Using AER to Improve Teacher Education

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Hands-on, Integrated Natural Sciences
for Pre-service Elementary Teachers
Using AER to Teach Teachers

Opportunities to Teach Teachers
Hands-on-Science & Using Edu Research
Using AER in Hands-on-Science
Suggestions for AER to benefit teachers

Hands-on, Integrated Natural Sciences for Pre-service Elementary Teachers
Opportunities to Impact Teachers

• Many of us teach teachers!
  – Astro101 courses are commonly taken to satisfy general education requirements for non-science majors
  – Enrollments of 250,000 students/yr (Fraknoi 2001)
  – 9-25% education majors (Deming & Hufnagel 2001; Rudolph et al. 2010)

• Universities, observatories, NASA centers, etc. provide professional development (PD) to in-service teachers

• Great laboratories to use education research (SER & AER!)
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)
• 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 workshop at Cosmos in the Classroom!
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
  • Learning in many contexts improves understanding (Bjork & Richardson-Klaven 1989; Confrey 1990)

• Misconceptions-oriented
  – Teachers can harbor similar misconceptions as their students (Atwood & Atwood 1996)
• In science:
  – Explicit connections between scale and organization of ideas (Larkin 1979; Perfetto et al. 1983)
  – Common misconceptions (Driver 1994; Keeley & Sneider 2012)
Giving Teachers Context

• In the classroom:
  – Pedagogical content knowledge (van Driel, Verloop, de Vos 1998)
  – Relation to standards teachers must cover
  – Time and collaboration to fit new ideas into existing classrooms
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Using AER to Deliver Content
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
How is AER useful?

1. Highlighting common misconceptions (naïve reasoning, alternate conceptions, etc.)
2. Patterns of reasoning among different age groups or demographics
3. Sharing effective instructional methods, built on a foundation of theoretical frameworks of learning

• See Bailey & Slater (2003) and Lelliott & Rollnick (2008) for more detailed reviews of AER literature
• Gravity misconceptions:
  – Universal “down” or mental model of Earth (e.g. Piaget 1929)
  – Dependence on an atmosphere or magnetic fields (Williamson & Willoughby 2012)
• Instructional notes about gravity:
  – Teachers hold similar misconceptions as students (Reynoso et al. 1993)
  – Understanding gravity & orbits facilitates understanding of other concepts like seasons (Smith & Treagust 1988)
Using AER for Curriculum

• Moon Phases misconceptions:
  – Earth’s shadow (Mant & Summers, 1993; Barrier 2010, etc.)
  – Scale of the Earth-Moon system (Taylor & Grundstrom 2011)

• Moon Phases instructional techniques:
  – Personal observations (Duckworth 1987)
  – Importance of physical models (Bell & Trundle 2008; Trundle, Atwood, & Christopher 2002)
Existing Misconceptions Research

- Seasons (Schneps 1989; Sneider, Bar & Kavanagh 2011)
- Astrobiology (Offerdahl, Prather, & Slater 2002)
- Cosmology (Bailey et al. 2012; Wallace, Prather & Duncan 2012)
- Light and Spectroscopy (Barder et al. 2006; Schlingman et al., 2012)
1. Misconceptions
2. Different age groups or demographics
3. Effective instructional methods
   • Bailey & Slater (2003) conclude that we need more research on effective instruction based on how people learn
1. Misconceptions
2. Different age groups or demographics
3. Effective instructional methods

Teachers appreciate and utilize this knowledge in their own classrooms!
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