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Improving the laboratory learning experience: a process to train and manage teaching assistants

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Abstract

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Keywords

learning, assistants, laboratory, teaching, improving, train, manage, process, experience

Disciplines

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Improving the Laboratory Learning Experience: A Process to Train and Manage Teaching Assistants

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Abstract—This paper describes in detail a successful training program developed for sessional (part-time or non-permanent) laboratory demonstrators employed in the Electrical Engineering Department of an Australian university. Such demonstrators play an important role in teaching practical concepts and skills in engineering. The success of the program relies on a centralized approach coordinated by a carefully selected Laboratory Manager, responsible for the recruitment, allocation, training and development of sessional teachers, and for assessing student satisfaction with them. The paper examines the overall impact of the program on these teachers’: 1) introducing laboratory material; 2) preparation; 3) communication; 4) interest in student learning; 5) ability to respond to questions; and 6) overall effectiveness. Sessional teacher satisfaction with the training program is also examined and the data was used to inform the program’s further development. The results show that the training program successfully improved the demonstrators’ teaching skills and thus led to greater satisfaction and hence learning experience of both students and demonstrators.

Index Terms—Continuous improvement, demonstrators, laboratory, teaching assistant, training, student satisfaction

I. INTRODUCTION

A COMMON ISSUE facing many schools and faculties within universities in Australia and around the world is the ever increasing requirement for teaching assistants to help support the normal academic teaching load. In Australia, the terms “sessional teacher” or “casual teacher” correspond to the role of “teaching assistant”. Sessional teachers are typically employed on an hourly basis for a fixed period, such as one or two semesters. Between 40 and 50 percent, and in some instances up to 80 percent, of teaching in Australian higher education is currently done by non-permanent staff [1]. Similar numbers have also been reported in the UK and the USA [2].

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The increase in sessional employment has required “universities to develop initiatives to deal with casualization, not only in relation to administrative management, but also to move towards a more principled appointment, training and support regime” [3]. The development and support of all teachers is important and necessary and can lead to an increase in both student and teacher satisfaction [2]-[5]. A common theme in the literature is that the best training takes the form of on-the-job practice with a focus on self-reflection [6]-[9].

To combat these issues, the School of Electrical, Computer and Telecommunications Engineering (SECTE) at the University of Wollongong (UOW), Australia, embarked on a number of reforms to quantify student satisfaction within teaching laboratories, and implemented a continuous improvement process. Continuous improvement was used to enhance the experience of the students, the skills of the sessional teachers, and the quality of the training program. One of the reforms was to facilitate a professional approach in managing and training the sessional teaching staff, to enhance their effectiveness.

A certification process was implemented to ensure that all sessional staff would complete a defined training program before being allocated work. The training program consisted of six stages as outlined in Fig. 1.

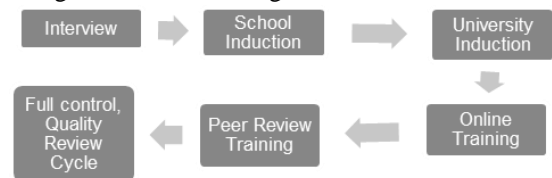


Fig. 1: Six-stage training program implemented

This paper outlines and examines the achievements of the management process and training program five years after implementation. Section II reviews the key literature related to measuring student satisfaction, sessional teacher training, sessional laboratory demonstrators, sessional teacher training programs and example case studies. Section III describes the history behind the development of the six-stage training program, Fig. 1, that is further described in Section IV. The impact of the training program is measured through student and sessional teacher satisfaction results presented in Section V. Conclusions and suggestions for future work are described in Section VI.

II. LITERATURE REVIEW

A. *Measuring Student Satisfaction*

Student satisfaction has grown in importance due to the competitive education environment and government driven reforms [10], [11]. A number of studies have also shown that low levels of satisfaction can negatively impact student achievement [5]. High student satisfaction has also been found to increase motivation, lower attrition rates and produce positive recommendations for future students [12].

In terms of improving learning, student satisfaction surveys are often used to evaluate the success of various teaching styles or delivery methods [13]-[15]. Student satisfaction surveys are also used to measure the quality of teaching. When measuring student satisfaction of teachers it is important to be aware that “they do not measure the ‘knowledge transfer,’ but only the students’ perceptions of the instructor’s teaching effectiveness” [16].

An identified threat to student satisfaction that is of concern around the world is the increasing use of sessional staff [2, 17]. This can be attributed to rising student numbers, resource constraints, cost efficiencies, and an increase of time spent undertaking research [2, 18]. Australian universities are a prime example of this trend with a report finding that “the full-time equivalent (FTE) hours performed by estimated sessional staff, by contract, increased 92% between 1996 and 2012” [19].

To ensure that student satisfaction is not compromised by this latter growth in sessional teaching staff, their performance can be measured. Measuring sessional teaching quality is important because students want a high quality, seamless education. “They do not want to know that their teacher is sessional or permanent. All they want is high quality teaching and high quality subjects” [20].

