

More work for less reward

Academic perceptions of service teaching

Delma Clifton & Steve McKillup

CQUniversity

Service teaching, through which core courses or modules are provided by a department other than the one administering the degree, occurs in universities worldwide, but there have been many reports of student dissatisfaction with their service-taught courses. The experiences of service teachers have received little attention and may help to suggest strategies for improvement, so we surveyed service and discipline teachers from the science departments/faculties at Australian universities for their perceptions of the difficulty, the effect on the likelihood of promotion, and qualifications needed, for each type of teaching. Both service and discipline teachers perceived service teaching to be significantly more difficult, yet significantly less valuable for promotion, than discipline teaching. More research is needed to investigate whether these perceptions reflect the realities of service teaching because, if they do, they will have implications for university policies and workload models.

Keywords: service teaching, discipline teaching, academic attitudes, academic promotion, perceived value, curriculum integration

Introduction

Service teaching, defined as the situation when core courses or modules are provided by a different department to the one administering the degree (Brown & Atkins, 1988), is common in universities worldwide. For example, life scientists teach anatomy, physiology and pathophysiology to health science students (Clifton & McKillup, 2016); statisticians teach students in biology, agriculture, environmental science, psychology and business (Fawcett, 2017; Pollock & Wilson, 1976); economists teach economic theory to business and management students (Barrett, 2005); and historians teach students in education and journalism (Crotty & Eklund, 2006).

The advantages of service teaching include reducing the duplication of expertise, facilities, and courses; and exposing students to broader knowledge delivered by teachers who have appropriate depth and current understanding of the topic (Brown, White & Power, 2017; Gordon, Petocz & Reid, 2007; Pollock & Wilson, 1976). Service teaching is becoming more common due to the

expansion of profession-specific programs and declining enrolments in traditional generic disciplines such as arts and science (McInnis, 2000). In many departments, service teaching is an increasingly important source of funding that helps maintain academic positions: for some it provides over half of the income based on student load (Pollard *et al.*, 2006).

For the majority of Australian and international nursing programs, the science components have been service-taught (Logan & Angel, 2014), but there has been considerable debate about the effectiveness of service teaching of science (i.e. chemistry, microbiology, human anatomy, physiology and pathophysiology) to health science students in relation to graduate outcomes (Prowse & Heath, 2005; Prowse & Lyne, 2002), student satisfaction and perceptions of the value of service-taught courses (e.g. Friedel & Treagust, 2005; Gresty & Cotton, 2003; Jordan, Davies & Green, 1999; Ralph *et al.*, 2017). A good understanding of anatomy, physiology and pathophysiology underpins and is essential to professional practice, but the majority of studies have found that health science students are dissatisfied with their science

service courses (Craft *et al.*, 2013), often describing them as content heavy, frightening, and neither enjoyable nor valuable (Birks *et al.*, 2011; Dawson, 1994; McKee, 2002; Walker, 1994). This has led to calls to rethink how science is taught to health science students (e.g. Larcombe & Dick, 2003; McVicar, Andrew & Kemble, 2015).

However, there are some reports of health science students appreciating the importance and relevance of bioscience courses to their careers (e.g. Friedel & Treagust, 2005; Gresty & Cotton, 2003; Jordan *et al.*, 1999; Nicoll & Butler, 1996). Reporting on student satisfaction, Clifton and McKillup (2016) found their nursing students rated the three service-taught science courses in the top four of the 14 that comprised the first and second years of their degree and, from these results, suggested four strategies for successful service teaching. First, the teacher needed to have enough knowledge, commitment and confidence to develop and offer clear and conceptual explanations instead of excessive and often irrelevant detail. Second, they needed to see things from the student's perspective and start at an appropriate level, take advantage of prior student knowledge and experiences, and put concepts into the context of the service class. Third, they needed to provide well organised, quality teaching materials that catered for a range of learning styles. Fourth, it was important to communicate clear expectations, give detailed and prompt feedback, respect the diversity within classes and encourage interaction with students.

