

## Enhancing students' learning in laboratories through professional development of teaching assistants

**Mauro Mocerino, Shelley Yeo and Marjan Zadnik**

Faculty of Science & Engineering, Curtin University, Perth, Australia - [m.mocerino@curtin.edu.au](mailto:m.mocerino@curtin.edu.au)

In response to concerns about the quality of instruction in laboratories, a Laboratory Demonstrators Professional Development Program (LDPDP) was developed to enhance the teaching skills of demonstrators (laboratory teaching assistants). This article describes the professional development program developed at Curtin University over the past 15 years.

*Any discussion of science education in universities must involve the key role played by demonstrators. Demonstrators were cited as a significant factor in the laboratory experience by most students, often the most significant factor. For many students:*

- *the demonstrators symbolised their interaction with the world of science at an immediate and practical level;*
- *the lab was a place of significant interaction with a more knowledgeable person who guided them through the complexities of lab work; and*
- *demonstrators had the power to make a lab a great or a miserable experience.*

(Rice, Thomas and O'Toole, 2009).

Laboratory classes are essential components of science and engineering degrees, with the potential to achieve a number of practical and theoretical objectives. Subsequently, the demands on students (and instructors) in these classes are great. The students must not only learn manipulative techniques, but also link theory to practice, problem-solve, analyse and interpret data, interact with staff and other students, and successfully navigate the lab itself. Learning in this situation can be greatly assisted by an instructor who is able to guide students through this complex process. However, these practical sessions are usually taught by Honours, Masters and PhD students who have been given little or no instruction on how to effectively supervise or teach students, and much of their knowledge of teaching is based on what they themselves experienced as students. Nor do they often understand the real purposes of the lab experience (Rice et al., 2009). New demonstrators usually start their laboratory teaching first year students. However, this is a major concern, as it is these first year students who are most susceptible to failure and dropping out of university, and who, critically from a risk assessment perspective, are least experienced in safe laboratory practices and therefore require most supervision. Demonstrators can have a profound influence (either positive or negative) on the student learning experience and motivation, and consequently there is a need to ensure effective teaching practices are maintained (or improved) and that consistent, accurate information is provided to the students by the demonstrators, as well as helping students develop laboratory skills and understanding of scientific methodology.

To the best of our knowledge, our TA program was the first, and is still the longest running in Australia. However, there are numerous reports of other similar programs in biology (Rushin et al., 1997; Lawrenz et al., 1992) chemistry/science (Roehrig et al., 2003; Stewart et al., 2004) and chemical engineering (Alpay and Mendes-Tatsis, 2000). In the School of Science at Curtin, we prepare our TAs by using a three stage process: (i) a full day workshop on teaching in laboratories with a focus on the educational issues and student learning, (ii) use of a demonstrator's preparation template to highlight educational objectives and practical issues and (iii) weekly group meetings to discuss teaching strategies for individual experiments.

The workshops are designed to encompass all science laboratories (including engineering) and to be an interactive forum for a variety of topics relevant to the laboratory teaching environment. The workshop was specifically designed to model excellent teaching techniques by using a variety of interactions and activities. The central focus of the workshops was discussion and maximizing participation and interaction from the whole group. Most activities of the workshop commenced with a short personal reflection, which was then shared within a small group of 4 to 6 participants (think, write, pair, share). After the discussion, group ideas were shared with the whole cohort (Figure 1). More details of the activities and their impact are provided below.



Figure 1. Selected photos from workshops showing participant involvement.

The Australian Learning and Teaching Council commissioned report on “Tertiary Science Education in the 21st Century” by Rice, et al. (2009), found that “the majority of departments had no clear explicit rationale regarding the necessity for first-year students to undertake mandatory laboratory work...” This very issue is the basis of the first main activity of the workshop. Demonstrators are asked to list reasons why universities have lab classes, and in particular, what learning is best attained through labs. This is then coupled with the role of the demonstrator. A significant component of the workshop deals with cognition—how students learn and what helps or hinders learning. The Information Processing (IP) Model (Johnstone, 1997) and the concept of working memory, effectively demonstrate why students have difficulty following instructions in laboratories (mostly because of information overload). The issue of alternate (mis)conceptions, how they arise, and how they can influence or indeed block learning is also discussed. The video “A Private Universe” from the Annenberg Learner (<http://www.learner.org/>) is used to highlight the issue of misconceptions (there are many other similar videos from this group that could also be used). This session provides the opportunity to discuss pedagogical methodology, group work and interaction, and building student confidence. The workshop also includes a session on assessment of students’ work and their lab reports, and many of the dilemmas associated with it; assessment tools/strategies, what is good and bad feedback, what are the demonstrators’

responsibilities in assessment, how to ask effective and productive questions (the associated workbook provides written suggestions that participants can go back to later). Finally, participants are presented with a number of potentially difficult laboratory scenarios to discuss and propose possible solutions.

