

DOES MARCEL MARCEAU HAVE A PLACE IN THE CHEMISTRY LABORATORY?

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KEYWORDS: chemistry, laboratory, peer led team learning, peer teaching, scientific literacy

ABSTRACT

A flood resulted in the Chemistry laboratories being unavailable for the last 5 weeks of teaching. Alternative peer led student learning strategies were developed to deliver the learning outcomes. The first strategy required students to video the last practical they performed before the flood 'Marcel Marceau' style without reagents, but narrating what they did. The following week students interviewed each other about their videoed practical. Fifty one percent of students felt the videos clarified 'new knowledge', while 76% either agreed or strongly agreed that they were able to identify glassware, equipment and instrumental or 'hands on' technique. Eighty one percent of students indicated that they would have viewed the video before their practical class if they were available. The second strategy required students to teach the application of a scientific concept to lay adults. Seventy nine percent of students felt that they understood the concept better after explaining it to an adult. While nothing can replace the 'hands on' experience that students gain in the laboratory, an alternative student centred learning approach incorporating peer teaching through producing laboratory videos and teaching lay adults resulted in deep learning. Student feedback suggested these activities could be incorporated into future courses.

Proceedings of the 16th UniServe Science Annual Conference, University of Sydney, Sept 29th to Oct 1st, 2010, pages 92-97, ISBN Number 978-0-9808597-1-3

INTRODUCTION

Considerable research into the qualitative and quantitative outcomes for higher education of peer assisted learning and peer teaching has emerged since the 1970s. The terms peer assisted learning and peer teaching are used interchangeably across the literature and are inconsistently defined. The terms are related to a variety of settings including teacher assisted schemes, peer mentoring and 'near-peer' and 'co-peer' teaching, where peer learners may be one or more students. An extensive literature review on peer teaching and peer learning research has been published by Topping (1996). This review however, draws almost exclusively on research into the implementation of 'peer led team learning' (PLTL) strategies. In PLTL, the student replaces the professional instructor in a class setting and peer teachers his or her co peers in selected aspects of the curriculum. The benefits of peer teaching and learning are typically categorised in the literature under the headings of pedagogic, socio-psychological and structural.

A PEDAGOGIC APPROACH TO PLTL

Improved academic achievement of students in targeted curriculum areas is widely employed as a measure of success for PLTL as a pedagogic strategy in educational institutions (Goldschmid & Goldschmid, 1976; Topping, 1996, 2005; Whitman, 1988). A recent PLTL case study in tertiary chemistry programs has measured improvements in students' academic performance in those courses and observed increased course retention rates where there has traditionally been a significant drop out rate (Lloyd, 2010; Stewart, Amar & Bruce, 2007; Tien, 2007). Students gain from peer teaching exercises because it requires much greater focus on the curriculum content. Students must plan to teach specific material and, therefore, must organise the content in such a way that it can be clearly communicated. This results in both increased cognitive repetition and deeper insight (Goldschmid & Goldschmid, 1976; Nichols, 1994; Topping, 2005; Whitman, 1988). To teach is to learn twice. The act of verbalising is more effective in reinforcing learning than merely preparing to teach (Whitman, 1988) and the obligation to teach, as opposed to merely presenting information to a passive audience, generates even greater cognitive demands and, ultimately, benefits for the peer teacher (Topping, 2005).

Learners also achieve more through being taught through their peers (Cate & Durning, 2007; Whitman, 1988) This appears to be because of the cognitive proximity between them. Although difficult to quantify these benefits, it has been observed that learners come to a greater understanding and retention of subject matter because peer teachers are able to explain and discuss concepts at an

appropriate level (Whitman, 1988). The social constructivist paradigm presents learning as an interaction between social and individual processes. Accordingly, PLTL increases cooperation and collaboration partly because peers are less threatening than expert instructors and also because they have a shared lexicon (Cate & Dunning, 2007; Whitman, 1988). The corollary of this is less competition between individuals within the group and less isolation of individuals, resulting in greater sharing of ideas and discussion between students, which enhances understanding and stimulates the processes – all of which is translated by learners into usable knowledge (Tien, Roth & Kampmeier, 2007; Whitman, 1988).

SOCIO-PSYCHOLOGICAL BENEFITS

The socio-psychological benefits of PLTL were largely qualitative and measured through self-reporting by individual students or by observation of students by their supervising staff. The benefits for both peer teachers and learners where a PLTL approach or some permutations of PLTL have been implemented are variously reported across the wide range of disciplines. Benefits cited include, higher levels of understanding, improved motivation to study, greater self confidence and self esteem and enhanced communication skills. (Assinder, 1991; Cate & Dunning, 2007; Depaz & Moni, 2008; Goldschmid & Goldschmid, 1976; Lloyd, 2010; Moni, Hryciw, Poronnik & Moni, 2007; Stewart et al., 2007; Tien et al., 2007; Topping 2005; Whitman, 1988). Developed or improved leadership skills have also been cited as a positive outcome (Assinder, 1991; Cate & Dunning, 2007; Depaz & Moni, 2008; Goldschmid & Goldschmid, 1976; Lloyd, 2010; Moni et al., 2007; Tien et al., 2007; Topping, 2005).