These strategies, and other recommendations (e.g. Brown & Atkins, 1988), suggest service teaching is more difficult and time-consuming than teaching into a program within one's discipline (henceforth referred to as 'discipline teaching'). First, service teaching requires a high level of ongoing consultation between the teacher and the recipient department. Second, the service teacher must design their teaching materials, explanations and presentation to cater for students who do not have a strong background, and often little interest, in the subject being taught (Pollock & Wilson, 1976). Third, they need to be able to integrate what they are teaching into the context of the external program (e.g. A physiologist teaching about respiratory physiology may have to be aware of the procedures used to assess and treat respiratory dysfunction in hospitals). Fourth, they may experience, and have to work to overcome, considerable initial hostility from students who have an aversion to, or even fear, the service topic (Pollock & Wilson, 1976).

If service teaching is more difficult, it may help explain why service-taught courses are often rated poorly by students because many service teachers may not appreciate

the extent of course development required or the level of prior knowledge of their students, nor be aware of the techniques needed to design, teach and maintain a relevant and effective service course. Even if they do, they may not have sufficient time or motivation for such development.

Previous studies have concentrated upon surveys of the recipients (i.e. students and recent graduates) to investigate their perceptions of service-taught courses. Feedback from the teachers who deliver service courses may also suggest strategies for improvement and we found it surprising that their perceptions and experiences had received very little attention, with no comparative studies of the perceptions of service and discipline teachers. Therefore, as an initial step, we surveyed service and discipline teachers employed in the science faculties of Australian universities for their perceptions of service and discipline teaching, including the relative difficulty of each, the qualifications required and how well each type of teaching is valued for promotion.

Methods

Participants

A survey was circulated by email to 37 Deans of Science in Australia with a request to forward it to their staff. We used a web-based survey as an efficient and inexpensive way of reaching as many staff in as many different institutions as possible. To ensure the introduction to the survey did not bias responses, potential participants were only told that the purpose of the research was to examine the attitudes of science academics towards service and discipline teaching. All responses were voluntary and confidential. The survey had low-risk ethics approval from our university (number H13/06-107).

Data

The 18 survey questions and their set response ranges are shown in Table 1. Since the survey was designed to provide comparative data for service and discipline teachers which may be confounded by differences in teaching experience, gender and academic level between these two groups, respondents were asked to give the number of years they had worked as an academic, their current academic level, highest academic qualification and whether they held a teaching qualification (questions 1 - 9). These were followed by questions 10 - 15 that were designed to compare the perceptions of service and discipline teachers of both types of teaching in relation to the qualifications needed, difficulty of the work and how it may affect a person's likelihood of being

Table 1. Questions asked in an anonymous survey of science academics in Australian universities and the set range of responses for each.

