

2016

Professional Development for Freshmen Research Initiative Teaching Assistants

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Recommended Citation

Sandquist, Elizabeth, "Professional Development for Freshmen Research Initiative Teaching Assistants" (2016). *CIRTL Reports*. 4. http://lib.dr.iastate.edu/cirtl_reports/4

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Professional Development for Freshmen Research Initiative Teaching Assistants

Abstract

In the 2012 Report to the President by the President's Council of Advisors on Science and

Technology, it was predicted that the U.S. will require 1 million additional STEM (science, technology, engineering and mathematics) professionals in the next decade if it is to maintain its international standing as a leader in science and technology. As such, retention of undergraduates in the STEM disciplines are critical to meet this goal. Research by the council found that loss of high achieving students was due to uninspiring introductory courses, and students of groups underrepresented in STEM fields found the research environment uninviting. An imperative of the report was to improve the first two years of STEM education at academic institutions, followed by recommendations to adopt evidence based teaching practices and the replacement of traditional laboratory courses with discovery based research.

Keywords

freshmen research initiative, teaching assistants, training, learning community

Disciplines

Educational Leadership | Educational Methods | Higher Education

Introduction

In the 2012 Report to the President by the President's Council of Advisors on Science and Technology, it was predicted that the U.S. will require 1 million additional STEM (science, technology, engineering and mathematics) professionals in the next decade if it is to maintain its international standing as a leader in science and technology. As such, retention of undergraduates in the STEM disciplines are critical to meet this goal. Research by the council found that loss of high-achieving students was due to uninspiring introductory courses, and students of groups underrepresented in STEM fields found the research environment uninviting. An imperative of the report was to improve the first two years of STEM education at academic institutions, followed by recommendations to adopt evidence-based teaching practices and the replacement of traditional laboratory courses with discovery-based research.

Iowa State University was awarded a \$1.2 million grant spanning 5 years by the Howard Hughes Medical Institute (HHMI) to continue its Engage to Excel program which transforms introductory courses and laboratories in the STEM disciplines to promote student engagement, active learning, and retention in STEM majors at ISU. The Freshmen Research Initiative (FRI) is one component of Engage to Excel, of which I coordinate as the HHMI postdoctoral fellow. The strategy of the Freshmen Research Initiative is to create course-based undergraduate research experiences for first-year students in the STEM disciplines. These authentic, discovery-based courses are adapted from faculty research occurring on campus in the fields of molecular biology, geology, astronomy, and electrical engineering, to name a few. In Spring 2016, 11 research streams (lab courses) will be available to freshmen, reaching up to 200 students. My responsibilities as the HHMI postdoctoral fellow include the promotion of good practices within the program and assessment of student outcomes in regards to scientific literacy skills, career goals, and interest in science. I am also developing a learning community for teaching assistants participating in the program. While my responsibilities as HHMI postdoc include the creation of this community, assessment is not a required component.

The objective of my Teaching-As-Research project is to evaluate the benefits of the learning community for teaching assistants, and to perform formative assessment of the FRI program. The goal of the learning community is to support teaching assistants as they navigate the

challenges unique to this laboratory environment, which is a hybrid between the traditional lab with large class sizes, and the one-on-one authentic research experiences occurring in work-study or internship positions. As teaching assistants in the FRI approach challenges to the implementation of research activities on a large scale, the learning community will serve as a forum in which they can discuss common obstacles and effective teaching strategies. As the teaching assistants are the "soldiers on the front lines," it is critical that they are provided the support needed for the success of the Freshmen Research Initiative at ISU.

Methods

I served as instructor and facilitator of the FRI teaching assistant learning community, which will have met approximately once monthly on campus from October to May. The first session was an introduction to the FRI by Dr. Craig Ogilvie, director of Engage to Excel. Topics for the learning community were be a combination of subjects I have found to be important in my experiences as a teaching assistant in a large-scale research environment, and subjects chosen by students from a list I assembled. Student suggestions were welcomed, as well. The teaching assistants requested one session on Communicating Science, in which the details of poster design and presentation were presented. Other suggested topics for TA's choice included diversity in research, careers at primarily undergraduate institutions, the freshman researcher, place based research, and undergraduate peer mentors.

Topic
FRI Kick-Off <i>Guest speaker: Craig Ogilvie</i>
Preparing your Research Stream <i>Guest speaker: Jeff Essner</i>
Leader, Manager, Mentor <i>Materials: "Entering Mentoring" and "At the Helm"</i>
Communicating Science
Challenges and Success Stories

Table 1. Topics discussed in the learning community.

Engage to Excel promotes the transformation of traditional laboratories and courses to active-learning, inquiry driven formats in addition to the authentic research-based activities of the Freshmen Research Initiative. These have been in place for several years, and HHMI postdoctoral fellows in the past developed a learning community for TAs teaching inquiry-driven labs. Assessment of the learning community was performed and published in the *Journal of College Science Teaching* in 2014. I adapted the surveys described in this paper to address the topics discussed in the FRI teaching assistant learning community. Selected results from a post-test are displayed below. The survey included questions about teaching background, current practices, value of freshmen research, knowledge of the field of science education, scientific teaching practices, and perceived competence to mentor undergraduate researchers in their FRI research stream. Formative assessment included questions on concerns about their research stream or the FRI program in general, the effect of the learning community on their teaching experience, 3 suggested improvements to the learning community, and 3 strengths of the learning community.