B. *The Need for Sessional Teacher Training*

The Australian government commissioned reports in 2003 and 2008 to investigate sessional teaching [1, 3]; these concluded that quality assurance of sessional teaching in many institutions is inadequate and there are virtually no instances of formalized standards of practice or professional development. The reports outlined that the general lack of performance management of sessional teachers is a high risk factor for universities and can result in low quality teaching.

There is substantial literature that shows the link between training to improve the quality of teaching and increased student satisfaction [2], [4], [21]. A study of 13 different training programs [22] found that each program in their own way resulted in a positive contribution. The study highlighted that more needed to be done to investigate training programs to find those that produce the greatest benefit.

One of the major problems with untrained teachers is that they do not concentrate on student learning, but instead concentrate on what they perceive they are expected to do [21]. To become effective a teacher needs to prepare and develop a number of competencies [23], but many universities do not enforce training for sessional teachers, and if they do,

the type of training provided may be ineffective [7]. The impact of this is best described by Macdonald [24], “We found that sessional teachers were quite outstanding – when they were supported properly. They were quite terrible when they weren’t supported properly. The difference was quite significant”.

C. *The Laboratory Demonstrator*

A subset of sessional teachers is the sessional laboratory demonstrator. The laboratory demonstrator undertakes teaching in a laboratory environment and is especially used throughout science and engineering. In 1983 it was observed that it was becoming increasingly rare to find professors in the laboratory [25]. Thirty years later this trend has continued with over 71% of laboratory demonstrators in the USA being sessional [26]. Hence, sessional demonstrators are now having more direct contact with undergraduate students than are permanent academic staff [27], and research has shown a link between student satisfaction and the quality of teachers [10], [21], [28].

Demonstrating in a laboratory is very different from teaching in a lecture or tutorial, as a wider range of skills are needed. Demonstrators need to know how to teach, manage a classroom, use instruments, monitor lab safety, and most importantly know how to troubleshoot. This is especially the case in electrical engineering and related disciplines where it is common for students to design, build, troubleshoot, measure and then analyze data. As a result demonstrators require different training programs to those required by general sessional teachers [29]. Without proper development most demonstrators will not be experts both in the discipline and in teaching [30].

D. *Training Programs*

Park [31] defined training as “bringing the teaching assistant to an agreed standard of proficiency by practice and instruction”. Most training programs used at universities are generic and this can leave large gaps in necessary knowledge, an example being for laboratory demonstrators [29]. A common problem with most generic training programs is the overemphasis on university policy [7]. Other generic training programs that expand into teacher education are designed for sessional teachers who run lectures, tutorials or seminars rather than laboratory classes.

Methods for training sessional teachers vary across disciplines and universities. Some of the variations include who provides the training, what the program and requirements should be, differences between domestic and international teachers, and how to evaluate the effectiveness of the program [17]. Some common training components include learning styles, seminars, videos, faculty demonstrations and classroom observations [22]. An important element of training that is not usually implemented due to time and logistical constraints is on-the-job training with feedback [6]-[9].

Generic training is usually not suitable for laboratory demonstrators as it is not specific enough for the skills required and generally does not deal with inquiry-based

approaches [29]. In engineering and science laboratories, an inquiry-based learning model is beneficial to student learning. The idea behind inquiry-based learning is teaching students how to think, as opposed to, not what to think [32], [33]. For example, when building electronic circuits students must be able to think for themselves about how to design and troubleshoot. As a result laboratory demonstrators should not help students by giving them the answer or doing the experiment themselves; instead they need to question the students strategically so they can procure their own answer or process [34], [35]. It has also been found that inquiry-based training improves the effectiveness of demonstrators [36].

E. Case Studies

Young and Bippus [37] designed a three-day training program that focused on preparation, presentation and practice. The first day focused on policy and procedure. The second day focused on the role and strategies of teaching. The third day was spent simulating a classroom environment. This last day was the most valuable as it allowed participants to gain confidence, practice the theory before getting in front of students, and most importantly, obtain feedback on their teaching style. The training was proven effective based on surveys of the participants before and after the training. This prevented the survey data being influenced by time spent in the classroom. The problem with this is that the data is based on self-evaluation, and the teachers could have felt obligated to report that the training was helpful. The study also highlighted that “nothing could replace actual experience in the classroom” without it actually containing that component.

Santhanam and Codner [21] outlined a teaching development program (TDP) to enhance engineering education. A certification process was put in place to ensure all teaching assistants in the faculty received training. A two-day training program was implemented to explore teaching styles, communication skills, and classroom management. The training was found to be successful from surveys of the participants. The success of the program was also matched to two survey questions related to student satisfaction in tutorial and laboratory classes. The major problem with the analysis is that the wording of the two questions did not provide a clear link to training, as a number of factors could have played a role in increasing student satisfaction. This program also did not contain an on-the-job training component.

