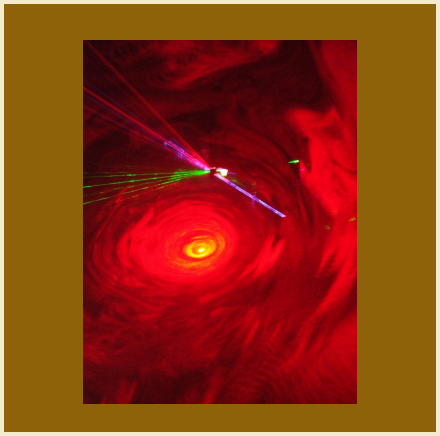
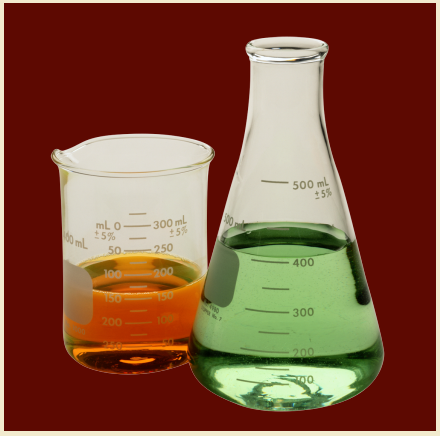




A Freshman STEP Curriculum:
A Project-Based Approach to STEM Student Success

Sponsored by NSF-STEP (#0653094) and Central Washington University

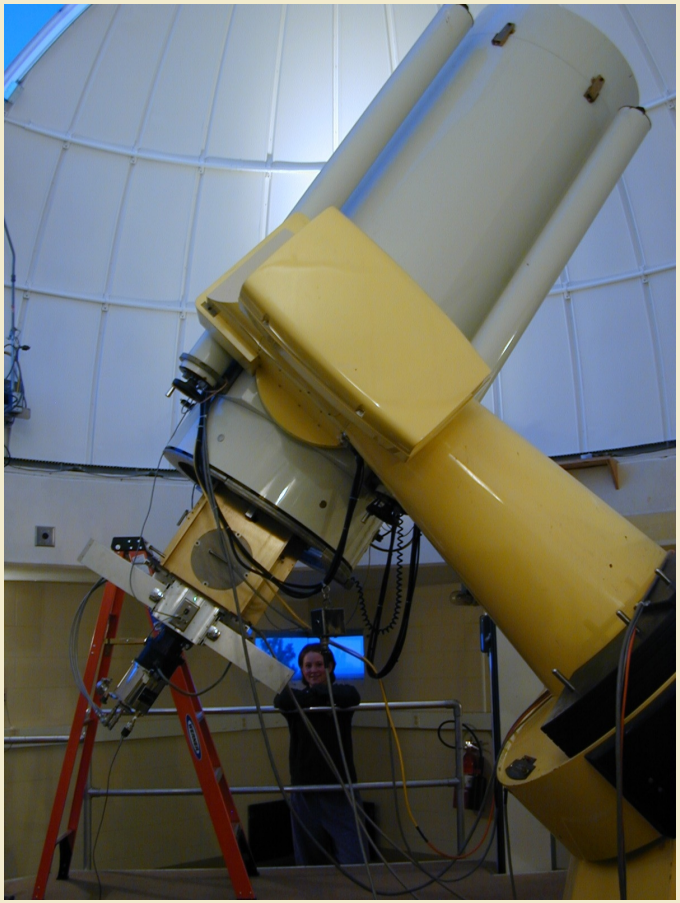
Michael Braunstein, Michael Jackson, Physics, Central Washington University

NSF STEP Grantees Meeting, March 2012

What is the Science Talent Expansion Program?

- The Science Talent Expansion Program (or STEP) is a program funded in-part by the **National Science Foundation**.

- STEP Seeks To . . .
  - Provide **direct**, **significant**, and **sustained benefits** to students.
  - Recruit and retain students in **science**, **technology**, **engineering**, and **mathematics** (STEM) fields through academic support and mentoring.
  - Direct students – equipped with essential knowledge and skills – toward **successful STEM careers**.



