Cottrell Scholars Collaborative New Faculty Workshop

Discipline: Chemistry

Workshop Leaders (PIs): Andrew Feig (Wayne State University) and Rory Waterman (Univ. VT)

Funding Source(s): Research Corporation for Science Advancement, American Chemical Society

Cost per participant: ~$400

Costs/Fees paid by the participants (or their home institutions): travel to and from workshop

Target Audience: new faculty either just starting or just finishing their first year

Typical Attendance: 25

Workshop Duration: two days

When Offered: Annual, early of August

Workshop Website: http://csc.rescorp.org/faculty-workshop/index.html

Program Description

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Overview

The Cottrell Scholars Collaborative (CSC) is a collection of chemistry and physics faculty who are past recipients of the Cottrell Scholars Award, a distinction given out by Research Corporation for Science Advancement (RCSA) to faculty demonstrating excellence in both the classroom and the laboratory. The mission of the CSC is to "develop, promote and implement transformative programs to improve STEM education through the integration of research and teaching." The CSC, in partnership with RCSA and the American Chemical Society, is implementing a New Faculty Workshop program to improve the penetration of research-validated pedagogies in chemistry departments around the country. By introducing new faculty to the scholarship behind scientific teaching before they enter the classroom, members of the CSC believe that we can help faculty develop great habits for effective teaching and student learning, and foster a new generation of more effective teacher-scholars. The workshop will also help the faculty develop a national cohort with whom they will become comfortable talking about teaching and pedagogy in addition to their research accomplishments.

Participants Emily Weinert (Emory University, Dept. of Chemistry) and Qiu Wang (Duke Univ., Dept. of Chemistry) working together on an active learning exercise during the 2012 CSC New Faculty Workshop.

Introduction and scope

There is an increasing body of literature that suggests that the classic lecture model of teaching is ineffective based on measurement of student learning (Hake, 1998. National Academies of Science, 2003. Knight &Wood, 2005. Handelsman, Miller, & Pfund, 2007. Derting & Ebert-May, 2010). Despite this fact, the standard lecture format is still widely practiced at the university level. Since the late 1990s, there have been several calls to improve undergraduate STEM education, but the uptake of these methods by chemistry faculty has overall been rather poor (National Academies of Science, 2003; Brewer & Smith, 2011) Though there are acknowledged faults in the chemical and science education literature, high-quality studies have shown that alternative methods to teaching (i.e. student-centered approaches as opposed to teacher-centered models) improve student learning (Singer, Nielsen, & Schweingruber, 2012). Additionally, these methods often lead to enhanced perception of science by the students. Interestingly, these advances in science education are compartmentalized by discipline, and there is less cross-communication in science education research than might be expected given the common goals. Although there have only been limited studies in this area historically, poor academic and learning experiences are believed to contribute strongly to student attrition. Therefore, improving the educational experience for students is highly likely to improve retention of students in higher education in general and more specifically, to help retain students within STEM fields.

It is important to catch new faculty early. Senior faculty members often cite a lack of time and the research-focused university reward structure as reasons why they continue to use passive lecture formats. Our view, supported by the recent work of Diane Ebert-May, is that one can provide great impact on the long-term teaching styles if the intervention occurs prior to the development of that style (Derting & Ebert-May, 2010; Ebert-May & Weber, 2006). If new faculty learn to teach using active classrooms from the very beginning of their careers, they need not “unlearn” the classical lecture style. It is our opinion that it takes no more time to teach effectively than it does to give a lecture, so long as one knows the tools and tricks of implementing active learning approaches.

Workshop participation

The first CSC New Faculty Workshop took place in Washington, D.C., in August 2012. The workshop was two days in length running from the evening of Wednesday, Aug. 8, to the afternoon of Friday, Aug. 10. Our venue could accommodate approximately 40 participants, but the current funding from RCSA was only sufficient to cover the local costs (~$450/pp) for 25 participants. Departments were asked to support the transportation costs to and from the workshop for all participants. We invited nominations from chemistry departments at ~100 research-intensive universities across the U.S. Nominations were open for faculty who began their appointments between June 1, 2011 – Aug. 31, 2012. Thus faculty were either newly appointed or would have just completed their first year on the job at the time of the workshop. Nominations were received for 45 new faculty members from 32 universities. Of those, we admitted 25 persons outright based on our funding and offered an additional 15 persons admittance on the condition that their department or university bears the entire cost of the workshop. Most of the people on the conditional admission list were able to identify funding sources from their institutions and ultimately 38 faculty attended the inaugural workshop. Approximately half the attendees were about to start their first faculty position in August 2012

while the other half had just finished their first year. Approximately 1/3 were women and three self-identified as from underrepresented minorities.

