A Survey of ‘Best Practice’ in Computer Science Teaching

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1 Overview

- themes in higher education underlying best teaching practice
  - student-oriented approaches to curriculum design and teaching
  - facilitating deep learning approaches
  - aligned and appropriate assessment
  - problem/inquiry/research-based education
  - action research and scholarship of teaching
- some examples of best practice in CS teaching
  - formative assessment
  - use of buzz-groups in large-group teaching
  - assignment design to foster student engagement and ownership
  - Communities of Practice in student projects
- discussion on ideas and perceptions of 'best practice'
- about the Graduate Certificate in Higher Education
- conclusions and acknowledgements

2 Theme: Approaches to Curriculum Design

- shaped by our values and beliefs (abstract knowledge vs. creativity and technical vs personal skills)
- can be discipline, performance, cognitive or experiential based
  - experiential learning relates a topic to the student's prior knowledge
- the goals (e.g. desired graduate profile) in turn effect on program/course design
  - nature of objectives (e.g. instructional, problem solving or expressive) and associated performance expectations
- all these have great impact on student learning modes and experience

3 Deep and Surface Approaches to Learning

- surface learning approach: student concentrates on memorization of facts and the ability to carry out procedures
  - fostered by teaching/assessment emphasising the above, unclear standards, poor feedback, excessive material, anxiety and stress
  - learning becomes a tedious, unrewarding activity ($\Rightarrow$ procrastination)
- deep learning approach: *also* involves understanding of the underlying ideas and concepts
  - fostered by teaching/assessment methods promoting active and long-term engagement; teacher enthusiasm and emphasis on meaning, context and relevance; student interest and background knowledge; opportunities to exercise responsible choice
    - its essence is to draw on current understandings to new concepts, and to find relationships
  - leads to higher-quality outcomes, better long-term retention rates
- both are also influenced by previous experiences (in a similar setting)

4 Aligned and Appropriate Assessment

- from the student's point of view, assessment always defines the actual curriculum!
  - not only is the focus of student activity but their learning!
  - hence can promote learning if *aligned* with the course's objectives
- essential to make explicit learning expectations and how they will demonstrated
- seeing it as a way of learning and demonstrating understanding $\Rightarrow$ deep learning approaches
- seeing it as a hurdle $\Rightarrow$ surface approaches
- what kinds of assessment foster each approach?
- what emphasis in the assessment fosters each approach?

5 Teacher vs Student-centred Teaching Approaches

- teacher-centred: teacher is focussed on their own performance
  - sees this as the primary determinant of learning
  - features transmission of information and possibly structured knowledge
  - factors: ignorance of alternatives, stress / high workloads
- student-oriented: teacher is focussed on what the student does and facilitates the learning process accordingly
  - *also* features facilitation of understanding and conceptual change
  - factors: empowerment in the conduct of teaching activities
- factors for both: teacher's values, conceptions on teaching and learning, view of the discipline (and its context)
- accordingly associated with surface vs deep learning
  - the latter is associated with higher student satisfaction and perception of high quality of teaching

6 Problem-, Inquiry- and Research- Based Education

- problem-based learning: engages student learning in the context of a (broad) problem
  - thus has potential to foster closer engagement and deeper understanding
  - inquiry-based learning is similar
  - both also foster the development of generic, long-term skills
- research-based education can share these properties
  - can also add the high-level expertise / understandings of an expert
  - "teaching should be directed towards helping students understand phenomena in the way that experts do"
  - the Boyer Report (1998) strongly advocated this idea
  - two approaches: cognitive apprenticeship and Community of Practice

7 Processes to Improve Teaching Practice

- action research: a cyclic process of planning, acting observing and reflecting
  - systematic observation and evaluation to improve teaching practice
- reflective writing is a tool often used to assist this; has 3 levels
  - measure one's performance against goals
  - establish morally defensible decisions on one's practice
  - examine the underlying assumptions of one's practice

  requires regular feedback from the students to be gained and analysed!
- Scholarship of Teaching: teaching conceived as an object of research
  - make *transparent* the way (successful) learning is made possible

8 Examples – Curriculum Design

- DCS curriculum redesign $\approx$ 1998
  - strong emphasis on degree goals in terms of graduate attributes
  - filtered down into courses using Biggs SOLO Taxonomy!
  - followup?
- design of the MSEng: experiential-based approaches used (and needed!)
  - reflected in both prerequisites and course design

9 Examples: Aligned Assessment

- alignment of assessment, Teaching and Learning Activities (TLAs) and course goals. E.g.
  - COMP1012 Introduction to Computer Systems (mid-late 90's)
    - clear flow-on from lectures, tutorials, laboratory exercises, assignments and examination
    - tutorials even included hand-in preparation sheets!
    - while many thought course was tedious, the students did engage as a whole
      - better performance in same assembly programming assignment than COMP2300 students in 2006
  - integrated course activities through taking a problem-based (or project-based) approach (COMP1110, 2005-6; COMP2031, 1993-4)
    - even better if you can get them excited about it!

