Teaching as Research Project July 24, 2016
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Research Question:
What question do you have about teaching and learning that is relevant to an educational setting in your discipline? The question you develop may be based on your observations as a teacher and/or as a student. Challenge yourself to write a specific question that is narrow and focused, try to write one that isn't a "yes/no" question.

> Does exchanging common prepared experiments for student-led, literature-based inquiry-based lab experiments enhance students' conceptual knowledge and understanding of the subject matter?

Project Objectives:
Your stated objectives should provide a clear set of expected outcomes for your project. What skill or ability do you want students to acquire? What behavior do you want to change as a result of your intervention(s)? What knowledge do you want to test? Your objectives should be measurable.

1. Determine if student-led groups working together to understand the science in a peer reviewed journal article can better understand scientific concepts at hand than a control group of students in a traditional lab.
2. Determine whether student-led groups can design an experiment based on the scientific concepts in the literature and assistance from the instructor.
3. Determine whether student groups who explore the scientific literature and plan an experiment understand the scientific concepts at hand than a control group of students in a traditional lab format.

Literature Background:
What literature are you using and/or do you need to investigate that helps inform the development of your project? This literature helps frame your teaching-as-research project questions, formulation of your objectives, and implementation methods.


1. Deters, K. M. K. "Student Opinions Regarding Inquiry-Based Labs." J. Chem. Educ. 2005, 82, 1178–1180.
2. Cummins, R. H.; Green, W. J.; Elliott, C. "'Prompted' Inquiry-Based Learning in the Introductory Chemistry Laboratory." J. Chem. Educ. 2004, 81, 239.
3. Lord, T.; Orkwiszewski, T. "Moving From Didactic to Inquiry-Based Instruction In A Science Laboratory." Am. Biol. Teach. 2006, 68, 342–345.
4. Garnett, P. J.; Garnett, P. J.; Mark W Hacking. "Refocusing the Chemistry Lab : A Case for Laboratory-Based Investigations." Aust. Sci. Teach. J. 1995, 41, 26–32.
5. Cheung, D. "Facilitating Chemistry Teachers to Implement Inquiry-based Laboratory Work." Int. J. Sci. Math. Educ. 2008, 6, 107–130.

6. Ferrer-Vinent, I. J.; Bruehl, M.; Pan, D.; Jones, G. L. “Introducing scientific literature to honors general chemistry students: Teaching information literacy and the nature of research to first year chemistry students.” J. Chem. Educ. 2015, 92, 617–624.
7. Brame, Cynthia. "Incorporating Research into Science Courses" Literature Center for Teaching Guide. <https://cft.vanderbilt.edu/guides-subpages/incorporating-research-into-credit-bearing-sciencecourses/>. Accessed on July, 20, 2016.

There is a significant amount of literature discussing the benefits of inquiry-based labs to student learning, ranging several decades. It has been shown that teaching students early in their careers to utilize the literature leads to an increase in correct answers on assessments and overall grades. Further, with the proper guidance, students as early as high school or the first year of undergraduate successfully design their own experiments. Despite this wealth of research, several major institutions have not explored this format of teaching laboratories for one reason or another (cost, extra effort of curriculum development, student reticence, etc.).

Evidence/Assessment Technique(s):
What instruments or methods are you going to use to collect information, to assess teaching and learning? Is it simple enough that you know how to analyze the results? Will the information you collect provide answers to the teaching and learning question? Is your assessment technique(s) (i.e. formative, summative) aligned with your teaching and learning objectives?

1. Peer Assessment: Since this TAR project requires students to work together in assigned groups, students will complete a peer assessment of group dynamics after each experiment. This will be a confidential 3-question open-answer assessment submitted directly to the instructor. The questions focus on the student's role in the group and how well they performed the role, the roles of other students in the group and how well they performed their roles, and finally, how the individual could enhance the group dynamics in future group work. Collaboration is an important part of science, so calling the students' attention to this and pushing them to take responsibility to resolve conflicts is an important part of their development as scientists.
2. Laboratory Reports: One lab report will be submitted by each group. It will be in the format of a scientific journal article. Students will have one week after the completion of the experiment to submit their lab report to the instructor.
3. Pre-Lab Quizzes: The quizzes will be one of two major assessments that provide data for this TAR project. Both the control group and the inquiry-based group will receive the same pre-lab quiz the day of the experiment. The quiz will be multiple choice and have 8-10 questions regarding the background concept and experimental processes that will be performed.
4. Exams: The exams will be one of two major assessments that provide data for this TAR project. Both the control group and the inquiry-based group will receive the same three exams over the course of the semester. The exams will be a combination of multiple choice and free response questions.

Project Approach/Practice:
What activity are you going to use in the class to try to test your question? When are you going to do it? Who will conduct it? Will it be graded? Will it be anonymous or will students sign their names? How long will it take? How will students know what to do with it? Who will explain it? How will the relationship between this assignment and activity and the course be explained?

1. The TAR project I'm proposing will span an entire semester, although it can be modified such that the first half of the semester utilizes a traditional lab approach and be switched halfway through the semester to an inquiry-based approach.
2. This project will use backward-faded scaffolding to assist students in developing their own experiments based on the literature provided by the instructor. The first several classes will instruct students on how to read and understand the literature and allow students to develop their experiment during class time with help from the instructor.
3. There are also elements of a flipped classroom, as students need to meet with their groups to prepare their experiment proposal and work on their lab report, in order to focus on the experiment during classroom time. Students will work in instructor-assigned groups to help each other understand the literature and discuss the development of the experiment they plan. Since collaboration is an important aspect of the scientific community, this also gives the students experience that will benefit them in the future.

Predicted Conclusion:
Assume you have completed your TAR project. Predict what you may learn. What might you do differently? What implications does this have for your future classroom practice? Finally, comment on the process of developing the TAR project plan itself.

I predict that I will learn that the deeper involvement required to develop and experiment will enhance student learning of scientific concepts in the laboratory and connect them to the information they learn in their lecture courses.

I would probably try to start on a smaller scale in the future. The development of the curriculum for an entire semester may take a lot of effort, especially if modifications need to be made before full implementation. Beginning with one or two of these literature focused inquiry-based laboratories per semester would require less time to develop, and less time invested would be wasted if modifications need to be made.

I enjoyed and was challenged by the development of the TAR project plan. I really appreciated the team structure and got good feedback from several people on my team. I think that the course content was relevant to this final capstone project, which I feel is equally relevant to my career as a STEM educator.