Key components of the workshop

Our primary goal is to provide new chemistry faculty training in modern, interactive teaching methods. The workshop format was designed around developing an interactive lesson on a topic relevant to a class the participant would teach in their first year. Through a series of interactive sessions, we first demonstrated active learning exercises so that the workshop participants, who may never have been students in a learner-centered environment, would experience these techniques first-hand. The participants then had a series of structured breakout sessions where they designed and revised their exercise.

In the first pass, they were challenged to identify a piece of content around which the lesson would revolve. Then, after a discussion about learning goals and assessments, they focused on whether the exercise was aligned with the stated learning goals and they revised it accordingly. At this point they began thinking about how to assess whether or not the lesson was effective. They were tasked with selecting an appropriate classroom assessment technique that could be used as a formative assessment of the unit. Finally, the participants were challenged with the topic of scale. What would happen if this exercise were done in a large classroom? Would there be issues in its implementation? How could it be modified to ensure that a class of 300 could all do it simultaneously and still obtain suitable feedback on their work in the wrap-up phase of the discussion?

On the second day of the workshop, the participants tried out their exercises on the other attendees. Working in groups of ~eight, they taught their lesson to their colleagues and received feedback on their concept and implementation. While this design exercise phase of the workshop worked quite well, this implementation exercise was particularly informative to us as workshop organizers. The kernels of the ideas were quite sound in most cases, but the actual implementation often fell short: faculty members reverted to lecture, talking about what the students should do and observe rather than actually getting the "students" to do the exercise itself and discover on their own. This element provided a terrific teachable moment where we stopped the instructors and asked them to compare what they were doing relative to the active learning examples they had done the previous day. It illustrated that in the short workshop format we could teach participants the content knowledge to understand evidenced-based teaching practices, but they received insufficient practice to get the implementation right. With some on-going mentoring, we hope that the faculty members will then practice the art of active learning in their classes and over time develop their style to make their implementation effective.

The workshop modeled the scaffolding approach to knowledge development. We demonstrated for them the process by which learning is enhanced by progressively adding layers to knowledge and then is solidified through active participation in the process. The undercurrent of these sessions allowed a discussion of setting up and articulating learning gains to the stakeholders (most importantly the students), designing exercises to build understanding, and tuning formative assessments to determine whether the content knowledge was internalized. Additional discussions

on teaching included the use of classroom assessment techniques to gauge learning in real time, effective use of clickers and the identification and confrontation of misconceptions to enhance learning. While the sessions were short, what came out of these discussions was an awareness of the issues and a guide about where to find more information if needed.

In preparation for the workshop, we developed a website that serves as a convenient interface for our participants with detailed information about the event and the activities performed by the participants. It can be found at: http://www.chem.wayne.edu/feiggroup/CSCNFW/. This website contains a collection of information on modern pedagogy. Using the ACS Network, we also developed a discussion group where workshop alumni can keep in touch with each other to share additional exercises they develop as well as share notes on the implementation of the individual lessons. The goal here is to foster community engagement and shared responsibility among the cohort to help everyone become effective educators. By sharing the development of interactive exercises, each participant in the program will gain access to many additional exercises that they can use or adapt in their own courses.

While teaching about modern pedagogy is central to the workshop experience, we provided a somewhat broader set of orientation topics to ensure buy-in from departments who were being asked to support the transportation costs to and from the workshop. Our keynote speaker (Prof. Michael Doyle, Chair of the Chemistry Department at University of Maryland, College Park) talked about the competing demands placed on faculty members' time. Overall, the talk set the tone that there is a lot to do and hard work alone won't make you successful. Instead, one must be strategic with one's choices. He shared with the new faculty an historic perspective on the calls for changes in the field of chemistry and chemistry education that had gone unanswered and the difficult task of changing departmental cultures.

We held a grantsmanship session (with program officers from NSF and RCSA) and a session on mentoring students in the laboratory. In the latter session, we discussed issues related to motivating students, working with difficult students, giving feedback and criticism effectively, annual student evaluations, etc. The goal here was to make faculty more effective at mentoring their research team to improve their overall productivity.