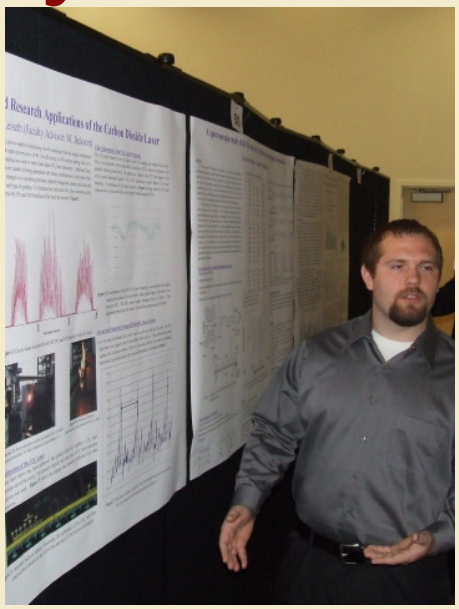
+ Central Washington University …

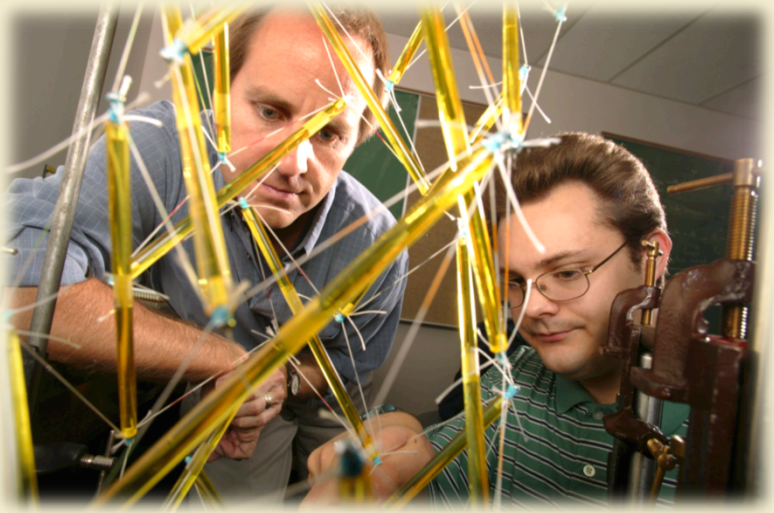
- Public, regional, comprehensive, Master's-granting:
  - About 8000 FTES served on main campus
  - About 500 full time equivalent faculty.
  - About 2500 Baccalaureate degrees/year,
    - about 25% in College of the Sciences
    - about 10% in STEP disciplines.
  - About 20% of undergraduates are minorities.
  - About 2 hours east of Seattle (across Cascade range)

Central Washington University …

Support for Undergraduate Research:

- Undergraduate Travel and Research Fellowships (University wide, COS)
- Summer Research Fellowships (COS)
- Science Honors program (select COS and Prof. Studies Depts.)
- The Symposium On University Research and Creative Expression
- Douglas Honors College – Science Honors program (University wide)
- The Undergraduate Creative Expression and Research Initiative (STEP equivalent for the Arts and Humanities)
- *The Pacific Northwest Journal of Undergraduate Research and Creative Activities*





