Physics by Inquiry: Preparing Teachers for Inquiry-Based Teaching and Learning

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Juan Nanez Rodriguez, Noyce Scholar
• 67% of teachers teaching physics in grades 8 – 12 and
• 61% of teachers teaching chemistry in grades 8 – 12 nationwide are uncertified and unqualified (NAS, 2007).
Number of Texas High School Teachers Assigned Out-of-Field (Fuller, 2009)
A Texas-Sized Problem in Houston

• Approximately 75% of physics teachers did not major/minor in physics
  (Brady, 2011; Jacobs, 2011)
• Collaboration
  ◦ Physics – Physics Faculty, Dr. Donna Stokes, Associate Professor, Undergraduate Academic Advisor
  ◦ Started working together during the Fall 2009 Semester
  ◦ First Physics Major – Spring 2010
• Goals:
  ◦ Increase number of physics majors and minors
    • Past decade – zero secondary teachers with physics major or minor
  ◦ Increase physics content level of those who will be composite certified and teach physics
    • Many of our biology majors teach physics with composite certification
  ◦ Better understanding of inquiry-based learning
• Collaboration
  ◦ Degree Plans (Physics and *teachHOUSTON*)
  ◦ New Degree Plan (Math/Physics)
  ◦ New Certifications (Math/Physics, Composite Science)
  ◦ Physics Minor:
    • Worked on a version most appropriate for teaching
    • Included Physics Inquiry Course
  ◦ Grant Writing: NSF Noyce Grant
  ◦ New Course: Physics by Inquiry (PHYS 4342)
Background of Study

- Continuation of study with in-service teachers
- Part of an NSF Noyce Grant
- teachHOUSTON Program
- Digital Stories
- [https://www.wevideo.com/hub/#media/ci/165148072](https://www.wevideo.com/hub/#media/ci/165148072)
• Inquiry – around for many decades
• Teaching science as inquiry - recommended
  ◦ American Association for the Advancement of Science, 1993
  ◦ National Academy of Sciences, 2007
  ◦ National Research Council [NRC], 2000, 2005
• Inquiry approaches in science teaching
  ◦ preservice science teacher preparation
  ◦ in-service science teacher training
• Majority of teachers fail to employ inquiry teaching methods
“Teachers tend to teach as they were taught. If they were taught through lecture, they are likely to lecture, even if such instruction is inappropriate for their students” (McDermott, Shaffer, & Constantinou, 2000, p. 412).

Background
“If teachers are willing to “re-culture” these kinds of classrooms, their first obstacle is the influence of their own personal histories as learners” (Windschitl, 2002).

Background
• Physics 4342
  ◦ Content taught as inquiry
  ◦ Based on:
    • McDermott’s Physics by Inquiry
    • PhET simulations (University of Colorado)
    • My own resources collected over the years
    • One engineering design challenge

Description of Course
Portable Iphone Charger
Why we built it?

- No where to plug in situations
  - Traveling on a bus
  - Back of a car
  - Good for camping
How does it work?

- Simple circuit
- Battery
- Resistances, capacitor, inductors to adapt the power from the battery to the phone.
Good teachers steal good ideas

- Regulation of power
Other Components

- Battery
- Switch
- Cables
Get it together!
Does it work?
Physics 4342

Snapshot (disclaimer):

https://drive.google.com/file/d/0B58LhruXdJk_dTV6LUhnN1k/edit
Voice from the Field

Juan Carlos Nanez Rodriguez
Who takes the course?

- teachHOUSTON Students:
  - Noyce Scholars
  - Physics majors
  - Physics minors
  - Composite science majors
  - Anyone who needs an upper level science credit
  - Math majors interested in the physics minor
Benefits

- Physics content for all majors
- Pedagogy
- Students realize they like physics
- Math majors – physics minor
• Composite Science Degree Plans – take Physics Inquiry Course
  ◦ Life Science Option
  ◦ Chemistry Option

• Teachers with composite certifications typically have a weaker content background in physics compare to other content areas (Jacobs, 2011; Brady, 2011; Resendez, 2011).
“This is the only course in which I experienced real inquiry-based instruction, rather than occasional model lessons in other courses” (participant).
“This was the first time during my teacher training that I was put in the seat of one of my pupils, experiencing the struggles that they may face during inquiry-based education. This granted me an excellent view into the mindset of a student of science, working hard and often failing to tease apart the complexities of a concept I don’t fully understand. This has helped me to empathize with my students and to encourage them during the process of learning in a meaningful and personal way” (participant).
Are student teachers more apt to employ inquiry-based learning subsequent to learning science as inquiry?

- Those that took the course created more inquiry-based lessons (ranked on inquiry continuum and lesson plan rubric)
- Enacting inquiry-based lessons was dependent on Milieus
“Inquiry-based teaching is, on my campus, considered at best a novelty and at worst a myth, and so I have struggled to weave my own methods through the fabric of the pre-existent status-quo. In other words, my greatest barrier to the implementation of the teaching style in which I believe and in which I am trained is simply inertia. That’s plainly not the way science is taught here, and therefore it will not be taught that way. This is not to say that my students don’t experience hands-on learning in my classroom, but simply that they don’t experience inquiry learning. There is a stark difference” (participant).
“It proved that the inquiry-based classroom, if established as such from the beginning (as my student teaching placement was not), is possible. The breadth of the content may be less, but the understanding will be robust to a degree previously unknown. I have said, time and again, if I can be taught physics in this way, anyone can. ” (participant).
Next Steps

• Longitudinal Study
  ◦ Ongoing...
• Develop other modules (in progress)
• Develop courses for other subjects
• Develop/teach physics inquiry course for elementary and middle schools students – Fall 2014
Physics Graduates thus far....

• Fall 2013: Graduated 1\textsuperscript{st} physics minor
• Spring 2014: Graduated 2 physics majors
  ◦ Approximately 4 majors and 10 minors in program
• Chemistry: top 2\% in nation for certifying chemistry teachers
  ◦ Approximately 15 majors in program
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Success!
Thank you!

Questions?