The workshop provided a mix of activity types and session formats, modeling individual work time, large group discussions and breakout sessions and hands-on activities. The idea is to use the workshop as a model for how classroom time can be balanced between knowledge transfer exercises and skill-development time—the same approaches we challenge them to employ to enhance student engagement in their classrooms.

Post-workshop follow-up and mentoring

Unfortunately, a one-time intervention, no matter what its duration, alone is not likely to change people's patterns of behavior. Two days is also too short to immerse chemistry faculty in modern pedagogy, but it is long enough to pass along the key concepts and prepare them with materials necessary to further explore on their own. Therefore, our approach is to couple the workshop with ongoing mentorship. Workshop alumni have been paired with members of the Cottrell Scholars Collaborative who have volunteered to serve in this capacity. These mentors are responsible for calling their mentees twice per year to discuss their career progress and concerns. The mentors are provided with

talking points to facilitate the conversations and ensure that specific topics are covered, like the success in implementing active learning in their classrooms, job satisfaction, grant writing successes and challenges and departmental environment. In addition, the coaching sessions provide a sounding board outside of the department that the new faculty members can use if they wish to get advice about navigating local issues within their own institutions. By having an external mentor, it is guaranteed that the information cannot be used against the faculty members and may allow them to have more candid discussions than they would with a member of their own department.

Workshop assessment plans

The workshop is just in its first year, so we do not have longitudinal data at this time on its efficacy and impact on the careers of the participants. Our workshop structure is consistent with the best practices professed by the book *Scientific Teaching* (Handelsman, Miller, and Pfund, 2007) and was well-aligned with the presentations from the NAS/NRC workshops in biology and the AAPT workshops for physics and astronomy faculty described elsewhere in this report. The two differences are that our workshop is shorter than those due to funding constraints and we are targeting faculty slightly earlier in their careers relative to those workshops.

We have teamed up with a chemical education specialist to assess the impact of our workshops. Prof. Marilyne Stains is on the faculty at the University of Nebraska, Lincoln. Her research interests are in the area of modern pedagogy and the barriers that keep chemistry faculty from adopting these approaches. In collaboration with Prof. Stains, the workshop organizers have developed a tracking plan that will involve both periodic surveys of the workshop participants on several aspects of their career development. We will track workshop alumni over a six-year period in comparison to a control group to see if the career and teaching trajectories of these groups differ. Initial data on the survey work and classroom observations should be available in just over one year. We are assessing the level to which faculty adopt interactive pedagogies in their courses as well as a collection of job-satisfaction and job performance metrics. As a control group, we are surveying faculty who are slightly older (three-five years into their first faculty position) who started before the workshops became available. In addition to the survey assessments, workshop participants and control faculty volunteered to have their classes videotaped and assessed using the RTOP method (MacIsaac & Falconer, 2002) to compare self-reported use of active pedagogies against actual classroom practices. Finally, we will monitor our workshop alumni through their career milestones (first grant, teaching awards, tenure, etc.) to assess whether or not the workshops provided significant improvement in job performance relative to national norms.

There was extensive discussion at the May 3, 2012 CSSP workshop regarding the need to measure student learning gains themselves. There is already significant literature, largely from the Physics Education Research community, that interactive classrooms consistently outperform non-reformed classroom pedagogies when one assesses student learning through pre- and post-testing using validated instruments like the Force Concept Inventory (Hestenes, Wells, & Swackhamer, 1992). Given the large number of students spread out over many institutions and in a variety of class types (due to the disparate teaching assignments of our workshop participants), measuring all those individuals will be a significant task. It would be much easier to assess uptake of research-validated pedagogical methods as a proxy for

student learning gains. The organizers of the workshop are still conflicted about the level of effort that should be applied toward showing the workshops' impact directly on student learning given the level of effort involved. We are testing the use of a concept-map based assessment that can be administered online across the country. The concept maps can then be scored using pathfinder analysis but whether this method will provide sufficient clarity regarding student learning outcomes to justify its use as an assessment on this scale is as of yet unknown.

While we would like to measure whether the workshops successfully impact the culture of chemistry departments to provide a more balanced view of our jobs as teacher scholars, assessing the impact is difficult and is a process that will take many years. We are still looking for validated survey instruments that would effectively assess this facet of the workshop's success or failure, but have yet to identify one that is suitable for our needs. This is a long-term impact, however and it may not be viable to assess such shifts over the timescales available to us.

