Seeing the BIG picture: how learning to teach assists final year engineering students develop their problem-solving skill set

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BACKGROUND

The focus of engineering education is to develop the engineers' ability to solve problems (Jonassen et al., 2006, Arlett et al., 2010, Harlim & Belski, 2010). Successful problem-solving relies on: competent problem-comprehension, the cognitive and metacognitive skills of the problem-solver, their motivation and social skills as well as their ability to effectively transfer knowledge/strategies gained through experience from one situation to another (Wankat & Oreovicz, 1993, Mayer, 1998, Bransford et al., 1999, Johnassen, 2000, Letzinger et al., 2011).

Engineering education is holding onto approaches to problem-solving and problem comprehension which are out of alignment with professional practice (Trevelyan, 2010, Tan & Trevelyan, 2011). By aligning educational practices with workplace realities and including more authentic, complex, ill-structured problems that require social navigation, we can: improve students' motivation levels, enhance their generic competencies and improve their professional success as engineering graduates (Jonassen et. al., 2006, Anderson et al., 2009, Trevelyan, 2010, Grolinger, 2011).

The Schools' Technology Project (STP) is a service learning based elective, for credit points, offered to all final year engineering students at Monash University, Clayton. The elective is run by the Faculty of Education and has been specifically designed to provide engineering students with the opportunity to develop a broad range of generic competencies including; problem-comprehension, problem-solving, communication and interpersonal skills with clients. The engineering students attend six hours of workshops, before being placed into a school to design, plan and teach a science/engineering based unit of work that meets the needs of their client (supervising teacher).

PURPOSE

1. To identify the skills that are required to be effective problem-solvers in the engineering workforce?
2. How does teaching provide engineering students the with the problem-comprehension / problem-solving skill set expected of graduate engineers by their employers?
3. Do the engineering students see how their learning/experiences as teachers can be transferred into the engineering workplace?

DESIGN/METHOD

Review of current, local and international literature identified the skill set required (desired by industry) to be effective workplace problem-solvers. The remaining research is being conducted using grounded theory. For the past six years extensive data has been collected about what and how the engineering students have learnt as a result of their teaching placements. The data consists of journal responses, written reports and formal and informal interviews. The initial data sets were informally analysed to inform practise and guide appropriate modification to the academic service learning program, the support provided to the engineering students and partnering schools and the assessment …for…as…and of learning. Data sets from 2010 are in the process of being formally analysed to answer research questions 2 and 3.

INTERIM FINDINGS

- Many of the problems that need to be solved in the workplace have non-engineering constraints.

- A number of strategies are being used by tertiary institutions to develop the problem-solving skills of their students; problem-based learning projects, case studies, project-based learning tasks, TRIZ etc. Very few include conative and social skills in their focus.
- At the start of the elective, more than three quarters of the students enrolled in the STP were very confident that their existing problem-solving skills / knowledge were more than adequate for the engineering workplace. They quickly learnt that most problems are not well constructed and defined and while they may 'have' the technical knowledge it's not organised well enough for efficient use.
- The enthusiasm for engineering as a career is re-ignited in some students.
- Many students initially struggled with problem-comprehension and creating mental representations (the 'big' picture) of the problem. As these skills developed their problem-solving abilities and confidence became more effective, efficient and creative.

CONCLUSIONS & CHALLENGES

The opportunity to teach in a carefully constructed program, that focuses on purpose, learning and reflection, can provide a comprehensive platform for engineering students to practice and enhance their problem-solving skills.

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KEYWORDS

Problem-solving skills, problem-comprehension, engineering education, academic service learning, generic skills