Mark et al. [38] outlined a training program that involved a multi-directional engagement team-teaching approach, supported by e-learning technologies. The team-teaching approach consisted of an on-the-job learning component where a team of new and experienced teachers would work in the classroom together. Every 10-15 minutes the main speaker would change. Video technology was also used for self-reflection together with feedback from peers and instructor. Feedback on the program was obtained from a learning experience questionnaire and a reflective portfolio submitted by participants, describing what they had learned from the course. While the program was found to be successful, one possible downfall of this program is that in some countries,

such as Australia, anyone undergoing training needs to be paid. This would result in a high cost of having to pay for five or more teachers (new and experienced) in the classroom.

The RED (Recognition, Enhancement & Development) Resource [39], published as a supplement to the RED report on sessional teaching staff [1], provided a number of good practice case studies used across Australia. Good practice case study number six identified a departmental approach to employing, developing and supporting sessional staff. The key to the success and sustainability of this program is the allocated role of the Department Manager, who manages all employment and timetabling processes and the financial commitment of the Department to these quality practices. Although the program does not have an on-the-job learning component, large teaching teams meet regularly to discuss progress.

The role of training the laboratory demonstrator was outlined in a report titled “Demonstrator Development: Preparing for the Learning Lab” [29] prepared for the Australian Council of Deans of Science. Some of the recommendations for demonstrator training included learning sessions linked to lab practice, pre-lab briefing sessions, mentoring, sharing ideas, and most importantly, establishing student feedback mechanisms for measuring demonstrator performance.

F. Summary

This literature review has shown the importance of student satisfaction to universities and the key role that teaching quality plays. The threat from the increasing use of sessional teachers can be combated with appropriate training and quality assurance measurement. Training is beneficial to both the sessional teacher and the students. Training can come in various forms but any training is of some benefit. On-the-job training with mentoring and feedback is said to be a highly valuable component of any training program and skills required for laboratory demonstrators are generally missing from most training programs. Approaches to determining the effectiveness of training programs can also vary. The next sections of this paper present and investigate a training program and management process that incorporates many of the valued features outlined in this section.

III. CREATING CHANGE

A. Background

The typical teaching structure for electrical engineering subjects at the University of Wollongong consists of four hours of lecture, two hours of tutorial and three hours of laboratory work every two weeks. Approximately 90 percent of lecture and tutorial workload is conducted by permanent academic staff, and approximately 90 percent of laboratory workload is conducted by sessional teaching staff. Hence, the majority of the reforms to increase student satisfaction have centered on the laboratory environment.

Historically the primary method for developing and managing casual teaching staff was via the subject

coordinator. The subject coordinator would request sessional teachers, who were usually selected from research students under their supervision. An administrative manager would prepare and handle all the necessary documentation. Training consisted of attending a generic two-hour university induction.

This method, while satisfactory, also had a number of disadvantages. Primarily there was no mechanism for ensuring the quality of sessional teaching. To begin with, there was no procedure in place to ensure that the sessional teacher assigned to a teaching position actually possessed the skills to teach, or to ensure that they did a good job. That is, teaching was allocated based on who you knew, not on how well you could teach. A number of recent benchmarking exercises conducted by the School have shown that this type of allocation is still common in other engineering departments.

The main feedback channels were via complaints through student representatives, forums, individual emails and direct approaches to the Head of School/Department. These methods, however, were unreliable as there was no way to measure how much substance any single complaint had. Secondly, if a complaint was found to be legitimate, there was no process to ensure that the casual staff member would be retrained as appropriate. With the responsibility for the development of sessional teaching staff residing with the subject coordinators, significant workloads on such individuals could easily lead to little or no professional development of their sessional teaching staff.

B. The Laboratory Manager

Change towards improving quality began with the employment of the first author as the School's Laboratory Manager, a non-academic position covering academic, administrative and technical-type work. The School-wide consensus insisted that change had to improve both the quality of the laboratories and also, the performance of the sessional teaching staff required to run them.

In 2007 the School approved a trial survey to investigate student satisfaction of the teaching laboratories. The results from the trial survey showed that student satisfaction was low and in need of significant improvement. The Laboratory Manager was given the task of investigating and implementing policies and procedures that would not only increase student satisfaction of the teaching laboratories but also of the sessional teaching staff employed to undertake the teaching. The new policies and procedures were debated and then approved by the School in 2008 [40]. Key changes included:

- Centralization of teaching allocations and training
- A certification program for demonstrators and tutors
- The approval of surveys to quantify student satisfaction with the laboratories and sessional teaching.

The centralized model of the Laboratory Manager has many similarities to the role of the Department Manager detailed in the literature review [39]. The model also adds the certification and training requirements identified by Santhanam and Codner [21], and covers all the recommendations outlined in the Demonstrator Report [29].

Key features of the training program included the requirement for on-the-job training as well as the quantification of student satisfaction to be used for continuous improvement purposes.

C. Development of the Training Program

The development of the training program was designed using previous management experience that focused on understanding the customer and implementing a process of continuous improvement; here, the primary customer was the student and the secondary customer the sessional teacher. For the students to be satisfied they need to enjoy and appreciate the learning environment while the sessional teachers need to feel supported and capable. The learning environment is optimal when both the student and teacher are satisfied [5].

