team micro-presentations and time for sustainability planning with my change agent. Great idea sharing to take away for potential implementation from hearing of others' work. Faculty perspective in what's needed to support change. Sustainability and continued development specific to our CA's work."
- "I enjoyed all the aspects of the workshops, but having the time to meet with my faculty and hear what they need most to continue their momentum was really valuable to me. This afternoon I meet with my change agents and got to hear what they were most excited about working on moving forward. I feel like we have a very good sense of how to keep a positive attitude as we move forward together."
- "I appreciated hearing from folks at other institutions and what changes they are implementing. With the culture of sharing, I know we can reach out to others and share ideas instead of having to reinvent the wheel. I also appreciated having time to talk about what we want to do in the future with my CA. We had ideas going into this workshop, but I feel we were able to flush them out and have a stronger plan moving forward."

Engaging your Change Agent(s) in the Future

Administrators were asked **what you've learned that will help you engage faculty in improving student success**. Administrators reported a range of strategies. Themes included providing additional support to faculty (n=4), focusing on equity (n=3), sharing knowledge (n=3), and the power of personalized evidence (n=2).

- "We discussed the need for some STEM-specific faculty development, as well as the importance of a long-term commitment with community for implementing and evaluating change and new practices. I am also taking away some specific examples of faculty development such as a session on leading field trips."
- "Faculty want to address equity, but don't know how."
- "I have been heartened to know to what depths faculty are willing to analyze their own practices and share with others for the benefit of our collective students."

Next Steps for Engaging Change Agent(s)

When asked **what are your next steps for engaging Change Agents in their future plans**, administrators highlighted increasing Change Agent dissemination opportunities, often beyond of the geosciences

(n=10), continuing discussions with Change Agents (n=10), and supporting Change Agents in their mission to become leaders of their college (n=8).

- "Will work with [change agent] and [the Dean] to implement a structure similar to the sage2yc to identify change agents in the other disciplines in out department and support their efforts to create a better learning community."
- "I am planning on reaching out on a regular basis to see how they are doing with their plans."
- "We plan to use the change agents in a significant role to work with another college department around student completion, student experiences and employee satisfaction."

Leveraging Lessons

Administrators were asked how they would **leverage the lessons from this project on your campus.** Top themes included increasing connections across campus (n=6), emulating SAGE's model and passing knowledge around (n=4), and continuing their mission to build equity throughout their campuses (n=4).

- "Student and faculty engagement is not specific to geoscience. A lot of ideas presented can be applied to other disciplines. I am hoping that the change agent will be able to share these ideas with other people at the college and to foster some collaborative work."
- "The project mentioned above will allow our change agents to practice and model the activities and skills learned through the SAGE project."
- "The definitions of equity and data shared about community college students will be useful in our on-going conversations about creating an equity-oriented campus culture. The intersections of the three project strands will also help in creating connections between different elements of faculty and administrative work."

Workshop Design

Administrators were asked to rate the extent to which they agreed with a set of statements about the design of the workshop. Overall, responses to all questions about workshop design were positive.

g. The workshop sessions were well facilitated. (n=17)

	Disagree	Tend to Disagree	Tend to Agree	Agree
Percent/Number of administrators	0	0	6% 1	94% 16

h. The logistics for the workshop were well executed. (n=18)

	Disagree	Tend to Disagree	Tend to Agree	Agree
Percent/Number of administrators	0	0	11% 2	89% 16

Goals

Workshop facilitators were asked to provide goals for the workshops prior to the day of the actual workshop. Administrators felt that goals were smashed.

a. Learn more about the geoscience program(s) at my institution. (n=18)

	Disagree	Tend to Disagree	Tend to Agree	Agree
Percent/Number of administrators	0	0	11% 2	89% 16

b. Learn about the SAGE 2YC project goals, the work of the Change Agents, and how these are related to work we undertake at my institution. (n=18)

	Disagree	Tend to Disagree	Tend to Agree	Agree
Percent/Number of administrators	0	0	0	100% 18

c. Support the faculty Change Agents in generating plans for the future. (n=17)

	Disagree	Tend to Disagree	Tend to Agree	Agree
Percent/Number of administrators	0	0	0	100% 17

Administrators were then given the opportunity to respond to how well they felt the workshops met the stated goals. All replies indicated satisfaction (n=7).

- "I felt that I had a good understanding of the SAGE 2YC work coming into this workshop, but participating here allowed me to expand that understanding beyond our own campus and more clearly understand the work that our change agent has been engaged with."
- "I'm happy with the direction of our plan using the work the CAs have already accomplished as our base."
- "Excellent."

Overall Satisfaction

Workshop administrators were asked to rate their overall satisfaction on a scale of 1-10 with 10 being "very satisfied" and 1 being "very dissatisfied." The average overall satisfaction was 9.4

The number of respondents giving the workshop each number ranking is listed below.

Administrator Overall Satisfaction (n = 18)

	1 "Very dissatisfied"	2	3	4	5	6	7	8	9	10 "Very satisfied"
Percent/Number	0	0	0	0	0	0	6%	11%	17%	66%

of Administrators	1	2	3	12

Administrators were also asked to explain the reasons behind their overall ratings. Most replies indicated complete satisfaction (n=9), mentioned including administrators (n=2), and thoughts about time being a bit less than felt required (n=2).

- "What a great Grant and program this was - I appreciate all that I have learned from my attendance at the 2YC workshops."
- "I wish the study/research would look at the impact of involving administrators and how that impacted the work."
- "Not much time for interaction; short trip."