A Community of Enhanced Assessment Facilitates Reformed Teaching

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Abstract

Need: Changing teaching strategies remains a challenge for faculty; faculty need long-term support with the opportunity for feedback and reflection. Our project supports college biology faculty who are changing their teaching by participating in the Automated Analysis of Constructed Response (AACR) project. AACR offers constructed response questions about biological concepts that can be analyzed by computers to generate reports about student thinking. Thirty-one biology faculty at six research institutions participate in Faculty Learning Communities (FLCs) engaged in teaching reform. The project also benefits the STEM higher education community because it generates new knowledge about the impact of teaching professional development.

Goals: Project goals include: (1) identifying ways to support faculty to use AACR questions and reports, (2) identifying essential components of FLCs designed to facilitate AACR use, (3) describing the progression of teaching practices and conceptions while faculty are engaged with AACR. The following activities are meant to accomplish these goals: faculty (1) meet in local FLCs three times per semester, (2) participate in cross-institutional curriculum development teams, (3) ask AACR questions and receive reports, and (4) the research team collects data from participants, including classroom observations, surveys, and interviews.

Approach: Our FLCs align with evidence for promoting teaching reform in university STEM. Our research is grounded in the innovation-decision model, which describes the adoption of innovations, like new teaching practices. Our overarching research question is: does participation in an FLC provide the impetus for faculty to change their teaching and sustain those changes? We use a mixed methods approach to investigate this question.

Outcomes: First, all 19 faculty who started the project have remained for two years and we added 12 new faculty this year. We hypothesize persistence is high because the FLC offers a low-cost, high-utility environment for participants. Second, we have identified FLCs as a successful strategy for promoting adoption of AACR use and for priming faculty to use AACR reports to answer questions about student learning or to modify their teaching. Facilitation of FLCs by experienced education researchers is essential. Third, we have learned that participants currently can be categorized into four quadrants in terms of their teaching practices and conceptions: (1) student-centered conceptions/practices, (2) student-centered conceptions/teacher-centered practices, (3) teacher-centered conceptions/student-centered practices, and (4) teacher-centered conceptions/practices. We hypothesize that in order to continue to improve as teachers, participants in each quadrant need unique types of support, which potentially can be

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offered in the FLC context. Key deliverables include: (1) two manuscripts in preparation about the persistence of faculty in FLCs and the teaching practices and conceptions of participants, (2) an in-class activity, developed by participants, to address misconceptions about stop codons in molecular biology.

Broader Impacts: This project improves teaching because it supports diverse types of faculty at a variety of career stages, including lecturers, tenure-track, and tenured. Specifically, these faculty are learning about an assessment strategy that can provide greater insights to student thinking than traditional assessment strategies. They also are exchanging materials and ideas with each other that can immediately be applied to the classroom. This project also improves teaching because local FLC members are discussing and coordinating teaching and assessment across courses in their departments. In most cases, this level of discussion and coordination has not previously occurred. This project enhances the infrastructure for research and education because it has led to the establishment of a multi-institution collaborative group of researchers at many stages of development, e.g., undergrads, grad students, postdocs, and faculty, and from diverse demographics. All members of the team are actively engaged in achieving project goals.

This paper presents findings related to outcomes one and two listed above. This paper will not address student learning outcomes. Findings about student learning are being prepared for presentation elsewhere.

Introduction

The Automated Analysis of Constructed Response (AACR) project is a collaboration among seven institutions. Lexical and machine learning technologies are employed to develop conceptual constructed response assessments and build computer models that predict how experts would score student responses. An overview of this project has been provided by Urban-Lurain and collegues in the paper entitled “Expanding a National Network for Automated Analysis of Constructed Response Assessments to Reveal Student Thinking in STEM.” To widen the adoption and sustained use of AACR reports and questions, Faculty Learning Communities (FLCs) were formed at six of the seven project institutions. We chose the FLC model[1] because it aligns with recommendations from research on facilitating change in undergraduate STEM instructional practices[2]. Specifically, FLCs allow for long-term professional development[3] that includes opportunities for performance evaluation and feedback[4] and deliberate focus on changing faculty conceptions of teaching and learning[3].

Faculty in AACR FLCs use one or more AACR questions in their classes each semester and attend AACR FLC meetings three times per semester. In the first semester (Spring 14), most of the FLC time was spent introducing faculty to AACR and discussing AACR reports, including what they show and how an instructor could use this information to inform her teaching. Subsequently, FLC meetings focused on discussing actual AACR reports from the classrooms of FLC members and general discussions about teaching

and learning. Nineteen faculty members joined the AACR FLCs in spring 2014; all nineteen faculty remain in the project to date. In fall 2015, participation increased to a total number of 30 faculty.

In the research reported here, we attempted to identify the primary motivators for faculty persistence in the AACR FLCs. This work will show how FLCs and similar professional development opportunities can be designed to maximize faculty engagement, which in turn may promote the adoption of evidence-based teaching practices.

We used the Expectancy-Value Theory (EVT) of motivation[5] to anaylze the experiences of faculty for the first three semesters of the project. According to EVT, expectancy (the ability to participate in a task) and value (the perceived benefit from participating in a task), both play a role in whether an individual will choose to engage in a certain task.