In 2007 the Laboratory Manager conducted surveys of the students and participated in laboratory classes to observe the delivery of teaching and the interaction between students and sessional teachers. The Laboratory Manager also sought advice from the University's Learning and Development Center to explore what resources and knowledge were available for training purposes. This action resulted in a more comprehensive training program in 2008. Continued observations showed that the training missed many variables that occur in the laboratory. Students would ask many questions in a variety of ways that an inexperienced teacher would not know how to interpret and handle correctly. For this reason it was determined that it was essential to include an on-the-job training component.

The training program has been subject to continual evolution. Continuous observations by the Laboratory Manager each year, as well as an end-of-year survey of the sessional teaching staff, has led to an incremental improvement of the program. The survey sought both quantitative and qualitative feedback. The quantitative data is used to create a weighted average score. The changes to the program, and response scores for the statement, "The school provided me with enough resources/training to perform my job successfully" are shown in Table I.

In 2009 the implementation of the new training process with an on-the-job training component led to an 8% increase in laboratory demonstrators' response to the statement, indicating that they felt better trained. The next major jump in demonstrators' opinion occurred in 2012, with a 4% jump that can be attributed to two new resources added to the program. In 2012 a sessional teacher forum was initiated to allow sessional teaching staff to share their ideas, tips, tricks and recommendations for the further development of staff and for improvements in the design of laboratory experiments. This has resulted in sessional teaching staff influencing course material and in some instances being granted the opportunity to redevelop labs or coordinate subjects. A student laboratory learning resource called the "Training Laboratory" [41], developed by the first author, was also introduced. This resource is an online collection of video tutorials and manuals on the equipment used in the SECTE laboratories; this ensures that all demonstrators are capable of using all the hardware

and software contained in the laboratory.

Table I: Changes to Training Program over Time, and response scores to the statement: “The school provided me with enough resources/training to perform my job successfully”

| Year | Changes to Training Program | Training Score |
|------|--|----------------|
| 2007 | Training program initiated. Consisted of a one hour school induction and two hour university induction. School induction primarily consisted of rules and policies. A sessional teaching guide was created to provide a reference guide for sessional teachers | N/A |
| 2008 | The sessional teaching guide and school induction was expanded to include instruction on their role in the class, how to engage with students, and inquiry based questioning | 75.3 |
| 2009 | Certification process commenced that included on the job training. Teaching guide and school induction further enhanced | 81.1 |
| 2010 | New interview process commenced. Videos introduced showing a range of laboratory demonstrator scenarios | 83.3 |
| 2011 | Online training site created to provide a comprehensive review and revision questions | 84.2 |
| 2012 | Online resource, 'The Training Lab' created to provide extensive resources on how to use equipment and how to fault find. Sessional teaching forum | 87.2 |
| 2013 | Some small content recommendations from the 2012 sessional teaching forum added to the training program | 87.5 |

IV. CASUAL TEACHER DEVELOPMENT

Development of casual teachers begins with certification in demonstrating. Tutor positions and the associated development opportunities are used to reward sessional teachers who show significant commitment to laboratory demonstrating.

The majority of sessional laboratory demonstrator development occurs during their first semester of employment, when significant resources are allocated to ensure that the foundations of teaching are in place. Six complimentary stages are associated with the development process, Fig. 1.

Approximately 15 potential demonstrators participate in the laboratory demonstrator program each year. During the five years it has been offered, 74 training participants have obtained demonstrator certification. The tutor training program has approximately four participants each year.

A. Stage 1 – The Interview

A key tool in the development of demonstrators commences prior to their employment, with the job interview. A 15-minute job interview mimicking a real life demonstrator experience was implemented, requiring the interviewee to firstly provide an introduction to the laboratory and then demonstrate how they would help a student fault-find a selected (typical) circuit. The laboratory notes and any facilities to help the interviewee prepare were provided before the interview. The basic circuit used for fault-finding is a simple first-year, first laboratory circuit incorporating common student mistakes. The interview process is used to evaluate preparation, communication, problem solving and inquiry-based teaching skills. In addition, the interview provides the opportunity to examine skills in using measuring equipment and other hardware used in electrical and computer engineering.

The interviewees have a high failure rate (~ 90%) in terms of the ability to assist students to troubleshoot the chosen circuit. However, most of the interviewees (~ 75%) can adequately explain the required concepts on the whiteboard. Importantly, this highlights the difference in skills required to run a tutorial compared to a laboratory. For this reason a key

focus of the interview process is to select candidates (approx. eight each session) who have the potential to be good demonstrators after receiving appropriate training.

The interview stage eliminates demonstrators who cannot communicate effectively, or clearly have no practical approach to problem solving. Those who have some potential are selected to proceed with the training program, now with greater enthusiasm because of the “wakeup-call” provided in the interview. Those selected realised the gap between theory and practical work, and the need to undertake a significant amount of preparation.