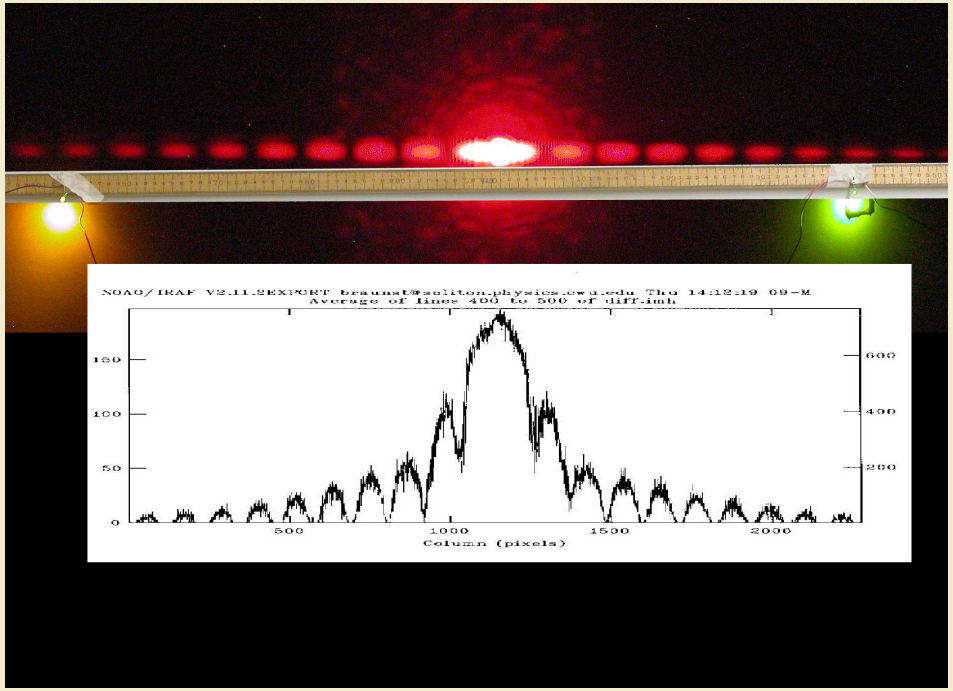
+ Central Washington University …

Other Notable Resources:

- Writing Center
- Math Center
- Supplemental Instruction
- McNair Scholar's Program
- College Assistance Migrant Program
- Living and Learning Communities
- Center for Excellence in Science and Math Education

STEP-Participating CWU Departments:

- Biological Sciences
- Chemistry
- Computer Science
- Industrial & Engineering Technology
- Geological Sciences
- Mathematics
- Physics

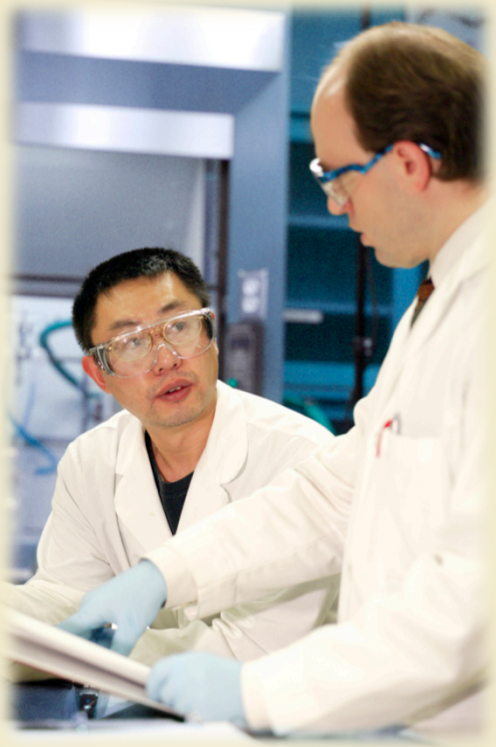


What does CWU's Science Talent Expansion Program have to offer?

- STEP Offers Special Programs . . .
  - For Incoming Freshmen – **STEP Freshman Science Seminar and linked courses**
  - For STEP Sophomores – **STEP Sophomore Bridging Program**
  - For College Transfer Students – **STEP Transfer Bridging Program**
- STEP offers **exclusive financial aid opportunities** for eligible students.
- STEP offers a unique housing opportunity for students – **STEP Living Learning Community**

+ STEP Freshman Science Seminar

- Freshman Linked Courses:
  1. STEP 101, 102, 103 - F(2), W(2), S(1)
  2. English 101, 102 – F(4), W(4)
  3. University 101 – F(1)
- Regularly scheduled meetings with the STEP Coordinator
- Informal activities: e.g., lunches, speakers, pizza gatherings
- Sophomore Bridging Program – student projects
- Cohort ~ 40 students



The STEP Freshman Curriculum (Freshman Science Seminar)

- STEP 101/102/103 (Gen Ed, W)
  - **101: Students are presented an overview of a broad science-based theme and develop a proposal for a project related to the theme to be carried out in the 102 course.**
  - **102: Students perform instructor approved projects**
  - **103: Introduces students to faculty and their research interests and development of a proposal for a Sophomore project**

STEP Freshman Science Seminar Objectives

- University transition, expectations, opportunities (STEM) - foundation for success in STEM disciplines
- Learning community
- Effective reading and writing for STEM
- Scientific practice
- Information Literacy
- Faculty contact
- (Note: no content objective)

Bloom's Taxonomy

1. **Knowledge**: Recall data or information.
2. **Comprehension**: Understand the meaning, translation, interpolation, and interpretation of instructions and problems. State a problem in one's own words.
3. **Application**: Use a concept in a new situation or unprompted use of an abstraction. Applies what was learned in the classroom into novel situations in the work place.
4. **Analysis**: Separates material or concepts into component parts so that its organizational structure may be understood. Distinguishes between facts and inferences.
5. **Synthesis**: Builds a structure or pattern from diverse elements. Put parts together to form a whole, with emphasis on creating a new meaning or structure.
6. **Evaluation**: Make judgments about the value of ideas or materials.