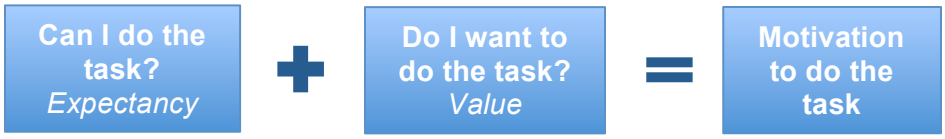

Figure 1. The Expectancy-Value Theory of Motivation. A graphical representation of EVT, as outlined by Eccles.

Expectancy consists of the belief an individual has about whether he or she can succeed and the relative ease of the task at hand. Value has four components. Intrinsic value addresses an individual's personal interest in the task. Utility value is the direct benefit an individual receives for participating, such as the task's degree of usefulness toward an individual's plans for the future[6]. Attainment value has to do with one's view of how personally important it is to do well at the task. Cost is the final factor, which describes the amount of sacrifice involved in exchange for the value.

Methods

Faculty were recruited by the project PIs at each of the six institutions. PIs also served as FLC facilitators. The number of participants at each institution varied from two to five. Participants met three times per semester at their local institution. Each faculty participant agreed to participate in FLC meetings and be interviewed at least once per year. Each faculty member was compensated $1500 annually. This research was conducted under exempt status at the University of Georgia (IRB STUDY00000257).

Author JM conducted two rounds of semi-structured interviews to elucidate the motivation for faculty participation in the AACR FLCs. Interviews included questions about the benefits of FLC participation, knowledge about AACR questions and reports, and teaching beliefs and practices. Each interview was recorded and transcribed.

Data analysis took place in three phases. In Phase 1, we attempted to gain an overview of the benefits and motivations of FLC participation as perceived by faculty. This analysis began during the interview itself, where JM took detailed notes and then

recorded major themes following each interview. After transcription, members of the research team listened to each interview and met to discuss their impressions. In Phase 2, we conducted *in vivo coding*[7]. JM went back through each transcript and formed codes that captured the nature of each benefit and motivator identified in Phase 1. The research team met regularly throughout this process to discuss the findings and modify the code list as needed. In Phase 3, we used the EVT model and other literature to generate themes from the data. We began by labeling each code as either expectancy or value. Again, members of the research team met to discuss the findings. We report the major themes below. Themes are illustrated with quotes from the transcripts, and we use pseudonyms in place of participants' real names.

Results

Our analyses revealed four important themes that can explain the persistence of faculty participants in the AACR FLCs.

I want to continue in the FLC. The overarching theme to explain our data is that faculty intend to remain in the AACR FLCs. After one semester in the project, some faculty were uncertain about the value of the FLC, but they showed high expectancy, primarily because of the ease of requirements. Liz explained it like this:

I thought [AACR] sounded interesting, and it didn't seem as though it was going to be labor intensive. So I agreed to do it.

After three semesters in the project, expectancy remained high, but the value of the AACR FLCs emerged more fully. For many, the value was intrinsic, personal enjoyment from attending the FLC meetings. This was the case for Ben, who explained how his FLC had been going in Spring 2015,

It's good. I look forward to those meetings. They are really interesting.

The personal enjoyment of the AACR FLCs can be explained primarily by the focus on teaching. All participants teach undergraduate biology courses, most of which are large-enrollment introductory courses. Some participants, like Ryan, consider teaching to be important, even though they are evaluated primarily for their research. Ryan explained about the benefits of the FLC to his teaching,

I think it is the diversity of ideas and approaches and opinions. It is very easy in university settings to teach … the way you think you should without having any verification of that … Getting 5 or 6 people in a room and having them talk about something, it's extremely valuable to me to hear the diversity of opinions.

Other participants consider teaching to be personally important and also are evaluated primarily for their teaching. As Samantha explained,

I put a lot of time and effort into teaching and sometimes when I don't see gains in student learning … It becomes frustrating and that can lower my morale… I feel a little bit reenergized after I leave the FLC meetings that okay, yeah, I'm not the only one that's feeling like this and we've just got to keep plugging away ...

The FLC helps me use AACR. Another theme revealed by our analyses is that the FLC is critical to the use of AACR. Apparently participants were not ready to use AACR without support from project personnel. In part, this was due to skepticism about the ability of the technology to accurately categorize student responses. As Liz expressed,

I was very skeptical about the idea that an open-ended answer could be analyzed with the type of precision that [the FLC facilitator] described.

In contrast, some faculty, who were accepting of the technology, needed focused time and discussion to discover how to interpret AACR reports and use the data in their courses. Allison said it like this,

… those meetings prompted me to really ask myself …How am I going to use this? Because at first I just said, "Sure, I'll do this." And I didn't give it much more thought. I just set up an assignment and did it. So to have these meetings has been good to first see what reports can come out … what information I can get out of it and also sort of bounce ideas about the best ways to make use of that information to improve the class.