Question	Response range
(1) Are you female or male?	1 = female, 2 = male
(2) At which university do you work? ##	1 – 13 where 1 = ACU, 2 = CQU, 3 = CDU, 4 = ECU, 5 = GU, 6 = SCU, 7 = UA, 8 = UNE, 9 = UQ, 10 = USyd, 11= UTS, 12 = USC 13 = CSU
(3) How many years have you been an academic?	1 – 4 where 1 = 0-5, 2= 6-10, 3=11-15, 4 = >15
(4) What is your academic level?	1 – 5 where 1 = A (Associate Lecturer), 2 = B (Lecturer), 3 = C (Senior Lecturer), 4 = D (Associate Professor), 5 = E (Professor).
(5) What is the highest level of education you have completed?	1 – 5 where 1 = PhD, 2 = Masters by research, 3 = Masters by coursework, 4 = Honours, 5 = Bachelor
(6) What teaching qualifications have you completed?	1 – 5 where 1 = Cert IV, 2 = GC or GD, 3 = Bachelor, 4= Higher degree, 5 = None
(7) Do you have any teaching qualification?	1 = yes, 2 = no
(8) Does your school/department offer service teaching of science (e.g. chemistry, anatomy, physiology, pathophysiology, pharmacology for programs such as a Bachelor of Nursing)?	1 = yes, 2 = no
(9) Do you teach science courses for other programs (e.g. A Bachelor of Nursing?)	1 = yes, 2 = no
(10) How difficult is it to teach science to science students?	1 – 5 where 1 = Very easy, 2 = Easy, 3 = Average, 4 = Difficult, 5 = Very difficult
(11) What level of qualification is necessary to teach science to science students?	1 – 5 where 1 = PhD, 2 = Masters by research, 3 = Masters by coursework, 4 = Honours, 5 = Bachelor
(12) How well regarded is teaching science to science students for academic promotion at your institution?	1 – 5 where 1 = Very low, 2 = Low, 3 = Neutral, 4 = High, 5 = Very high
(13) How difficult is it to teach science to non-science students such as nursing students?	1 – 5 where 1= Very easy, 2 = Easy, 3 = Average, 4 = Difficult, 5 = Very difficult
(14) What level of qualification is necessary to teach science to non-science students such as nursing students?	1 – 5 where 1 = PhD, 2 = Masters by research, 3 = Masters by coursework, 4 = Honours, 5 = Bachelor
(15) How well regarded is teaching science to non-science students such as nursing students for academic promotion at your institution?	1 = Very low, 2 = Low, 3 = Neutral, 4 = High, 5 = Very high
(16) In my school/department service teaching is used to 'top up' science staff workloads.	1 – 5 where 1 = Strongly disagree, 2 = Disagree, 3 = Neutral, 4 = Agree, 5 = Strongly agree
(17) In my school/department active researchers are not required to do service teaching.	1 – 5 where 1 = Strongly disagree, 2 = Disagree, 3 = Neutral, 4 = Agree, 5 = Strongly agree
(18) I would be likely to apply for a job in which a major component of the workload was service teaching.	1 – 5 where 1 = Strongly disagree, 2 = Disagree, 3 = Neutral, 4 = Agree, 5 = Strongly agree

ACU = Australian Catholic University; CQU = Central Queensland University; CDU = Charles Darwin University; ECU = Edith Cowan University; GU = Griffith University; SCU = Southern Cross University; UA = University of Adelaide; UNE = University of New England; UQ = University of Queensland; USyd = University of Sydney; UTS = University of Technology, Sydney; USC = University of the Sunshine Coast; CSU = Charles Sturt University.

promoted. Then each respondent was asked to give their perceptions of the administration of service teaching in their department/school and whether they would be likely to apply for a service teaching position. Finally, respondents were invited to submit a free text comment in answer to the question ‘Would you like to make any other comment about service teaching in universities?’.

Data analysis

Data were analysed with SPSS version 25 (IBM Corp., Armonk, New York 2017). All ordinal scale data showed no significant heteroscedasticity or lack of normality, so were analysed with parametric tests: either single factor ANOVAs, two factor repeated-measures ANOVAs or single

sample t tests. For all analyses $p < 0.05$ was considered significant.

Results

The profiles of service and discipline teachers

We received responses from 136 academics, of which 40 per cent were female and 60 per cent male, at 13 universities. Most respondents (106) belonged to departments or schools that conducted service teaching and approximately half (62) were service teachers. The universities were a mix of older and more-recently established, city and regional, and included research-focussed and teaching-intensive institutions.