In recent years, domestic students who undertook undergraduate studies within the School performed significantly better in the interview than in previous years. In particular, these students have been highly successful in communicating how to troubleshoot the circuit. Lately it has been observed that the undergraduate students are absorbing the techniques used by the trained demonstrators. As a consequence the inquiry-based technique is being replicated in the interview.

B. Stage 2 – School Induction

All of the candidates who passed the interview stage underwent a three-hour induction session with the Laboratory Manager. One of the key tasks at the start of this induction is to have participants think about their experience as a student and describe what they did not like about demonstrators, and then determine what they wanted to learn during the induction session. The “I did not like list” is used to create a list of skills a demonstrator should have and follow. These are listed on the whiteboard and ticked off when covered. The most common items are listed in Table II.

Table II: Common items raised by participants in induction

| What I believe a lab demonstrator should do | Things I want to learn today |
|---|---|
| Be prepared - know equipment, resources and experiment | How to use the equipment |
| Don't give students all the answers | How to deal with unprepared students |
| Engage with the students. Don't live in your own world | How strict to be with students |
| Need a good introduction to provide a plan or overview of what students will do | What to do with unwanted students in the laboratory |
| Need to be able to quickly identify mistakes | Criteria of marking |
| Need to be able to communicate how to troubleshoot | What to do with plagiarism |
| Be flexible and respect the students' approach | How to troubleshoot hardware problems with students |
| Allow students to feed off each other | How to troubleshoot software problems with students |

The next stage of the school induction covers expectations, duties, training process and administrative requirements. This is followed by an outline of workplace health and safety policies and procedures, an essential skill for demonstrators [29], since the laboratory can be dangerous, especially the power engineering laboratories when working with high voltages. Demonstrators must know how to maintain a safe learning environment and pass this knowledge on to students. This is also reinforced by discussing the School, University and laboratory rules that the demonstrators must enforce.

The next component of the School induction covers the theory of teaching styles [42], communication skills and classroom management [43]. The goal of this section is for the participants to gain an understanding of how students learn, how demonstrators can motivate and keep control the class, and how their body and tone are perceived by students. The participants also learn about marking, marking rubrics and plagiarism.

This theoretical knowledge is then supplemented by a number of videos [44] developed within the university that reinforce key demonstrating concepts. First, participants watch five different scenarios of a laboratory demonstrator assisting students. The demonstrator plays out a number of different attitudes including aggression, impatience, and unpreparedness. After each scenario the participants discuss the positives and negatives of each approach, including the approach to answering questions, the behaviour and body language of the demonstrator, the body language and facial expressions of the students, and the overall effectiveness of the demonstrator. A sixth video consists of academic staff and previous laboratory demonstrators providing tips on their experiences. At the end of the video each participant selects the tip they liked best and explains to the group why they chose it.

The final stage of the School induction consists of examining the circuit used in the interview. This circuit is used to teach a range of techniques for fault identification, problem solving and the use of resources and questioning to enhance a students learning/understanding. The participants are also taught to break their help into stages, to enable them to assist multiple students concurrently. Finally, the participants are given time to work in pairs, practicing providing support.

C. Stage 3 - University Induction

The next stage of the training program is for the participants to attend a two-hour university-wide induction program that includes: 1) comprehensive coverage of all relevant aspects of teaching; 2) information about privacy, safety and equal opportunity; and 3) important aspects of campus life such as pay and facilities available across the campus. The university induction alone could not be considered a comprehensive training program [7], especially for laboratory demonstrators, hence the need for more in-depth training at the school/faculty level as indicated by this study.

D. Stage 4 – Online Training

The fourth stage of the training program is an online module designed to reinforce all the knowledge delivered in the school induction. The online content [45] is supported by an eLearning quiz via Moodle. The participants can repeat the eLearning quiz until they pass. A number of additional videos that reinforce preparation, laboratory introductions, tips and skills in answering student questions are also included. The resources available in the ‘Training Laboratory’ [41] are also used to provide the participants with skills on the use of laboratory equipment and software. In addition the Training Laboratory resource, also available to students, teaches

approaches to troubleshooting.

E. Stage 5 – Peer Review Training

The next stage of demonstrator development consists of on-the-job training with the Laboratory Manager. This training is carried out in a real laboratory class, typically a first or second-year laboratory in order to keep the concepts simple and generic. The purpose of this process is to build the confidence and exposure of the demonstrator gradually. This process usually runs for three or four laboratory classes. The first laboratory class is primarily run by the Laboratory Manager. The participants observe the process of running the class, providing an introduction, answering questions and marking. In particular they learn how the same question can be asked many different ways by students, and how all those questions can be answered using the same process. They also learn how to deal with non-academic questions such as students asking to swap classes, or having special needs.

When the participants have witnessed a number of student questions, they are given the opportunity to answer themselves. The Laboratory Manager listens to their answer and provides assistance when necessary. At the end of each laboratory class the Laboratory Manager provides feedback and if necessary activities to practice.