In the FLC, I interact with my colleagues about teaching. Although the AACR FLCs were created to support the use of AACR in the classroom, our data show that using AACR was not the primary motivator for persistence in the project. Rather, the AACR FLCs provided time and space for general discussions about teaching. As Daniel's quote illustrates, participants liked it when the FLC meetings included discussions that went beyond the use of AACR:

The last meeting … I think we may have gotten way off topic. But we were talking about the goals of intro courses and how AACR could be used. Well, we started out talking about how AACR could be used and stuff like that … But we wound up in this long range of discussion of what exactly is the goal of intro courses … There was an interesting discussion … So that was really useful.

The AACR FLCs have brought together groups of faculty who teach the same or similar courses at an institution. In most cases, these faculty were not previously discussing their courses or their teaching at all, so faculty expressed the desire to persist simply because the FLC was providing a much-needed, previously absent place to air their questions about teaching and to hear back diverse ideas. Like Kyle said,

Well, I think very often it's quite beneficial just to get people with common interests and goals together in a room talking about something. So from that stand point, I almost

always enjoy getting together … talking about the [biology] courses and teaching [biology].

My FLC provides classroom and curricular support. In addition to general discussions about teaching with colleagues who share similar teaching responsibilities, participants reported that the AACR FLCs are valuable because they provide new insights about teaching and actual curricular materials. This outcome makes participants' teaching preparation more efficient and can speed up their efforts toward changing their teaching. This benefit ranges from new insights about student thinking gained from the AACR reports to activities to use in the classroom. For example, Claire gained new ideas about how to present material in her class, which raised additional questions about implementation:

I've been getting some good ideas about how to present various things. I think next time I'm going to try to get a little more information about how people actually do some interactive things in their class.

Sara actually implemented an activity that her FLC facilitator shared at an FLC meeting:

[Our facilitator] had a really good idea for a different sort of modeling exercise that would be an alternative to what the broader FLC was doing in terms of DNA replication, transcription and translation, and I ended up adopting his idea too for a followup exercise. So I don't think I would have necessarily come up with the same idea had he not shared his insight. So I think in that regard, it's doing exactly what FLC should do, in that I got ideas from my colleagues and directly implemented them into my class.

Conclusion

In summary, the AACR FLCs provide an easy and valuable method for faculty to learn to use AACR and to focus on their teaching and innovations in their teaching. The FLCs are valuable enough that even though they've been going for two years, no one has dropped out and new members have been added. In this way, the AACR project serves as a nucleus for ongoing teacher professional development. One important question that remains is the extent to which faculty participants change to become more student centered in their teaching practices and beliefs about teaching and learning.

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Paula P. Lemons, University of Georgia PI and Co-PI. http://sites.bmb.uga.edu/lemonslab/ Dr. Lemons is an Associate Professor in the Department of Biochemistry and Molecular Biology at the University of Georgia. Her research interests are in faculty development, with a focus on the process by which faculty change their teaching beliefs and practices while engaged in activities like faculty learning communities. She also studies problem solving among biology undergraduates, focusing on students' application of threshold concepts in biochemistry to problems involving visual representations.

Jill McCourt, University of Georgia. Dr. McCourt is a Postdoctoral Associate in the Department of Biochemistry and Molecular Biology. She is an active participant in the AACR project. Her primary research interests focus on how faculty change both their beliefs about teaching and learning and their teaching practices in response to participation in teaching-related professional development.

Jennifer Knight, University of Colorado Boulder PI. Dr. Knight is an Associate Professor in the Department of Molecular Cellular and Developmental Biology (MCDB). She has a Ph.D. in Neuroscience, and previously worked as a developmental biologist and geneticist. Her research now focuses on developing and using active learning materials and concept assessments, and studying the factors that influence students' in-class discussion. Dr. Knight coordinated the MCDB Science Education Initiative for 7 years, and is actively involved in CU's Center for STEM Learning, as well as other national organizations devoted to science education research.

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Dr. Merrill is Associate Professor of Microbiology and Molecular Genetics (College of Osteopathic Medicine) and Director of the Biological Sciences Program (College of Natural Science). Primary research interests include assessment of student learning in foundational undergraduate biology courses. Previous work on concept inventory type assessment instruments led to an interest in finding better ways to explore student thinking about important biological concepts.

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Dr. Nehm is Associate Professor of Ecology & Evolution and Associate Director of the Ph.D. Program in Science Education. He studies student thinking about biological concepts such as natural selection and evolution. Additional work has examined novice and expert reasoning strategies, psychometric evaluation of education instruments, science teacher belief revision and professional development, conceptual structuring of scientific understanding, and the comparative efficacy of educational innovations. Currently, several projects are focusing on developing and evaluating machine-learning models for automated assessment of complex scientific practices, such as biological explanations.

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Mary Anne Sydlik, Western Michigan University. Dr. Sydlik is the Director of the Science and Math Program Improvement (SAMPI) Center, an outreach division of the Mallinson Institute for Science Education. SAMPI specializes in evaluation, research, and technical assistance for higher education institutions and K-12 schools. She is the external evaluator for AACR III. Dr. Sydlik has been the lead external evaluator for a number of STEM and NSF-funded projects. Her interests are in adding to efforts to improve the educational experiences and outcomes of undergraduate STEM students.

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