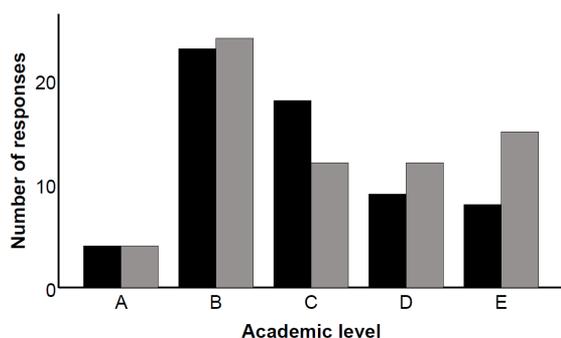


Figure 1. *The number of responses received against academic level for service teachers (black bars) and discipline teachers (grey bars).*

Ten respondents did not specify whether they were service or discipline teachers and were excluded from all analyses. Almost equal proportions of female (47.5 per cent) and male staff (52.5 per cent) were service teachers and the gender ratio did not differ significantly between service and discipline teachers (Fisher exact test, $p = 0.068$). There was no significant difference between the distributions of the academic levels of service and discipline teachers (Fisher exact test, $p = 0.463$) (Figure 1), the mean number of years spent teaching (single factor ANOVA: $F_{1,127} = 1.036$, NS) or the mean highest academic qualification (single factor ANOVA: $F_{1,125} = 0.317$, NS).

Although a greater proportion of service teachers (53.6 per cent) had a teaching qualification compared to discipline teachers (35 per cent) this difference was not significant (Fisher exact test: $p = 0.065$). For those with a teaching qualification there was no difference in the proportions of each type of qualification between service and discipline teachers (Fisher exact test: $p = 0.640$).

Perceptions of service and discipline teaching

Respondents gave their perceptions of the difficulty of teaching science to science students and science to non-science students; how each teaching type was regarded for promotion; and the academic qualification required to teach each. These three sets of dependent data were analysed as two factor repeated measures ANOVAs with the between-subjects factor whether the person was a service or discipline teacher, and the two types of teaching (i.e. science to science students and science to non-science students) the within-subjects (repeated measure) factor.

Teaching science to non-science students was perceived as significantly more difficult than science to science students ($F_{1,111} = 52.041$, $p < 0.001$). There was no significant difference between the perceptions of service and discipline teachers ($F_{1,111} = 1.712$, NS) and no interaction between the two factors ($F_{1,111} = 0.200$, NS) (Figure 2). The mean difficulty scores given by service and discipline teachers, respectively, for service teaching were 3.48 and 3.38, while for discipline teaching they were lower: 2.95 (by service teachers) and 2.77 (by discipline teachers) (Figure 2). On the response scale of 1 - 5, where 3 was average, (Table 1), discipline teaching was rated as having slightly below average difficulty while service teaching was rated between 'average' and 'difficult'.

The perceived difficulties of teaching a service course and a discipline course were also compared between respondents who held a teaching qualification and those who did not. There was no significant difference in the perceptions of teaching difficulty by these two groups (two factor repeated measures ANOVA: $F_{1,104} = 0.007$, NS) so the possession or lack of a teaching qualification had no effect on the perceived difficulty of either service or discipline teaching. Here too, however, both

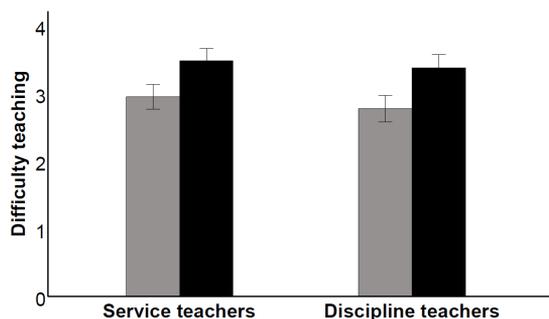


Figure 2. *The perceptions of service and discipline teachers of how difficult it is to teach science to science students (grey bars) and science to non-science students (black bars).*

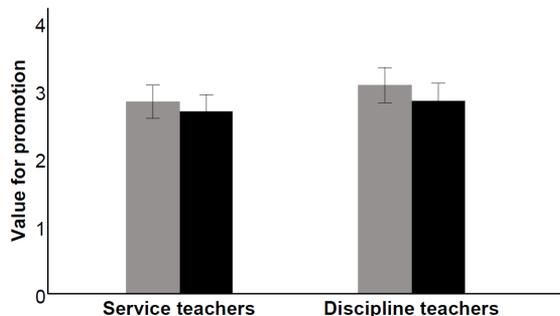


Figure 3. The perceptions of service and discipline teachers of the value for academic promotion of teaching science to science students (grey bars) and science to non-science students (black bars).

groups perceived service teaching to be significantly more difficult than discipline teaching ($F_{1,104} = 45.98, p < 0.001$) and this perception was consistent between groups (interaction $F_{1,104} = 0.028, NS$).

