National Study of Education in Undergraduate Science	# NSEUS Instruments for Data Collection

Standardized Instruments for Data Collection

Research Questions

1) How does the NOVA professional development model change undergraduate science faculty members' teaching practice based on evidence of their descriptions of their curricular priorities, lesson planning, instruction, and explanations of their pedagogical decision-making? **(CLES, STEBI-B, RTOP, CoRe, PaP-eR, Faculty Interviews)**
2) How do reform science course characteristics - learning environments, course structure, pedagogical content knowledge, and collaboration - differ between reform (treatment) and comparison (traditional) courses and how does this relate to the learning outcomes of undergraduate students? **(CLES, TSSI, DAST, STEBI-B, RTOP, CoRe, PaP-eR, Student Focus Group Interviews, SCA)**
3) How do the levels of reform science course characteristics - learning environments, course structure, pedagogical content knowledge, and collaboration - differ between reform courses (treatment only) and how do these differences relate to the learning outcomes of undergraduate students? **(CLES, TSSI, DAST, STEBI-B, RTOP, CoRe, PaP-eR, Student Focus Group Interviews, SCA)**
4) How do the science course characteristics of reform and traditional courses compare in the long-term based on graduated in-service K-6 teachers in their own science classrooms? **(CLES, DAST, STEBI-A, CBATS, RTOP, Interviews, CoRe, PaP-eR)**

QUESTIONNAIRE-TYPE TOOLS:

- CLES (p. 2)
- TSSI (p. 2)
- DAST (p. 3)
- STEBI-A (p. 4)
- STEBI-B (p. 4)
- CBAT

OBSERVATIONAL TOOLS

- RTOP (p. 5)

OTHER

- CoRe (p. 6)
- PaP-eR (p. 6)
- Interviews (p. 6)
- Science Content Achievement (SCA) (p. 6)

Timing for Administration of Tools:

PRE-TESTS: Undergraduate Students: 1) DAST & 2) Demographic survey, CLES, TSSI online

DURING VISIT: Undergraduate Faculty: 1) CLES, STEBI-B online & 2) RTOP, Interviews, CoRe, PaP-eR
Undergraduate Students: Focus Group Interviews

In-Service K-6 Teachers: 1) CLES, TSSI, STEBI-A, online & 2) RTOP, Interviews, CBATS, CoRe, PaP-eR

POST-TESTS: Undergraduate Students: 1) STEBI-B (pre-service teachers), CLES, TSSI online DAST & Science Achievement)

QUESTIONNAIRE-TYPE INSTRUMENTS

Constructivist Learning Environment Survey (CLES)

- Survey designed to monitor the development of constructivist approaches in the classroom (increasing the role of students in the classroom in helping to construct their own learning), as perceived from the teachers' and students' points of view.
- Survey divided into 5 key dimensions of a "critical constructivist" learning environment:
    - Personal relevance (the degree that what goes on in the learning environment relates to the students' lives)
    - Uncertainty of Science
    - Critical Voice (whether or not students' have a voice in the classroom)
    - Shared Control (level between students and teacher)
    - Student Negotiation (to what degree do students have the ability to negotiate with the teacher about the nature of learning activities and assessment criteria)
- Six items are given for each of the 5 dimensions with possible responses of Almost Always, Often, Sometimes, Seldom, and Almost Never.
- Found to have high reliability on small and large scales. Results very close to what researchers would expect from close classroom observation.
- To be administered to undergraduate students (pre- and post-) and to in-service K-6 teachers (during visit).
- **Data supports (student and teacher versions) research questions 2** (course characteristics)**, 3** (course characteristics)**, and 4** (course characteristics)**.**

References:

Taylor, P. C., Fraser, B. J., & Fisher D. L.(1997). http://surveylearning.moodle.com/cles/?PHPSESSID=6620efe47ced32ae6b57c4744487345f (Online version of CLES)

Taylor, P. C., Fraser, B. J., & Fisher D. L.(1997). Monitoring constructivist classroom learning environments. *International Journal of Educational Research. 27*(4):393-301.

