UNIVERSITY of WASHINGTON

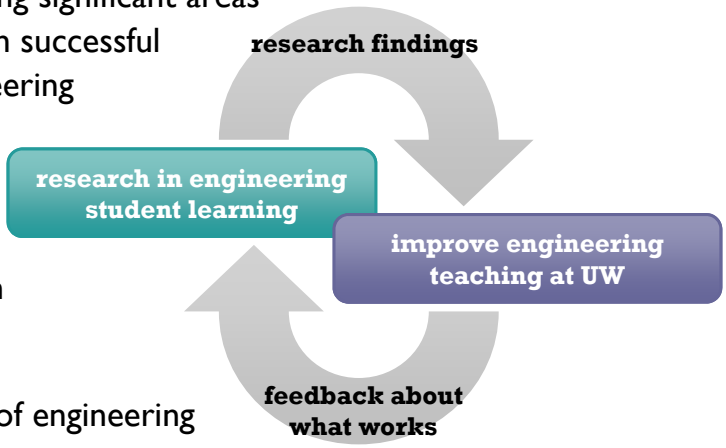
CELT

center for engineering learning and teaching

COLLEGE OF ENGINEERING

CELT Overview

The Center for Engineering Learning and Teaching (CELT) is focused on two synergistic activities: research on engineering education and improving engineering teaching through instructional development. This dual-role structure is based on an awareness that a solid engineering education research base is needed to inform educators about how their students learn and that this research should drive and support effective teaching. Similarly, a broad understanding of what takes place in engineering classrooms is important for pinpointing significant areas for research. Since 1998, CELT's model has proven successful in the University of Washington College of Engineering and has had an impact on engineering education at national and international levels.



Our mission

- To conduct internationally recognized research in engineering learning
- To improve engineering teaching at the UW
- To be a model for effecting change in colleges of engineering

research in engineering student learning

CELT educational researchers work on funded research projects with colleagues from the University of Washington and across the nation to conduct research that advances engineering education. CELT's research agenda includes many aspects of scholarship in engineering education. Research is ongoing in the areas of design learning, knowledge integration of learners, understanding students' learning experiences and their preparation for professional practice, and integrating research findings with teaching innovations.

improve engineering teaching at UW

CELT instructional consultants build on current research to offer a diverse set of program elements with a goal to improve engineering learning and teaching in the College of Engineering at the University of Washington. This includes working with individual instructors, conducting workshops and seminars, and actively participating in strategic-level initiatives.

Current Funding: The Boeing Company, National Science Foundation and the University of Washington College of Engineering. Special thanks to Mark and Carolyn Guidry, Jim and Sue Hewitt and the Mitchell T. and Lella Blanche Bowie family.

contact information

Dr. Cynthia J. Atman, Director
atman@u.washington.edu

Dr. Jim Borgford-Parnell, Assistant Director
bparnell@u.washington.edu

Dr. Jennifer Turns, Affiliate Faculty
jturns@u.washington.edu

http://depts.washington.edu/celtweb/
celt@u.washington.edu

How does CELT integrate research and teaching improvement?

Instructional development efforts must be backed by good research, and research should be driven by what needs to be known about engineering education. One important objective in engineering education is to develop proficient engineering designers. CELT researchers are studying engineering design processes by asking questions such as: what do students' engineering design processes look like, how do student design processes at various levels compare, and how do their design processes compare with those of experts? The results of this research are increasing the knowledge base for engineering faculty and some of our findings are going right to the students.

research in engineering student learning

Research questions

How do years of experience shape how expert engineers solve design problems? What have they learned to do that sets them apart from engineering students?

Method

Participants: 19 engineers with an average of 19 years of experience, 26 first-year engineering students, and 24 senior engineering students).

Experiment: Given 3 hours to design a community playground (working individually in a lab setting) and asked to think aloud.

Analyses

Line-by-line coding of participants' think-aloud commentary by mode of design activity and type of information considered.

Selected findings

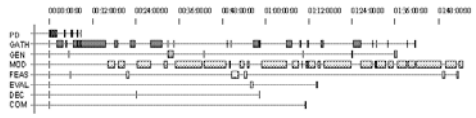
Compared to freshmen, *seniors*…

- …have higher quality designs
- …scope the problem more effectively by
  - gathering more information
  - considering more categories of information
- …make more transitions among design steps
- …progress farther in the design process.

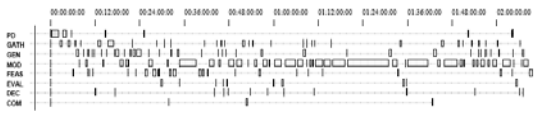
Compared to students, *experts*…

- …spend more time solving the problems in all design stages
- …exhibit a 'cascade' pattern of transitions
- …scope the problem more effectively by
  - gathering more information (explicitly)
  - covering more categories of information

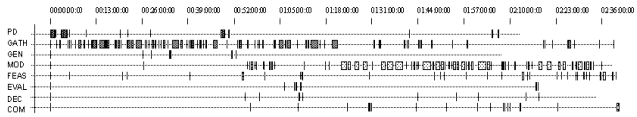
▼ *Representative entering first-year timeline*



▼ *Representative graduating senior timeline*



▼ *Representative expert timeline*



Implications for engineering education

This research provides empirical insights and rich representations that can illustrate to students and faculty important aspects of the design process that may be difficult to describe in design texts. For example, the importance of spending adequate time at the beginning of a design process scoping the problem, and similarly, attending to each of the elements of project realization at the end of the process.

improve engineering teaching at UW

In an ongoing project the CELT team is collaborating with engineering instructors in project-based courses to improve their students' awareness of the components, complexities, and benefits of well-planned and executed engineering design processes. Drawing from our design research findings, we developed interactive seminars, in which students analyzed design process timelines and formed insights for discussion. In these seminars, students compared findings from our design research to their own analyses and those of their peers.

Examples

In winter 2008, the CELT team facilitated a 90-minute seminar for 38 seniors in a capstone design course. The seminar was entitled "*How Prepared Are You? Compare Your Engineering Skills With Other Graduating Seniors.*" The seminar was seen as helpful by both the students and the instructor. Students were particularly interested in our findings that showed how much more complete a representative senior design process is than that of a representative freshmen. Finding that senior design processes are beginning to look more like the experts also captured their attention.

In spring 2008, the CELT team facilitated a 50-minute interactive seminar entitled *Engineering Design Processes*, with 35 students in a junior level structures course. The course was centered on a team-based design/build project. In addition to the seminar, CELT developed several instruments for use by student teams to help them record, monitor, and plan their project design processes.

These examples illustrate how educational research that is current and discipline-focused can readily compliment an instructional development process. These interactive seminars not only benefit students, but by working collaboratively with engineering faculty in the planning and implementation of the seminars we can concretely demonstrate important learning theories and pedagogical principles. This also benefits students in future courses. Additionally, by asking students and instructors to bench-test our findings, we get a better idea of their usefulness, their clarity, and what students view as important that we might study further.

(Research reported in Journal of Engineering Education, Vol. 96 No. 4, 2007; and Design Studies, vol. 20, no. 2, 1999)