Teaching science to non-science students was perceived as significantly less valuable for promotion than teaching science to science students ($F_{1,108} = 7.437, p < 0.01$). Here too, there was no significant difference between the perceptions of service and discipline teachers ($F_{1,108} = 1.486, NS$) and no interaction between the two factors ($F_{1,108} = 0.472, NS$) (Figure 3). Service teaching was given a mean value for academic promotion of 2.69 by service teachers and 2.85 by discipline teachers, both of which are between 'low' and 'neutral' for the scoring system used (Table 1). The perceived promotional value of discipline teaching was consistently higher with a mean of 2.83 (but still between low and neutral) by service teachers and 3.08 (very slightly above neutral) by discipline teachers.

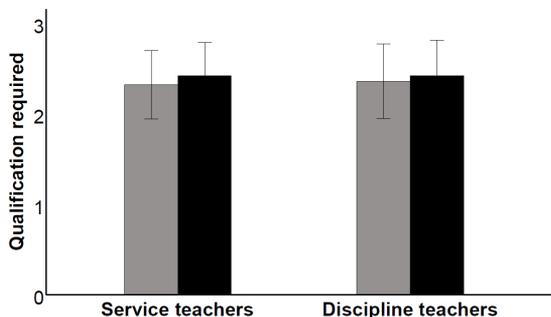


Figure 4. The perceptions of service and discipline teachers of the academic qualification required to teach science to science students (grey bars) and science to non-science students (black bars).

There was no significant difference in the qualification level considered necessary to teach science to science students compared to non-science students ($F_{1,107} = 1.049, NS$), no difference between the perceptions of service and discipline teachers ($F_{1,107} = 0.004, NS$) and no interaction between the two factors ($F_{1,107} = 0.070, NS$) (Figure 4).

Perceptions of the administration of service teaching

For each of the last three questions (16 - 18) we used single factor ANOVA to examine the relationship between the response to the question (coded as 1 - 5 on the Likert scale: Table 1) by service and discipline teachers.

The responses to question 16 'In my school/department service teaching is used to 'top up' science staff workloads' showed no significant difference between service and discipline teachers ($F_{1,110} = 0.202, NS$). A single sample t test comparing the combined mean response of 2.88 for both service and discipline teachers to an expected mean of 3.0 corresponding to 'Neither agree nor disagree' was not significant ($t_{111} = 1.07, NS$).

For question 17 'In my school/department active researchers are not required to do service teaching' there was no significant difference in the mean response between service and discipline teachers ($F_{1,111} = 2.50, NS$). A single sample t test comparing the mean (2.48) of all respondents to an expected mean of 3.0 (i.e. neither agree nor disagree) showed that active researchers were also required to service teach in that there was significant disagreement with the statement in question 17 ($t_{112} = 5.31, p < 0.001$) (Figure 5).

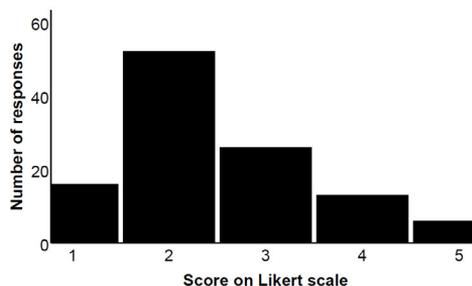


Figure 5. The number of responses for each category on the Likert scale (1= Strongly disagree, 2= Disagree, 3=Neutral, 4= Agree, 5= Strongly agree) to the statement 'In my school/department active researchers are not required to do service teaching'. The mean of the distribution is significantly less than a neutral response of 3.