The workshop booklet also contains 25 pages of hints and guidelines, among them safety in the laboratory (a checklist); a laboratory exercise preparation sheet template; survival tips for the first day of class; time-saving tips when giving feedback; laboratory scenarios and references from science education research.

It is known from the research literature on staff development that a one-off workshop is unlikely to have a sustained influence on participants' behaviour in the classroom. Consequently the workshop is coupled with regular meetings with the demonstrators to discuss specific laboratory classes. As a preparation for these meetings all demonstrators complete and submit, prior to the meeting, a "preparation worksheet". This worksheet may be considered a "lesson plan" in which the demonstrators identify the key learning objectives and key issues required for successful completion of the laboratory class, safety issues and possible questions to probe student understanding. We believe it is an important and valuable exercise for the demonstrators to complete this themselves (thus becoming "reflective practitioners"), instead of us providing them with this information; feedback on their responses is then provided during the weekly meeting.

Over the past decade, we have also run workshops at many Australian institutions including the University of Western Australia, Murdoch University, the Australian National University, Macquarie University, the University of Tasmania, and overseas (Malaysia, Kuwait and Poland). Resources we provided to chemistry colleagues at the University of Cape Town and Victoria University of Wellington have been used in their demonstrator training programs. Feedback from workshop participants has been overwhelmingly positive. Responses from workshop evaluations have indicated that over 97% of respondents (N = 429) agreed that attending the workshop was worthwhile, 98% (N = 421) that it was pitched at the right level and 98% (N = 433) that the level of interaction and discussion was appropriate (Figure 2).

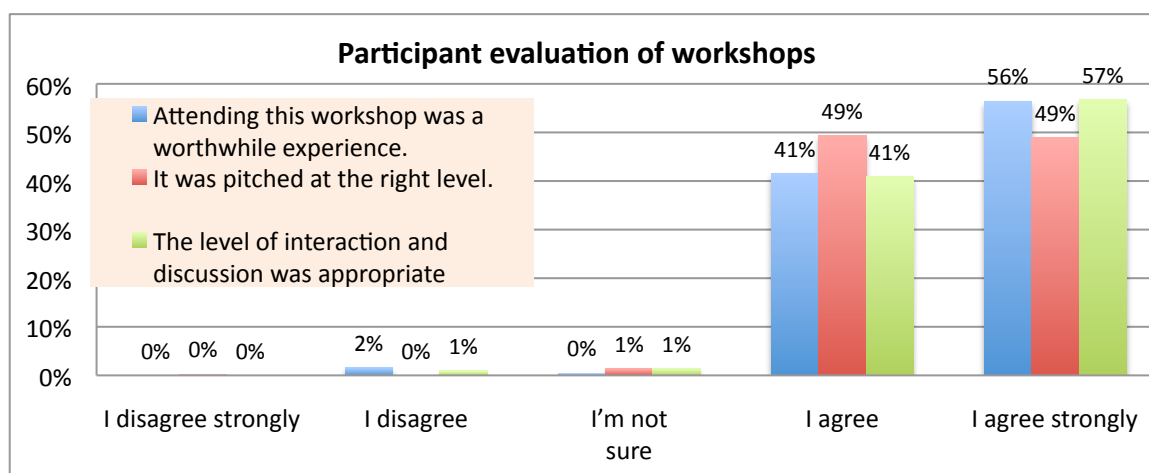


Figure 2. Results of participant evaluations of workshops.

In conclusion, the Curtin University LDPDP has provided new and experienced demonstrators with support and resources to improve their teaching skills in laboratory classes. This has occurred via three key stages, (i) a full day interactive workshop, (ii) use of a lab preparation

activity sheet and (iii) weekly meetings to discuss key issues and teaching strategies. A key focus in this PD is for demonstrators to be proactive in the laboratory class and to initiate discussions on the science in progress.

### Supplementary Materials

Copies of the workbook and other resources used in this laboratory demonstrator PD program are available from Mauro Mocerino ([m.mocerino@curtin.edu.au](mailto:m.mocerino@curtin.edu.au)).

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