The Thinking about Science Survey Instrument (TSSI)

- Developed to assess preservice and inservice elementary teachers' attitudes toward science. (How well do students' thoughts about science align with "a commonly presented image of science in the public square?" (Cobern & Loving, 2002, p. 1025))
- Examine individual's attitudes about "the public place of science with respect to society and culture" (Cobern & Loving, 2002, p. 1020). ***NOT NOS.***
- **Data supports research questions 2** (learning outcomes of undergraduate students)**, 3** (learning outcomes of undergraduate students)**, and 4** (views of K-6 teachers)**.**

References:

Cobern, W. W. (2000). The *Thinking about Science* Survey Instrument (TSSI) – SLCSP

151. Kalamazoo, MI: Scientific Literacy and Cultural Studies Project (http://www.wmich.edu/slcsp/slcsp151/tssi-v2.pdf).
Cobern, W. W., & Loving, C. C. (2002). Investigation of preservice teachers' thinking about science. *Journal of Research in Science Teaching*, *39*(10), 1016-1031

Draw A Scientist Test (DAST)

- Intended to provide students with opportunity to:
  - Picture perception of scientists
  - Relate the scientist to their personal environment – lab, etc
  - Consider the ways in which they view scientists relate to their own science beliefs about the nature of science

- Includes an **illustration** plus a **short personal narrative** (Contributes additional information and confirms evaluator's interpretation of drawings- Since interviews with each student are impractical)
- Evaluator follows a checklist to interpret drawing. Evaluator gives one point for each item present. The higher the score, the more stereotypical the image is.
- **Data supports research questions 2** (how do reform science course characteristics affect all student's views of what a scientist does and the student's view of the inherent nature of science)**, 3** (how do levels of reform science course characteristics affect all student's views of what a scientist does and the student's view of the inherent nature of science)**, and 4** (How do reform science course characteristics affect pre-service and in-service K-6 teachers' perception of what scientist does and the student's view of the inherent nature of science)**.**
- Developed by Chambers (1983) to examine people's beliefs about what a scientist is.
- Subjects draw a picture of what they think a scientist looks like.
- Symington and Spurling (1990) added the prompt: "Do a drawing which tells what you know about scientists and their work." This was added in response to concerns that students were drawing the societal stereotypes that they thought they *should* draw, rather than what they actually thought.
- Subjects are asked to write a few sentences under their drawings to explain why they drew what they did.
- To be administered to undergraduate students (pre and post).

<u>References:</u>

Chambers, D. W. (1983). Stereotypic images of the scientist: the Draw-A Scientist Test. *Science Education 67*, 255-65.
Symington, D., & Spurling, H. (1990). The Draw-A-Scientist Test: interpreting the data. *Research in Science and Technological Education, 8*, 75-77.

Science Teaching Efficacy and Beliefs Instrument (STEBI-A and B)

STEBI-A

- Survey used to measure two components of teacher efficacy beliefs ("extent to which teachers believe they have the capability to positively affect student achievement" (Riggs & Enochs, 1990, 626)):
  - Teacher's self-efficacy (level of confidence in own teaching abilities)
  - Teacher's outcome expectancy (belief that student learning can be influenced by effective teaching)

- Each question on survey is specific to one of the 2 components, but the 2 types are mixed together
- Teachers respond to each item by circling Strongly Agree (score = 5), Agree (4), Uncertain (3), Disagree (2), Strongly Disagree (1).
- To be administered to in-service K-6 teachers during site visit.
- **Data supports research question 4** (self efficacy beliefs of in-service elementary science teachers who have taken reformed classes as compared to those who haven't)**.**

Reference:
Riggs, I M, & Enochs. L. G. (1990). Toward the development of an elementary teacher's science teaching efficacy belief instrument. *Science Education 74*(6):625-637.

STEBI-B
- Survey designed to measure the self-efficacy of pre-service elementary science teachers.
- Modified version of STEBI-A
- To be administered to education major undergraduate students (post only)
- **Data supports questions 2** (self efficacy beliefs of pre-service elementary science teachers who have taken reformed classes as compared to those who haven't) **and 3** (self efficacy beliefs of pre-service elementary science teachers who have taken reformed classes as compared between different reformed classes)**.**

Reference:
Enochs, L. G., & Riggs, I. M. (1990). Further development of an elementary science teaching efficacy belief instrument: A preservice elementary scale. *School Science and Mathematics, 90*(8), 695-706.

Context Beliefs About Teaching Science (CBATS)
- Survey instrument designed to assess "teachers' beliefs about the potential influence of specific environmental factors on their science teaching behaviors" (Lumpe, Haney, & Czerniak, 2000, p. 279).
- For each of 26 environmental factors, teachers are asked to rate:
  - How much they agree that the factor would enable them to be an effective teacher of science (SA = strongly agree; A = agree; UN = undecided; D = disagree; SD = strongly disagree)
  - How likely it is that the factor will occur in their school (VL = very likely; SL = somewhat likely; N = neither; SU = somewhat unlikely; VU = very unlikely)
- To be administered to inservice K-6 teachers online.
- **Data supports research question 4**.