Perception of the desirability of a service teaching position

The response to 'I would be likely to apply for a job where a major component of the workload was service teaching' showed no significant difference between teacher type ($F_{1,113} = 2.50$, NS) nor a significant difference between the mean response to the question by all respondents and an expected mean of 3.0 (neither agree nor disagree) (single sample t test, $t_{114} = 0.690$, NS).

Discussion

This appears to be the first report of the perceptions of service and discipline teachers about the relative difficulty, promotional value and qualifications needed for these two types of teaching. Our samples of service and discipline teachers appeared comparable in that they did not differ significantly in the proportions at each academic level, gender, whether they had a teaching qualification, the level of teaching qualification, years spent teaching, or highest academic qualification.

Perceptions of service and discipline teaching

Both service and discipline teachers perceived science service teaching to be significantly more difficult than science discipline teaching and both groups had extremely similar perceptions of the difficulty of each teaching type. Five of the 55 free text comments emphasised that service teaching is difficult because students have not chosen to study the service topic and are less prepared than discipline students, as noted by Pollock and Wilson (1976).

Both types of teacher perceived science service teaching as being significantly less valuable for promotion than science discipline teaching. Here too, the perceived difference between the two teaching types was consistent between groups. The reason why service teaching was considered less valued for promotion may be because most service teaching is in first and second year of an undergraduate degree, whereas discipline teaching occurs across all three years and is therefore seen as being of 'higher level' and of greater value and importance: five of the 55 free-text comments were that service teaching is regarded as less important than discipline teaching. Discipline teaching can also provide an opportunity for the teacher to showcase their research to students within their own discipline, thereby attracting future postgraduates who are likely to contribute to research output, which may increase the teacher's likelihood of promotion. It is notable that teaching, in general, was perceived as having little value for promotion (with near-

neutral scores assigned to both service and discipline teaching) and seven of the 55 free response comments were that university teaching was given little recognition compared to research. This is a common perception worldwide (e.g. French & O'Leary, 2017).

All teaching shows some degree of instructor-specific student satisfaction, but this may be accentuated in service classes where students have no interest in the topic and see it as an unpleasant hurdle to overcome as part of their study. Only three of the 55 free responses to our survey reported that service teaching was enjoyable: we suspect they were from academics who had the time, skills and personalities to be able to engage with their service students. For example, for the service teaching of statistics, Pollock and Wilson (1976, p. 248) emphasise that 'far more than with specialist students the service course lecturer has to be showman and salesman as well as teacher'. A basic and essential tenet of good teaching is the contextualisation of course content to make it relevant to students, but even a service teacher who is extremely knowledgeable may be unfamiliar with the application of the material they are teaching in the program taken by their service students.

Furthermore, it is not uncommon for universities to offer one service course to students from several different programs (e.g. engineering, psychology, environmental science and biomedical science students taking the same service course in introductory statistics) but this is likely to make it even more difficult and time-consuming for an instructor to contextualise the material and engage with such a diverse class. Service-taught classes are often much larger than those in science disciplines and therefore have the potential to greatly affect the reputation of a department and university if they are taught badly: they cannot be taken for granted and should be taught by experienced, capable and committed staff.

There was no significant difference between service and discipline teachers of the perceived level of academic qualification (i.e. from A to E) needed to teach science to science students and science to non-science students. This is not surprising considering that most academic qualifications above bachelor level are based on research, which may have little to do with the ability to teach. The free responses were consistent with this: seven noted that having teachers who engage with their students and make material relevant was more important than specifying a certain level of qualification needed to teach.