Conclusion

The CSC New Faculty Workshop is a new addition to the chemical community that directly addresses modern research-based pedagogy and the failure of the chemical community to broadly implement it in our university classrooms. The effort has the full support of the American Chemical Society and the RCSA. Our current funding will allow us to support the workshop for two years by which time we will need to have developed an alternative model for how to support the program. If we can show quick success, it is possible that departments and universities will help to bear the burden by paying the costs of their new faculty to attend. Also, at this time the workshop was only open to faculty at major research universities. Faculty from primarily undergraduate institutions were not invited to participate this year because of the limited funding available. The decision was made that training university faculty would have the greatest impact on the field. Once established, however, we would like to extend the invitations to provide this type of training to all chemistry faculty, regardless of institution type. Under such a model, we would add targeted break-out sessions to deal with the specific challenges faced by faculty at two-year, four-year colleges, four-year comprehensive universities, and research universities to ensure that all faculty received the mentoring they need to get off to a great start in their chosen positions.

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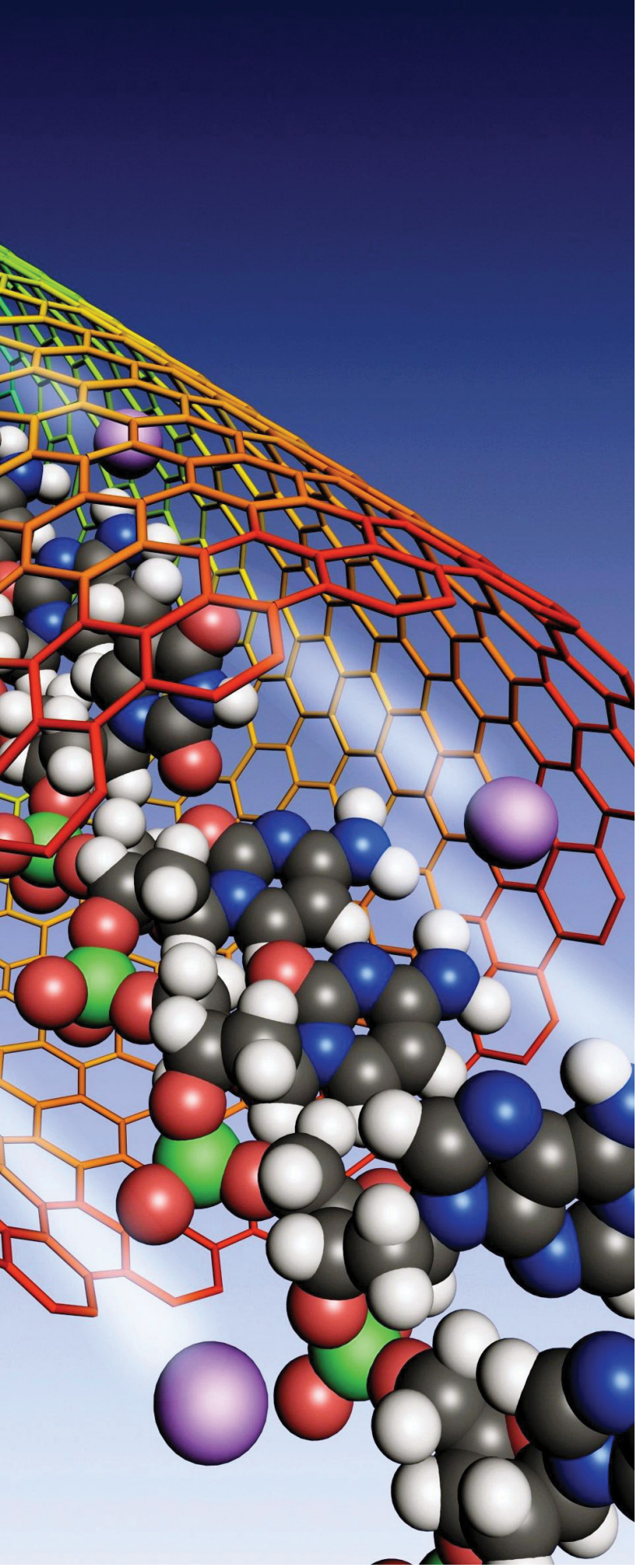

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