Over the following two or three laboratory classes the participants are gradually given more freedom to take control. The goal is that by the third or fourth laboratory the participant has enough experience, confidence and skill to run the laboratory independently. This process reinforces the findings in the literature, which identifies the most effective training as on-the-job practice with a focus on self-reflection [6]-[9].

At the end of the training process the participants are subjected to a student satisfaction survey (Section IV.F), whose results are used to provide a benchmark for further development. It is important to note that this survey does not indicate the effectiveness of the training program, as no survey is run before the participant commences the training program. However, the survey does indicate an individual’s level of teaching ability compared to all other sessional teachers as measured by the survey data. In effect the survey measures student satisfaction with the sessional teaching staff, but this does not necessarily equate to teacher quality.

If the demonstrator satisfactorily completes all stages of the training program, they are issued with laboratory demonstrator certification. Certification allows the casual teacher to apply for any future demonstrating positions. In the five years that the program has been in operation only three demonstrators have failed the program. The primary reason for this failure was the demonstrators’ lack of motivation to prepare appropriately for the experiments being taught. Their motivation to teach was to earn money rather than to have learning experience. Participants who fail can reapply for the program.

F. Stage 6 – Full Control, Quality Review Cycle

The development program continues by, at the end of each semester, measuring the demonstrators’ teaching performance

via student satisfaction surveys.

Approximately 400 student survey responses are received each semester. Demonstrator's performance scores are calculated from the weighted average of responses, on a 5-point Likert scale from "Strongly Disagree" (1) to "Strongly Agree" (5), to five questions:

- Question 1: At the start of each laboratory does the casual demonstrator give you a satisfactory introduction to the laboratory?
- Question 2: Is the casual demonstrator well prepared for the subject?
- Question 3: Does the casual demonstrator communicate the subject matter clearly?
- Question 4: Did the casual demonstrator appear interested in helping me to learn?
- Question 5: Is the casual demonstrator helpful in responding to questions or problems?

At the end of each semester each demonstrator meets with the Laboratory Manager to receive their survey results, discuss their teaching experiences and develop a plan to improve their performance for any following semesters. For example, demonstrators receiving: 1) a low communication score could be asked to attend an English conversation group or to undertake regular discussions with the Laboratory Manager; 2) a low introduction score could be asked to give their introduction to the Laboratory Manager for feedback before each scheduled class; and 3) a low helpfulness score could be given practice in answering questions before each scheduled class.

It can happen that a demonstrator's survey score may be lower than that of the previous semester, especially when that was a very high score. In such cases the lower score is taken in context and monitored. Should the survey score continue to fall to below an acceptable level, and additional support has been ineffective, employment opportunities are restricted primarily to marking rather than laboratory teaching.

The quality review process is complemented with a defined process that recognizes high performance and encourages high-performers to apply for university-level teaching awards. School-based special recognition and awards are used as incentives. In post-survey interviews with the Laboratory Manager demonstrator usually express their desire to increase their performance to obtain the recognition/awards. For example, in 2014 one of the School's high-performing sessional teachers won the sessional teacher category of the University of Wollongong Vice Chancellors' Outstanding Contribution to Teaching and Learning Award [46].

One form of recognition to high achieving demonstrators is tutor training. The tutor generally provides direct instruction to a tutorial class of between 15-30 students. Since student attention is very focussed on the teaching ability of the tutor, on tutor is paid at double the rate of a laboratory demonstrator. Firstly, potential tutors are required to attend a university-run 'Tips for Tutors' course. Upon completion of the course they are assigned to work on at least three tutorials with a permanent academic staff member. The first tutorial is to observe how the academic runs the class. The second tutorial

is run by the potential tutor with the assistance of the academic. Finally in the third tutorial the potential tutor runs the tutorial independently and is assessed by the academic to predetermined criteria. Success leads to tutorial certification. Surveys are not run on casual tutors.

G. Managing Quality

The training program is designed to develop sessional teachers to an acceptable standard. A number of additional measures are undertaken to maximise the survey results and the development of sessional staff. The most important measure is that the employment of sessional teaching staff is managed [39] using a centralized Laboratory Manager. This removes the 'who you know' element in the selection process, and allows the best people to be selected for the right job, and a more even distribution of workload. Another major benefit of this method of allocation is that in larger classes, junior sessional teachers are assigned with experienced sessional teachers to facilitate a transfer of knowledge in both teaching and subject knowledge.

Sessional teachers' level of preparation can highly influence student satisfaction. If the sessional teachers do not know the material, experiments or resources, students are quick to discredit the teacher. At the start of session, to ensure that the sessional teachers have prepared adequately and have had a briefing session with the subject coordinator, a 'preparation form' must be signed by the subject coordinator and returned to the Laboratory Manager before the first scheduled class. The signed form confirms that a briefing session has taken place, and that the subject coordinator is satisfied with the sessional teacher's preparation.