Taken together, the perceptions of greater teaching difficulty and less value for promotion are of concern because they suggest service teachers are disadvantaged

compared to discipline teachers, but further research is needed to investigate whether these perceptions reflect reality: do service teachers have a greater workload per student and are they less likely to be promoted? If they do reflect reality then, for the same number of students, a service teacher may have a higher workload, experience greater levels of stress and have less time for research. Furthermore, the perception that service teaching is significantly less valued for promotion may reduce the self-esteem of service teachers and affect their attitude towards their students. We received responses from 13 Australian universities: further research is also needed to establish whether these perceptions of service teaching are more widespread. We have only considered service and discipline teaching in science: it would also be useful to investigate whether staff in other fields (e.g. economics, psychology, statistics) have similar perceptions of service teaching.

Perceptions of the administration of service teaching

For the administration of service teaching there was no evidence it was being used to 'top up' staff workloads and there was significant disagreement with the statement that active researchers are not required to do service teaching. As we noted earlier, there has been an expansion in profession-specific courses and a decline in enrolments in traditional courses such as arts and science, so service teaching is increasingly important to maintain academic positions in science departments, resulting in increased student to staff ratios and academics being expected to spend more time teaching. The widespread adoption of formula-based workload calculations, which often differ greatly among departments and institutions but are usually heavily dependent on the number of students taught, also means that researchers are increasingly likely to be asked to teach.

Despite the poor perceptions of service teaching, the response to the statement to 'I would be likely to apply for a job where a major component of the workload was service teaching' was neutral. It may reflect the current shortage of available academic positions in Australia so that even a service teaching position is desirable.

Conclusion

More research is needed to establish whether the perceptions that science service teaching in Australian universities is more difficult, and less valued for promotion, reflect reality. If they do, then staff who teach

service courses are likely to need more time per enrolled student and perhaps even the opportunity for industry experience to help them integrate what they teach with the program they are servicing and to use examples their students can identify with, as well as assistance in developing teaching materials and techniques to help them successfully engage with service classes. These recommendations, from our survey of tertiary teachers, are congruent with those from student and graduate perceptions of service teaching which also emphasise the need for more collaboration between the service teacher and staff in the recipient department to achieve better integration of service content (e.g. Larcombe & Dick, 2003; Ralph *et al.*, 2017; Wynne, Brand & Smith, 1997). More research is also needed on the staff perceptions and realities of service teaching in other fields. If service teaching is found to be more difficult and time-consuming than discipline teaching, it will need to be recognised and accounted for in institutional workload planning and assessment of applications for promotion, to ensure service teachers are given adequate support and gain appropriate recognition for their work.

Disclosure statement

No potential conflict of interest was reported by the authors.

Acknowledgements

We thank two anonymous reviewers whose comments improved the manuscript.

Delma Clifton is Academic Lead – Scholarship of Learning and Teaching and an Associate Professor in the School of Health, Medical and Applied Sciences at CQUniversity, Queensland, Australia.

Steve McKillup is from the Audit and Advisory Directorate in the Vice-Chancellor & President Division, Rockhampton North Campus, CQUniversity.

Contact: s.mckillup@cqu.edu.au

References

- Barrett, S. (2005). Addressing the problem of service teaching introductory economics subjects. *International Education Journal* 5(5), 152–165.
- Birks, M., Cant, R., Al-Motlaq, M., & Jones, J. (2011). I don't want to become a scientist: undergraduate nursing students' perceived value of course content. *Australian Journal of Advanced Nursing* 28, 20–27.

