A Plan for Transforming Systems and Database Courses in Computer Science

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MOTIVATION AND BACKGROUND

Every student majoring in computer science is required to take at least one *systems* course (CPSC 213). Most go on to take 313, and over half take 317. In addition, our *data structures* course (221) is required by all CPSC students, and related versions (259, 260) are required by all electrical engineering students. Following this, almost all CPSC students (and some engineering students) take one or both of the *database* courses—304 and 404.

Collectively any changes made to these CPSC courses will impact many students and are therefore good targets for transformation.

Furthermore, the 11 systems and database faculty members responsible for these courses have been interested in facilitating changes to these courses for a number of years. Consequently, there was faculty "buy in" to improve the courses using evidence-based instructional methods.

PRIMARY GOALS

1. Revisit and rationalize course learning goals.
2. Improve the sustainability of the course (e.g., develop course timelines, assignment banks, clicker question banks, in-class exercise banks).
3. Improve student confidence in course- and program-specific outcomes.
4. Enable students to visualize the "big picture".
5. Improve student motivation.
6. Incorporate more active learning in lectures, labs, and tutorials.
7. Where appropriate, collect baseline data.

PRIMARY GOALS

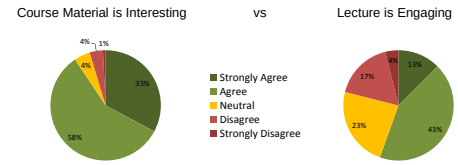
This is a phased, multi-year approach being led by two faculty members who are committed to working on these transformations, on an average of one day per week in exchange for reduced duties in other areas.

Some of the techniques are going to be new, and we'll be undertaking pre- and post-analyses of them. However, there are many proven techniques for increasing engagement and improving student learning outcomes, such as active learning, and we are simply going to incorporate these into the courses.

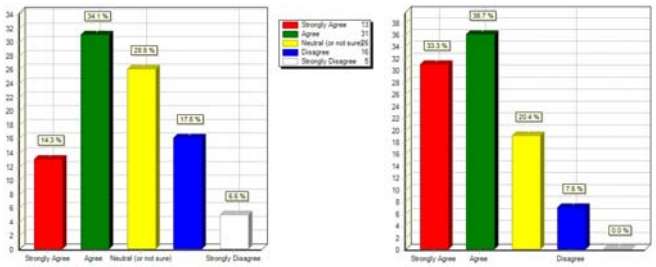
Phase 1: Gather data using attitudinal survey data and assessments (e.g., appropriate clicker questions, exams, and assignments). Learn about strategies and approaches to improve student engagement.
Phase 2: Implement some of the engagement techniques, and where appropriate, measure the changes.

Furthermore, we want to make sure that the content of our courses excites, motivates, and challenges our students in relevant ways, given the shifting landscapes in computer science.

EXAMPLE QUESTIONS



How confident are you in writing a 10-20 page program?



Start of course. End of course.

We started collecting baseline data, including student performance data and surveys of student attitudes and engagement with the summer 2012 courses.

BUILDING ON PAST EXPERIENCE

The systems and database faculty involved in this project have experience with transforming other courses—namely CPSC 317 (Computer Networking) and CPSC 259 (Data Structures). We are using the experiences gained through those courses to have direct applicability to the courses under revision. Examples of engagement techniques that we are using include:

1. Clicker questions
2. In-class exercises
3. Online exercises and low-stakes online quizzes
4. Pre-reading
5. Invention activities
6. Simulations
7. Group projects or pair programming
8. Smaller, more frequent assessments

Peer instruction forms a key component of many of the above activities.

OPEN QUESTIONS

- Some students are asking for even more exercises, practice questions (with full solutions), slides, notes, and office hours; but, how representative are these students?
  - What's the balance (i.e., how much is too much)? How do we decide what's best to help improve learning? How do we set student expectations?
  - If students retain only about 10% of the material in a traditional lecture, and since students' notes are incomplete and inaccurate, then how, when, and where are students learning?
- What do we need to do to facilitate efficient learning?
- Students are like a black box. We feed them "information". How do they go from knowing nothing to knowing something, given the above comments?
- What are some of the best practices to reduce faculty workload, and to reduce cognitive load among instructors?

SUMMARY

We are partway through Phase 1, and are starting Phase 2. Some interventions overlap, so we're simultaneously doing both. Improving engagement—especially through active learning—is the focus of much of our work to date.

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