+ Content Topic…

- Energy. Why?
  - **Editorial decision – it's an important topic**
  - **Spans the STEM disciplines**
    - **Provides wide latitude for STEP 102 projects**
  - **CWU special considerations**

STEP 101/102 Writing Component

- 15 – 20 Writing assignments:
  - Most are short (1 – 3 pages)
  - 2 – 4 are scientific logbook entries
  - 2 long (5 – 15 pages)
    - Project Proposal
    - Project Final Report
    - Explicit drafting assignments
    - Peer review

Instructor Management

- Detailed, explicit, consistent assignments and instructor expectations
- Rubrics
- Instructor prepared "model" assignments
- Curriculum includes units on information literacy and citing sources
- Resources:
  - Faculty Office Hours
  - Teaching Assistants
  - Peers
  - Linked English 101/102
  - University Writing Center
- Grading

+ STEP 101

- Instructor lectures
- Assigned readings
- Instructor-led experimental exercises
- Research assigned subtopics (jigsaw)
- Written assignments on assigned subtopics
- Group presentations on subtopics
- Develop project proposals
- Selection of projects from “acceptable” proposals
- Brief final exam on topic of energy

Examples of Experimental Exercises

- Electronic snap-kit
  - Team-building
  - Problem solving
- Wind turbine/Solar Cell
  - Hypothesis formation
  - Experimental methods and procedures
- "Home-made" calorimeter
  - Experimental controls and uncertainties
- Microbial Fuel Cells
  - Experiment design
  - Experimental controls
  - Analyzing data and interpreting results

Wind Turbine Exercise

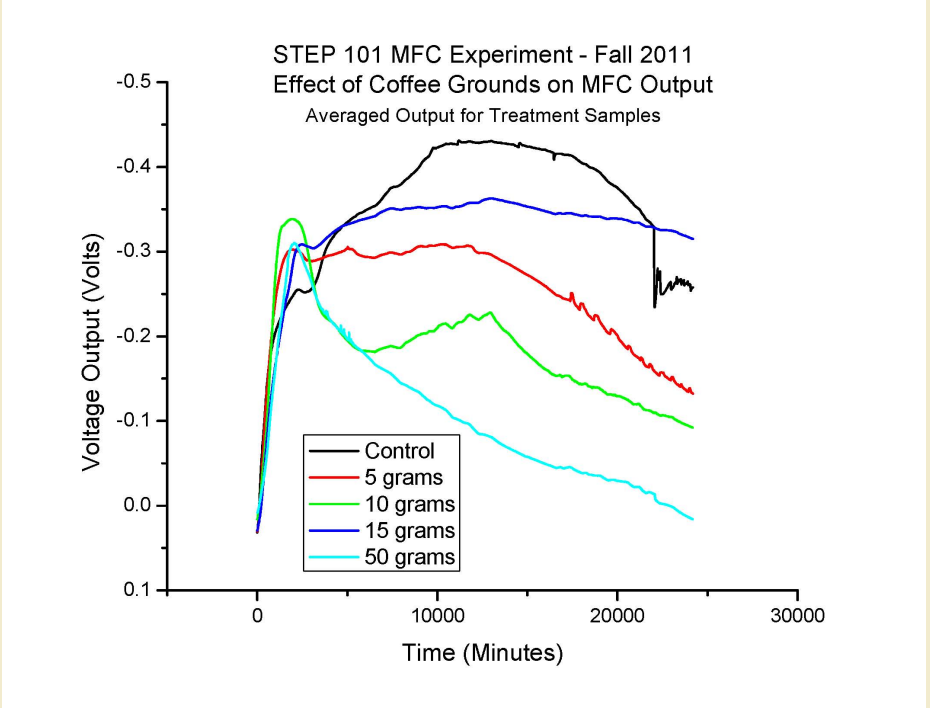
- "Side 1"- Instructors model for students:
  - Simplicity – single question
  - Limited variables
  - Formulation of hypothesis
  - Experimental controls
  - Detailed methods and procedures
  - Using data to evaluate hypothesis
- "Side 2" – Students' turn

Solar Cell Exercise

- "Side 1"- Instructors model for students:
  - Simplicity – single question
  - Limited variables
  - Formulation of hypothesis
  - Experimental controls
  - Detailed methods and procedures
  - Using data to evaluate hypothesis
- "Side 2" – Students' turn

STEP 101

- Examination and discussion of some of the STEP 101 curriculum and issues
  - Information Literacy
  - Citations
  - Exercises
  - Preparing proposals
  - Explicit drafting of assignments
  - Selection of proposals
  - Goal: viable project proposal



Student Project Criteria

- Do we know where the project will “go”?
- Are resources available?
- Is there instructor expertise?
- Can projects be completed in the time allowed?
- Is there student interest?