- Brown, G., & Atkins, M. (1988). *Effective teaching in higher education*. London, Routledge Publishers.
- Brown, S.J., White, S., & Power, N. (2017). Introductory anatomy and physiology in an undergraduate nursing curriculum. *Advances in Physiology Education* 41, 56–61.
- Clifton, I.D., & McKillup, S.C. (2016). Why such success?: Nursing students show consistently high satisfaction with bioscience courses at a regional university. *Australian Journal of Advanced Nursing*, 33, 21-28.
- Craft, J., Hudson, P., Plenderleith, M., Wirihana, L., & Gordon, C.J. (2013). Commencing nursing students' perceptions and anxiety of bioscience. *Nurse Education Today* 33, 1399–1405.
- Crotty, M., & Eklund, E. (2006). History as service teaching: possibilities and pitfalls. *History Australia* 3, 47.1–47.10.
- Dawson, P. (1994). Contra biology: a polemic. *Journal of Advanced Nursing* 20, 1094-1103.
- Fawcett, L. (2017). The CASE Project: Evaluation of Case-Based Approaches to Learning and Teaching in Statistics Service Courses. *Journal of Statistics Education*, 25, 79–89.
- French, A., & O'Leary, M. (2017). *Teaching Excellence in Higher Education: Challenges, Changes and the Teaching Excellence Framework*. Bingley, UK. Emerald Publishing Limited.
- Friedel, J.M., & Treagust, D.F. (2005). Learning bioscience in nursing education: perceptions of the intended and the prescribed curriculum. *Learning in Health and Social Care* 4, 203-216.
- Gordon, S., Petocz, P., & Reid, A. (2007). Teachers' conceptions of teaching service statistics courses. *International Journal for the Scholarship of Teaching and Learning* 1, 1-14
- Gresty, K.A., & Cotton, D.R.E. (2003). Supporting bioscience in the nursing curriculum: development and evaluation of an online resource. *Journal of Advanced Nursing*, 44, 339–349.
- Jordan, S., Davies, S., & Green, B. (1999). The biosciences in the pre-registration nursing curriculum: staff and students' perceptions of difficulties and relevance. *Nurse Education Today*, 19, 215–226.
- Larcombe, J., & Dick, J. (2003). Who is best qualified to teach bioscience to nurses? *Nursing Standard*, 17, 38–44.
- Logan, P.A. & Angel, L. (2014) Exploring Australian Undergraduate Pre-registration Nursing Curricula: Where do Science Subjects Fit? *Journal of Learning Design*, 7 (2), 62-84.
- McInnis, C. (2000). Changing academic work roles: the everyday realities challenging quality in teaching. *Quality in Higher Education*, 6, 143–152.
- McKee, G. (2002). Why is biological science difficult for first year students? *Nurse Education Today*, 22, 251–257.
- McVicar, A., Andrew, S., & Kemble, R. (2015). The 'bioscience' problem for nursing students: An integrative review of published evaluations of year 1 bioscience, and proposed directions for curriculum development. *Nurse Education Today*, 35, 500–509.
- Nicoll, L., & Butler, M. (1996). The study of biology as a cause of anxiety in nursing students undertaking the common foundation program. *Journal of Advanced Nursing*, 24, 615-624.
- Pollard, J., Sharma, M., Mills, D., Swan, G., & Mendez, A. (2006). Physics Education for Australia. *Australian Physics*, 43, 20–26.
- Pollock, K.H., & Wilson, I.M. (1976). Statistics Service Teaching in Universities. *Journal of the Royal Statistical Society Series D* 25, 247-252.
- Prowse, M. A., & Heath, V. (2005). Working collaboratively in health care contexts: The influence of bioscientific knowledge on patient outcomes. *Nurse Education Today*, 25, 132–139.
- Prowse, M. A., & Lyne, P.A. (2002). Revealing the contribution of bioscience based nursing knowledge to clinically effective patient care. *Clinical Effectiveness in Nursing*, 4, 67–74.
- Ralph, N., Birks, M., Cant, R., Chun Tie, Y., & Hillman, E. (2017). How should science be taught to nurses? Preferences of registered nurses and science teaching academics. *Collegian* 24, 585–591.
- Walker, K. (1994). Confronting 'reality': nursing, science and the micro-politics of representation. *Nursing Inquiry* 1, 46–56.
- Wynne, N., Brand, S., & Smith, R. (1997). Incomplete holism is pre-registration nurse education: the position of the biological sciences. *Journal of Advanced Nursing* 26, 470–474.