Results

The quantitative data collected from the survey is described below. The learning community consisted of 3-10 participants depending upon the meeting, and three teaching assistants completed the voluntary survey. Due to the small sample size, the data collected preliminary and can be used mainly to optimize the instrument for future use.

Item	Description
	Scientific Practices
1	Asking new questions based on data analysis from a previous experiment
2	Creating hypotheses
3	Identifying variables and designing appropriate controls for experiments
4	Collecting data
5	Using graphs, basic statistics (mean, standard deviation, t-test, etc.) to summarize and analyze results
6	Explaining unexpected results, and considering potential sources of error
7	Explaining data from experiments without a predicted outcome, or using other evidence to make and defend conclusions
8	Using internet-based software to manage and share information
9	Performing literature searches
10	Reading primary literature
11	Reflecting on one's own work or learning
	Lab Practices
12	Participating in a journal club
13	Using a lab notebook
14	Reviewing or critiquing another students' work
15	Attending lab meetings
	Collaboration
16	Working with other undergraduates in the lab
17	Working as the only undergraduate in the lab
18	Sharing equipment with other lab members
19	Comparing data or otherwise collaborating with other groups
	Mentorship
20	Performing research as a freshman
21	Mentorship by faculty
22	Mentorship by graduate students/postdocs
23	Mentorship by undergraduate peer mentors

24	Receiving mini-lectures on topics relevant to the lab
25	Observing demonstrations of experiments and techniques
	Communication
26	Communicating findings with the rest of the lab
27	Giving PowerPoint presentations
28	Giving poster presentations

Table 2. Items included in the survey.

When asked how important the participants believed undergraduate research is at the freshmen versus upper levels, two of three teaching assistants stated that undergraduate research at the freshmen level was important, with the third stating it was very important. One of three teaching assistants stated that undergraduate research at the sophomore to senior levels was important, while the other two said it was very important. A question of this type can be useful to determine if teaching assistants share the same values as the faculty leading the class.

Teaching assistants appeared to have a good understanding of course-based undergraduate research following participation in the learning community. The following definitions were provided in response to the prompt, "In your own words, please describe 'course based undergraduate research.'"

"Research experience throughout a semester which gradually immerses the student."

"I think that course base undergraduate research can be defined by providing students with the tools, skills, and knowledge to develop and test a hypothesis based on an authentic topic."

"Learning via experiments and performing techniques to answer questions. It wouldn't be textbook based but focused on "doing" science."

When asked about their greatest concerns as teaching assistants for the FRI, time and resource management were two common worries quoted by teaching assistants. One student was worried about the depth to which freshmen understood their research projects, while another mentioned that individual student attention may decrease as class sizes

become larger. The opportunity for freshmen to choose research questions outside of the teaching assistants' skill or knowledge set was another concern. Sustainability of the FRI was also a concern.

Teaching assistants were asked how the FRI learning community influenced their experience as scientists and as teachers/educators. The responses to these two questions were very similar, suggesting that they could be combined into one question in future iterations of the survey. The ability to meet other teaching assistants and share common challenges and strategies was appreciated by a majority of teaching assistants. Improved time management and organization skills were reported, as well as a greater value placed upon mentorship of young scientists. When asked about strengths of the FRI learning community, open discussion of difficulties and ideas was a positive benefit reported by teaching assistants. Presentations and provided resources were also valued.

Teaching assistants were prompted to provide an example of one challenge in their research stream that they experienced, and how they overcame the issue. Responses are shown below.

"Students wanted to use advanced equipment, so we connected w/ faculty from departments for collaboration."

"I didn't know if students understood the project and why we were asking particular questions. So we had individual assignments where students wrote a report on what we were studying and this helped me understand who understood things better."

"One challenge faced was that the course ended up moving a lot more slowly than anticipated. This was because the students did not have the biology background we had anticipated. We overcame this by moving slowly and covering a lot of background information. We also tried to solidify core topics with discussions and reflections."

Teaching assistants were interested in learning more about successful FRIs through supplemental resources, guest speakers, and knowledge of other FRI programs. Strategies to

improve upon future iterations of the FRI were also desired. Mentorship advice for working with undergraduate peer mentors was also desired.

The described learning community, survey utilized, and its results were presented at the Council for Undergraduate Research Biennial Conference held June 25-28 in Tampa, Florida. Visitors of the poster expressed appreciation of the learning community and identified the unique training necessary for teaching assistants in course-based undergraduate research experiences, no matter the student year. One attendee is creating a course in which multiple sections of students will be performing research of the same topic, and was interested in this information for use as training materials for the large number of teaching assistants under his supervision.

Conclusions

As a whole, the learning community for teaching assistants in the Freshmen Research Initiative was a valuable experience for participants. The ability to meet other teaching assistants and share common challenges and successes was one of the greatest strengths of the learning community, which enhanced participants' self-confidence in their teaching abilities. In the future, supplemental information provided at the sessions will be increased to further support interested teaching assistants. A session on the implementation of successful strategies in future iterations of the course will likely be added, as well.

The survey created and demonstrated in this report will continue to be used, with slight modifications. Earlier IRB approval will allow for pre- and post-testing of teaching assistants, providing opportunities for focused instruction on participant needs. With the increasing size of the FRI program, larger sample sizes will be obtained, allowing for conclusions made about the effect of teaching assistants' past experiences, value of particular design features, and self-confidence in the implementation of these features on the experience of students in the program.