10 Examples: Assessment Scheme Design

- design assessment schemes which foster deep learning:
  i.e. promote engagement and reduce anxiety. E.g.
  - staged assignment submission (e.g. COMP1012, COMP1110)
  - do not weigh the exam component too high; have an MSE
  - design exam questions to demonstrate understanding, *and make this clear to the students*!
  - considered use of model answers, preferably accompanied by explanations
    - 'live' solution of exam questions in lectures (COMP1100, 2005; COMP2030, 2007)
- use of formative assessment techniques
  - e.g. students submit assignments with a self-assessment questionnaire a post-marking discussion with tutor, with a chance to resubmit (SE Projects?)
  - use of peer feedback (eScience Project CoP, 2006–7; see also ACE'07)

11 Examples: Large-group Teaching

- encourage engagement and conceptual development through student-participating demonstrations in lectures

  e.g. students demonstration of a stack calculator (COMP2300, 2004)

- encourage further reading for conceptual development

  (the BCS students in COMP2300 2006 did this on own volition)

- facilitate buzz-groups in lectures

  e.g. in computer systems course, after introducing the main ideas, discuss question "*'which is better: RISC or CISC?*"

  - avoiding too large a volume of (complex) material may be required; this should be considered in their own right
  - more useful if combined with instant feedback techniques

- use of Votapedia or a similar technology to assess students' understanding (using a multiple choice question) of current / previous lecture

  e.g. COMP1710, 2007?

12 Example: Small-group Teaching and Assignments

- improve engagement by making (active) participation assessable

  e.g. COMP2300, 2007: Prep. Sheets and computer-marked lab ex.

- expose learning misconceptions through careful design of tutorial questions and group discussions

  e.g. in an OO programming course, discuss difference & similarities between variables of primitive and reference types

  - need to determine (observe) the common misconceptions first!

- apply problem-based learning where possible

  e.g. COMP1110 (2005-6): assignments were based on a problem encompassing most of the practical activities and illustrating the course's main principles

  - the nature (GUI-based) of problem helped foster student engagement and ownership
  - specified by simple instructions and clear outcomes, yet allowing latitude in student choice

13 Project Courses and Evaluation of Practice

- combining the action research and community of practice (CoP) approaches to teach research-related skills

  e.g. eScience Projects CoP (2006)

  - combining them fostered student ownership and engagement
- use of reflective writing for the benefit of own and colleagues' teaching practices

  e.g. extensive reflection documents for COMP1100 over 2004-5 made available to colleagues in DCS
- determine prior knowledge / conceptual understanding / orientations of students and adjusting TLAs accordingly

  e.g. by entry surveys, non-assessable entry quizzes, and short surveys and 'minute papers' throughout a course
- apply the Scholarship of Teaching

  e.g. educational paper on the evaluation of approaches in COMP2110 in the early 2000's

14 Discussion on Best Practice

- thoughts on the Education research community's ideas?
  - is deep vs surface simply a synonym for good vs poor ?
  - will concentrating on concepts and relationships lead to poorer learning of the fundamentals?
- other perspectives and ideas?
- other examples?
- *I have been teaching for many years; I don't need to be told how to do it*

15 About the Graduate Certificate in Higher Education

- College-Based Program of the GHCE first introduced in 2006
  - emphasis on underlying principles in education, rather than techniques of practice
  - that year, emphasis on research-based education
  - six from CECS 'invited', one still standing . . .
- experiential- based curriculum; courses covered include:
  - EDUC8003: *Curriculum Design and Innovation* S1
  - EDUC8002: *Learning and Teaching in Higher Education* S2
  - EDUC8006: *Action Research Project* S1/S2
    - combination of projects undertaken with EDUC8003 & EDUC8002
  - EDUC8001: *Enhancing Your Academic Practice* S3
    - capstone review
- portfolio-based; *flexible*; pass/fail/deferred only

16 The GCHE – My Portfolios

- Integrated Reflection Portfolio (EDUC8003)
- Applying the Community of Practice Approach to Postgraduate IT Projects (EDUC8003/8006)
- Goals for Teaching and Student Learning (EDUC8002)
- Analysis of Different Approaches to Learning in First Year Students of the BSC (EDUC8002/8006)
- Analysis of Different Intentions, Approaches and Experiences of Of Computer Science Teachers (EDUC8002/8006)
- Integrated Review: A Survey of 'Best Practice' in Computer Science Teaching (EDUC8001)
- Professional Enquiry: Research-Based Education in Computer Science at the ANU: Challenges and Opportunities (EDUC8001)
  - seminar next week!

17 The GCHE – My Experience

- *lots* of reading – textbook chapters and research papers
  - a few paradigms, each with a close community
  - (arguably) some of the research could have more rigor?
- a different mindset required, e.g. qualitative research methods
- opportunity to follow own interests, do some research in education
  - eScience Projects CoP (2006) was a highlight!
  - some confusion over what, where, end when
- really good teachers ($\approx$ colleagues)
- some interesting contact with fellow students
- but finding the time would have been really heard without OSP in S2...
- will I be a better teacher?
- should everyone be doing this?

18 Conclusions

- large number of principles and themes from educational research underpin what is considered ‘best practice’
  - there may be other defintions!
- several examples can be found in (relatvely) recent DCS history
  - those I have highlighted are only a small (biassed?) snapshot!
  - they might not have been recognized as such at the time!
- how does our general practices weigh up with ‘best practice’?
  - encouraging deep learning and taking a student-centered teaching approach implies considerable effort
  - both in the short and long term; how committed are we?
  - can find some room in the (judicious) removal of complex material

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