Table III: Student satisfaction (%) with sessional laboratory demonstrators, by year, showing the total change over the 5-year period.

| Year | Q1 | Q2 | Q3 | Q4 | Q5 | Average |
|--------|-----|-----|-----|-----|----|---------|
| 2009 | 71 | 82 | 79 | 83 | 83 | 80 |
| 2010 | 77 | 84 | 81 | 84 | 84 | 82 |
| 2011 | 81 | 88 | 85 | 87 | 88 | 86 |
| 2012 | 85 | 89 | 88 | 89 | 90 | 88 |
| 2013 | 87 | 91 | 89 | 91 | 91 | 90 |
| Change | 22% | 10% | 13% | 10% | 9% | 13% |

V. RESULTS

Student survey data indicates that student satisfaction with laboratory demonstrators increased over the five-year period. Their satisfaction with tutor's was not measured and thus cannot be compared. In 2009 the overall satisfaction with demonstrators was at 79.69%, and by 2013 it had increased to 89.74%, a 13% increase. Table III summarizes how the scores changed for the five survey questions over time.

Approximately 30 to 40 sessional demonstrators are hired and surveyed each session. Individual survey scores show that over time student satisfaction with the laboratory demonstrators is increasing; Table IV shows that the peak of the demonstrator score distribution shifted upwards each year.

A. Providing an Introduction

The survey question showing the largest improvement (22%) is the ability to provide a suitable introduction. In the trial survey conducted in 2007 one of the most common complaints was the lack of an introduction at the start of a laboratory class. This also features frequently in the dislikes about demonstrators listed by participants in the School's induction training. The Laboratory Manager observed that many of the sessional demonstrators did not feel comfortable in providing an introduction. The training program provides the experience for the demonstrator to provide the introduction and the survey question itself enforces that the introduction takes place.

Table IV: Percentage of demonstrators obtaining a score within a defined range by year: "Bolded figures are the peak of the annual score distribution"

| Score | 2009 | 2010 | 2011 | 2012 | 2013 |
|----------------------|------|------|------|------|------|
| 95-100 | 0% | 2% | 7% | 9% | 10% |
| 90-94.99 | 6% | 17% | 19% | 29% | 43% |
| 85-89.99 | 24% | 31% | 48% | 42% | 35% |
| 80-84.99 | 26% | 25% | 24% | 12% | 8% |
| 75-79.99 | 28% | 12% | 2% | 6% | 5% |
| <75 | 16% | 13% | 0% | 3% | 0% |
| Demonstrators | 18 | 28 | 36 | 42 | 33 |

B. Preparation

The perception of demonstrators' level of preparation increased by 10% over the five years, according to the survey data. The training program teaches the demonstrators that preparation includes: understanding the theory, knowing how to build/code/troubleshoot the experiments, knowing where to find the equipment/software and notes, understanding the assessment, and talking to the subject coordinator. The laboratory preparation form, Section IV.G, has also enforced the need to prepare.

C. Communication

Communication skills have seen the second largest (13%) improvement over the period, partly because weak communicators are eliminated at the interview stage. A further factor is that the training program focuses heavily on using inquiry-based questioning to guide the students to the information that they seek. As a result the demonstrator does less explaining and more guiding. Communication is also a skill that can be easily enhanced by practice.

D. Interest and Helpfulness

The final two survey questions relate to the demonstrators' interest and helpfulness in the laboratory; their scores have been closely linked over the five-year period. The training program emphasizes that the demonstrator must be constantly engaged with the students and always provide support, even when the students have not asked a question. This builds a relationship between teacher and student and shows that the demonstrator is interested in their education. Helpfulness is

used to ensure that the knowledge and skills possessed by the demonstrator can be transferred to the student. A demonstrator is deemed helpful if they can enhance the student's education by providing a transfer of knowledge.

E. Demonstrator Growth

The survey score only measures stage 6 of the program, the full control, quality review cycle in which the demonstrator works in a class, and thus does not show the growth that individual achieved between stages 1 and 5.

During the five-year period, 74 sessional teachers obtained demonstrator certification. Only 59 of these taught for more than one semester. The importance of stage 6 is that the demonstrators' effectiveness is constantly being monitored. There were eight instances during the five-year period where the individual's survey score trended down. Fig. 2 shows the average rate of improvement in individual scores compared to the number of semesters teaching, i.e. the teaching experience.