STEP 102

- Research Plan
- Carry out project
- Group work
- Instructor “consultants”
- Logbooks/Abstracts
- Report drafting with “peer review”
- Final Report
- (Presentation of results)

STEP 102 Project Examples

- Radiation absorption coefficients
- Stirling engine properties
- Battery efficiency
- Calorimetry
- Hydrogen fuel cell efficiency
- Thermoelectric generator efficiency
- Water chemistry
- Invertebrate responses to stimuli
- Efficiency of electronic transformers
- Hydrogen production by electrolysis
- Plant growth
- Conversion of cellulose to glucose
- Microbial fuel cells
- Bicycle generator
- Computer energy use
- Solar cell efficiency

+ Logistics in STEP 101/102/103

- Resources
  1. Time
  2. Space
  3. Equipment
  4. Expertise

STEP 102

- Examination and discussion of some of the STEP 102 curriculum and issues
  - Writing
  - Group work
  - "Unsuccessful" projects
  - Time
  - Resources
  - Consulting responsibilities

+ Impact

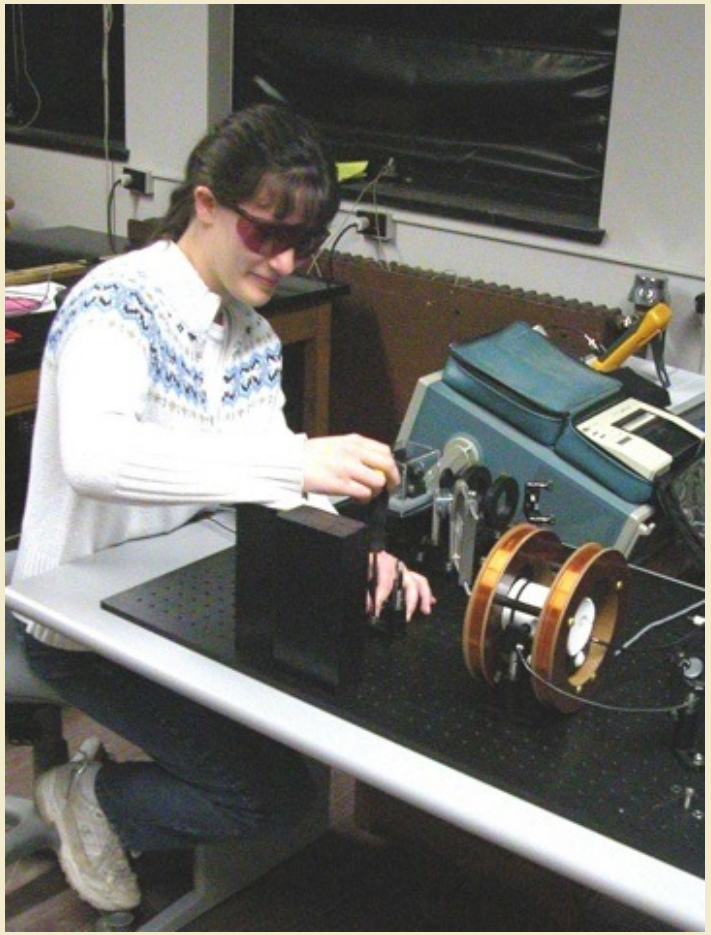
- Freshman to Sophomore retention at higher rate than overall student body
- Higher GPA's than control group
- Higher declaration rate for STEM majors than control group
- Anecdotally, higher participation, more productive in undergraduate research
- Some portions of the curriculum adopted outside the STEP program

Managing Student and Instructor Expectations

- Hierarchical learning: meeting curriculum objectives necessarily places some uncomfortable demands on the students
  - Reassurance
- Relevance of the curriculum to student goals is not always clear
- Projects: faculty must be enthusiastic about problem solving, JITT.

Teaching Techniques

- Jigsaw
- Just In Time Teaching (JITT)
- Frequent short writing assignments
- Detailed Assignments
- "Model" Assignments
- Grading Rubrics
- Explicit drafting assignments
- Peer review of drafts



Questions and Conclusions

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