Using Education Research to Construct Learner-Centered Classes

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Using Education Research to Teach

- What is Hands-on-Science?
- Using Edu Research in Hands-on-Science
- Hands-on-Science Astronomy
- Effectiveness of Hands-on-Science

Hands-on, Integrated Natural Sciences for Pre-service Elementary Teachers
Hands-on-Science Programs

1) Four-semester, integrated science courses for pre-service K-5 teachers

2) 100 hr/yr in-service professional development

Curriculum is:
- Focused
- Integrated
- In Context

Modeling best practices
How People Learn

• Active engagement promotes learning and retention (Hake 1998; Prather et al. 2004)
• Watching entertaining lectures is not enough (Duncan 1999)

• Students learn by explaining (McDermott 1991)
• Importance of social interactions (Mazur 1996; Green 2003)
Hands-on-Science Environment

• People teach how they were taught! (Lortie 1975; Britzman 1991, 2003)
• Hands-on-Science pedagogy based on other work in physics (Goldberg, F., Otero, V., and Robinson, S. 2007, *Physics and Everyday Thinking*)
• Whole class discussion (50 students) using white-boarding (Wells, M., Hestenes, D. & Swackhamer, 1995)
Hands-on-Science Curriculum

• Standards-based content coverage (K-5)
  – Focusing on deeper understanding of relevant concepts (McLoughlin & Dana 1999)

• Integrated, four-semester sequence
  ▪ Physics
  ▪ Chemistry & Geology
  ▪ Biology
  ▪ Astronomy & Earth Science

• Common terminology & big ideas
  • Stripped of jargon
  • Learning in many contexts improves understanding (Bjork & Richardson-Klaven 1989; Confrey 1990)

• Misconceptions-oriented
  – College students often have similar misconceptions as children (Schnepps 1989)
Hands-on-Science Astronomy

Covers many commonly taught Astro101 topics (Slater 2001) including:

• Light & Optics
• Gravity
• Size & Scale in the Universe
• Apparent Motion of the Sky
• Seasons
• Moon Phases
• Weather
Effectiveness of Hands-on-Science

- Changes in Student Attitudes
- Changes in Content Knowledge
- Changes in Astronomy Knowledge
Changes in Student Attitudes
Attitude Assessment

- Online, 25-item, 1-5 Likert-scale survey
- Attitude assessment adapted and expanded from first HW in PET
- Pre/Post survey at beginning and end of semester
- Treatment group: HoS students
  - N=217, SP11-SP12
- Control group: students in 5 large intro science courses (2 bio, 3 chem)
  - N=270, SP12
- Interested in attitude shifts in four categories:
  - Affect
  - Anxiety
  - Confidence
  - Utility
Attitudinal Results

HoS students enjoy science more, show less anxiety, higher confidence, and increased utility of science!
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Changes in Content Knowledge
Science Content Assessments

• Assessments from the MOSART (Misconceptions-Oriented Standards-based Assessment Resources for Teachers) Project

• Multiple choice questions based on misconceptions and national standards

• Questions with varying levels of difficulty allow for finer resolution of student achievement

• Elementary and middle school topics geared to assess teachers and their students
### Science Content Assessments

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<th>Content Area</th>
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<th>(Date_{HoS})</th>
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HoS students are better prepared with the science content they need than they would have been in large intro science courses!
Changes in Astronomy Knowledge
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Improvements in Student Learning

• Could be many different factors
  – Time on task
  – Hands-on data collection
  – Peer learning

• For topics assessed here, pre-service teachers are better prepared in Hands-on-Science
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Hands-on, Integrated Natural Sciences for Pre-service Elementary Teachers
Modeling a Learner-Centered Classroom

• From “Sage on the Stage” to “Guide by your Side” (Fraknoi 2011)

• Initial Ideas
• Collecting Evidence
• Summarizing Questions

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