References:
Lumpe, A. T., Haney, J. J., & Czerniak, C. M. (2000). Assessing teachers' beliefs about their science teaching context. *Journal of Research in Science Teaching*, *37*(3), 275-292.

OBSERVATIONAL TOOLS

Reformed Teaching Observation Protocol (RTOP)

- Developed by Arizona Collaborative for Excellence in the Preparation of Teachers (ACEPT)
- Protocol designed to measure quantitative characterization of the degree to which a science classroom is "reformed." For this test, characteristics of reformed teaching practices are based on national standards for math and science education.
- Observer has a list of characteristics that she rates 0-4 (never occurred -> very descriptive)
- Found to have high inter-rater reliability
- Training manual and reference manuals available:

  Piburn, M, Sawada, D, Turley, J, Falconer, K, Benford, R, Bloom, I, & Judson, E. (2000). *Reformed Teaching Observation Protocol (RTOP): Reference manual* (ACEPT Technical Report No. IN00-3). Tempe, AZ: Arizona Collaborative for Excellence in the Preparation of Teachers. (Eric Document Reproduction Services, ED 447 205.)

  Sawada, D & Pilburn, M. (2000). *Reformed teaching observation protocol (RTOP).* (ACEPT Technical Report No. IN00-1). Tempe, AZ: Arizona Collaborative for Excellence in the Preparation of Teachers.

- All observations will take place during site visits in the middle of the semester.
- **Data supports research questions 1** (measure to what extent faculty members' teaching practices are "reformed")**, 2** (same as 1, but how compare between treatment and traditional courses)**, 3** (same as 1, but how compare between treatment courses)**, and 4** (to what extent are teaching practices of K-6 teachers who took or didn't take treatment classes "reformed")**.**

Reference:
Sawada, D., Turley, J., Falconer, K., Benford, R., & Bloom, I. (2002). Measuring reform practices in science and mathematics classrooms: the reformed teaching observation protocol. School Science and Mathematics. 102(6):245-252.

OTHER

Content Representation (CoRe) and Profesional and Pedagogical experience Repertoire (PaP-eR)

- Used together to "capture and portray" pedagogical content knowledge (PCK)
- PCK = Knowledge related to ways to best formulate and present knowledge of subject to that is comprehensible to others (in particular, students)
- Specific to particular science subject
- **Data supports research questions 2** (measure PCK of science faculty members) **and 3** (measure PCK of science faculty members) and K-6 teachers

Reference:
Loughran, J., Mulhall,P., &Berry, A. (2004). In search of pedagogical knowledge in science: developing ways of articulating and documenting professional practice. *Journal of Research in Science Teaching. 41*(4):370-391.

Interviews

- Faculty subjects and in-service teachers will be interviewed individually and undergraduate student subjects will be interviewed in small focus groups (5-6 students).
- Faculty interviews will be focused on their experiences related to developing and teaching the study course.
- In-service elementary school teacher interviews will focus on the purpose and rationale for teaching the observed lesson and how it relates to other lessons recently taught in science.
- Student focus group interviews will focus on students' opinions about the study course, science, and science education.
- All interviews will take place during site visits in the middle of the semester.
- Proposed for research questions 1-3.

Science Content Assessment (SCA)

The content questions used in this study are devised to explore students' reasoning while they are using the scientific knowledge gained in the courses. These questions are open ended and rich in content with a distinguishing feature of applying the recently-learned concepts in a new context. They require that the students recognize relevant facts and concepts and their interrelationships which should be generalized to the knowledge of theories and principals. Consequently students may rethink the structure of their conceptual schema, select the relevant concepts and find associations between concepts, theories, procedures by inference, induction, deduction, analogical, relational or cause and effect reasoning.

To evaluate students' answers we developed a rubric based on Bloom's taxonomy as revised and expanded by Anderson[1]. In the process of evaluating students' answers we interpret them in terms of knowledge and cognitive types indicated in the taxonomy. We have defined three levels of accomplishment for knowledge types and cognitive processes that students employed. This method accomplishes our primary objective of constructing a method for comparing students reasoning across different disciplines. This type of evaluation is conducted as a post test near the end of the undergraduate science course.

- Achievement measure for undergraduate science course students developed in conjunction with course instructors
- Science content assessed as a post test only achievement test items near the end of the undergraduate science course
- The items will only measure one or a few key concepts developed in the course related strongly to the course goals
- Criterion based rubric measures will be used to compare across courses and disciplines
- **Data supports research questions 2 and 3.**

Reference:

Nieswandt, M. & Bellomo, K. (2007). *Written extended-response questions as assessment tools for meaningful meaningful understanding of evolutionary theory*. Ontario Institute for Studies in Education of the University of Toronto (OISE/UT).