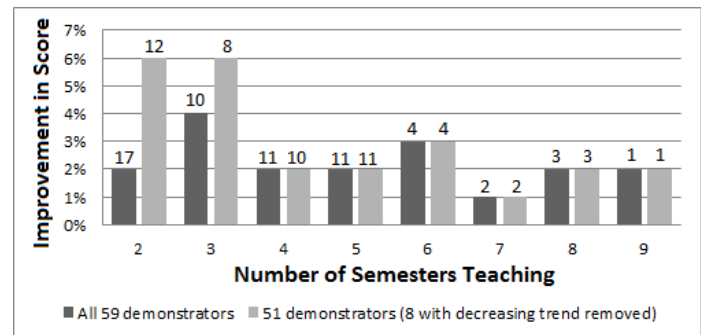


Fig. 2: Average improvement in demonstrator scores by semesters taught; numbers above histobars give number of demonstrators having taught that number of semesters

The data in Fig. 2 illustrates that the majority of improvement occurs in the first three semesters worked. The rate of improvement increases further if the eight individuals whose scores decreased are removed. This shows that some demonstrators struggle to adjust to teaching without the direct support of the Laboratory Manager to guide them. Individuals who have a decreasing score after three semesters are usually no longer employed, resulting in the convergence in growth rate from semester 4. This data reinforces the notion that on the job training with feedback [6]-[9], representing stages 5 and 6 of the training program, plays an important role in the development of teaching staff.

F. Effect of Repeating a Laboratory

There have been 39 instances of a sessional demonstrator re-teaching the same laboratory subject in another semester or year. In most cases, this repeat teaching would occur after a one-year interval, as the majority of subjects with laboratory classes are taught in only one semester per year. It is of interest to investigate if the feedback component of stage 6 was of particular benefit when repeating a subject.

Fig. 3 shows the average change in score for demonstrators repeating a subject one or more times. The data confirms a similar pattern to that found in Fig. 2 in that the average rate of growth improved at around 2%. This shows that the

feedback received in stage 6 provides support to the overall development of the sessional teacher, with the score not being significantly influenced by repeat teaching experience.

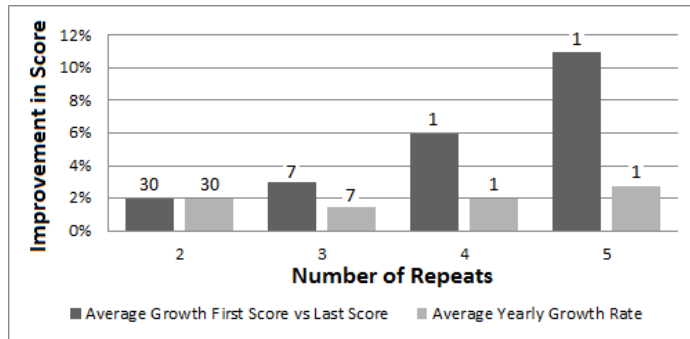


Fig. 3: Average change in satisfaction score for demonstrators repeat teaching a subject

VI. DISCUSSION, CONCLUSIONS AND FUTURE WORK

This paper has outlined a comprehensive six-stage process for training and for managing the performance of sessional teaching staff. The system of continuous improvement has led to a 13 percent increase in student satisfaction with sessional teaching staff over a five-year period. The satisfaction of sessional staff in regards to the training program also increased over the five-year period.

The training program uses social development [47] to scaffold the learning, providing less assistance over time. This process commences with direct learning via the induction sessions. Social learning [47] (imitation / modelling) is then integrated via the video scenarios, on-the-job training, partnering of junior and experienced demonstrators, and partnering with senior academics for tutoring. The end goal is that the sessional teachers will have multiple examples of good practice to work with, and the experience to work independently. The major risk is that the modelling is based on providing examples of good practice.

The social learning is complemented by operant conditioning [47] in that positive and negative reinforcement is guiding the sessional teaching staff to improve. For instance, low scores results in less work and high scores results in more work. The best example of this was the inclusion of a question about the laboratory introduction. Most demonstrators are uncomfortable with this task and did not do it; including a survey question on introductions forcing them to provide one, if they did not want a low survey score. Survey questions must thus focus on what outcomes are desired.

The operant conditioning is also used effectively by providing extra rewards to the best performers, such as prizes and awards. This increased competition between the sessional teachers. A major risk is that the sessional staff may be too lenient or give too much away in order to obtain a good survey result, but this has never been an issue.

In its successful practical applications, the training program implements the recommendations from the report on demonstrator training prepared by the Australian Council of Deans of Science [29], that states the need for better-trained demonstrators. This program can be modified to other science

or engineering departments needing to improve sessional teaching.

It has been very beneficial to have all the core training and administrative work conducted by one person, the Laboratory Manager; this individual should be within the discipline and have administrative and training skills. In this role, the first author of this paper has found *on-the-job training* with the casual staff to be a very valuable means to observe individual strengths and weaknesses, so as to be optimally place sessional staff in specific subjects and tailor their training accordingly.

The management structure is also very important, so that feedback can be delivered and career development encouraged. This has led to the important stage 6 results (quality control). Continuous improvement requires that the individual demonstrators self-reflect and find ways to improve their teaching. The 'preparation form' that forces the sessional teachers to prepare and meet with the subject coordinator is also a key management tool to ensure a successful teaching environment with sessional teaching staff.

This research also further reinforces the findings in the literature that the best training comes in the form of on-the-job practice with a focus on self-reflection [6]-[9]. This approach led most, although not all, sessional demonstrators to improve their teaching effectiveness. Future research would need to investigate what impact the improvement of sessional laboratory demonstrators had on laboratory satisfaction.

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