In the summer of 2015, four underclassmen began a research project in organic chemistry at Berea College, with little coursework in chemistry as preparation. In this session, we will present a public conversation with these student scientists in which they will contrast their experiences learning through research with their coursework. Presenters and attendees will examine whether their research is effective as a learning experience and begin developing a module incorporating research-based learning into coursework.

Outcomes:

Evaluate one of their primary courses to determine what subjects would naturally arise as part of a student researcher's work.

Develop an exercise for a non-research-based course simulating this experience.

Evaluate their undergraduate research practice for effective development of subject knowledge and research ability.

Develop the first day of an introductory "crash course" lecture for beginners in their field beginning a research project in it.

Observe differences in the topics covered in the "crash course" versus the traditional course content.
Category: Application

Describe the theory, approach, and revision that you applied in your course, curriculum, or program. Describe what you saw in your students', colleagues', or institution's behavior that you wanted to change. Describe the learning objectives you wanted students or colleagues to better achieve as a result of your application.

A great deal of research and anecdotal evidence showing that participation in undergraduate scientific research makes people feel more engaged with science and causes them to believe that their research skills have improved (Lopatto, 2004). However, a careful examination of data from participants in undergraduate research does not always find a corresponding improvement in actual subject knowledge or "soft" research abilities, e.g., literature searching (Linn, 2015). While the boost in student engagement and confidence from undergraduate research, particularly in underrepresented groups (Russell, 2007), may be worth the "price of admission," it seems clear that undergraduate research supervisors must prioritize efforts to make sure that their undergraduate colleagues actually learn during their experience; indeed, participants report higher satisfaction with their research experiences where supervisors spend more time directly involved in mentoring them (Shellito, 2001).

The learning goals for session participants are twofold, focused on evaluating our own practices, moving toward incorporating research-based learning in our coursework and intentional instruction in our research.

Goal 1: Begin design of an exercise for incorporation in a traditional class taken directly from a research topic in our disciplines. Through this process, we will make the connection for ourselves between our teaching content and appropriate subject matter in our areas of research expertise, preparing us to in turn help our students make that connection.

Goal 2: Begin construction of a bare-bones formal instruction session designed to prepare undergraduate research students for their work. Through this process, we will pare our own curricular knowledge down to essentials, helping us construct a reasonable core of knowledge which we can easily convey to students and which they can subsequently expand in the full "curricular" course.

Describe the project's related course(s) or curriculum, its students, and its place in the curriculum or program.

All work is carried out in the context of the Berea College Undergraduate Research and Creative Projects Proposal system, an interdisciplinary system for funding and disseminating summer research at the presenters' institution. Students are paid for their work over the summer as part of Berea's renowned labor program, and many students use their
participation to fulfil an institutional capstone requirement and/or active learning requirement for their degree.

How is your application different from ones that others have tried?
While enthusiasm for undergraduate research is high, and many outstanding experiences exist, the granularity of studies in the field is low, and there are few standards for what constitutes "undergraduate research." This leads to contradictory results of the sort highlighted by Linn et al. (2015). We aim to highlight exemplary practices and, in so doing, provide a blueprint for creating powerful experiences that contribute to scientific knowledge.

Assessment and baseline: Indicate how you determined the success and effectiveness of your application.
We are in the middle of a series of post-research interviews with program participants, which we will cross-reference with their grades and performance on standardized chemistry examinations in relevant fields.

References:


Organization:
The session will begin with a three-slide image-only (no text) presentation giving an overview for the organization, workspace, and context in which the project was carried out. We will then begin the student conversations, in which the student presenters will respond to questions on their experience as novice scientists learning the content of organic chemistry (primarily) for the first time through their research. If funding for travel allows, the student presenters will do this portion of the session in person. If this is not possible, it will be done via a video interview. Each question will be given about five minutes, with session participants being asked to discuss the response with a partner for approximately two
minutes between each one. To conclude the session, we will provide discussion prompts related to content learning through research, distribute notes and images from the lead presenter's "crash course" first-day lecture, and invite participants (working with a partner) to create notes and materials for a similar presentation. The last five to ten minutes of the session will be devoted to this task.

**Keywords:**

Crash Course  
Discovery Learning  
First-Year Students  
Science Pedagogy  
STEM  
Undergraduate Research