Nicholls (1994) cites that issues experienced by expert instructors such as learner passivity or inattentiveness can still persist between learners and peer teachers. These issues impact on the experience of both the peer teacher and learner with regard to perceptions of competence, relatedness and autonomy (Cate & Dunning, 2007).

STRUCTURAL BENEFITS OF PLTL

The use of PLTL is a strategy that not only potentially benefits students, but may also benefit the educational institution by alleviating teaching pressures, which have increased logistical challenges as class sizes expand without accompanying increases in staff or other resources (Cate & Dunning, 2007; Stewart et al., 2007). A PLTL approach, however, is not without its own resource demands. The extent to which the expert teacher may be required to supervise and have input into training for peer teachers will vary depending on how PLTL is implemented and structured (Goldschmid & Goldschmid, 1976).

PEER LED TEAM LEARNING

Although most research reports positive outcomes from the use of PLTL, not all research reports an unqualified success. Persky and Pollack (2009) studied implementation of a peer teaching approach combined with a problem based learning approach to teach selected curriculum of a pharmacokinetic course to second year Pharmacy students. Students reported negative attitudes to the learning experience, and performance in the course was not observed to improve (Persky & Pollack, 2009). Sprat and Leung (2000) reported similar difficulties with a 'Legal and Documentary English' course which formed part of a final year program in translation and Chinese. Reduced levels of performance were observed in the students, while the students themselves reported feeling less motivated and confident. Sprat and Leung (2000) attributed the negative outcomes to study design and implementation issues.

PLTL approaches have been applied in a diverse range of educational contexts with an even broader variety of designs. Some studies have involved small teams of as few as three students (Depaz & Moni, 2008; Persky & Pollack, 2009) deliberately selected (and mixed) on the basis academic performance, while other studies have used much larger groups of 20 students or more, which represent groups of mixed abilities (Lloyd, 2010; Stewart et al., 2007; Tien et al., 2007). Some studies recommended or included training for peer teachers (Tan Tee Hwa, 2009; Tang, Hernandez & Adams, 2004; Tien et al., 2007), while other studies have tied the PLTL approach with the use of web technology (Ross & Cameron, 2007; Stewart et al., 2007; Tan Tee Hwa, 2009).

CONTEXT OF THE STUDY

On September 21st, 2009, the Reid building which houses the chemistry laboratories for the Pharmacy and Medical Sciences programs at University of South Australia was flooded. Students had five remaining 3 hour practical sessions to complete as part of a 13 week round robin practical series for a Chemistry course prior to the flood. Given that the laboratory practical class rooms lacked power, water and drainage, other strategies needed to be implemented to achieve the learning outcomes. This paper will focus on two peer led strategies which were implemented to bridge this gap and replace the practical classes; Marcel Marceau (Salm, 2007) chemistry which involved miming and videoing the last practical performed before the flood and secondly conveying a key concept learnt during the course to an adult from a non scientific background which was also filmed.

METHODS

Students enrolled in the second year food chemistry laboratory classes within the Nutrition and Food Science program were unable to complete their laboratory program due to a flood. Two key strategies to replace the practical sessions are outlined in this paper.

The first of these strategies was 'Marcel Marceau chemistry' (named after the famous mime artist (Salm, 2007)). The students worked in pairs and were asked to 'act out' the last practical they performed in the rotation using the correct glassware and other equipment, but without reagents, gas or water. The students were required to narrate precisely what they had done detailing both the technique and reaction outcomes. This process was filmed by a staff member and put on the web for other students in the class to view. There was a three week delay between actually performing the last practical in the rotation and filming the 'Marcel Marceau' (Salm, 2007) version. The following week students were given the opportunity to view the videos and to 'interview' their classmates to seek clarification where required. Students were surveyed via a paper based survey during week 11 of the course to find out what they thought of the videos. The feedback was grouped and analysed. Given that students were unable to produce the normal practical portfolio, students were examined through formative questions on all 13 practicals and two of the experiments were assessed in their final exam. Students were not given options in the final exam and hence were unable to avoid the laboratory based questions.

The second strategy required the students to individually choose a concept from any part of the course, apply it to an 'everyday situation' and teach the concept and application to an adult from a non-science background. This activity was performed individually and videoed via their mobile phone or camera. Students were required to produce a video of 10 - 15 minutes length in which they could demonstrate both strategies as a teacher and evidence that the learner was gaining some understanding of the concept being taught. Lay adults were given a written questionnaire to provide an independent evaluation of their learning experience which was posted back to the lecturer in a reply paid envelope. The feedback was grouped and then analysed. As students varied in their choice of key concept, not all the concepts chosen for this activity were examined in the final exam. Assessment was based on how well the concept was applied to an every day setting and later explained, the level of understanding gained by the lay adult (both assessed from the video) and feedback from the adult via the questionnaire.

RESULTS

Seven male and 21 female students studying Nutrition and Food Sciences were enrolled in a second year chemistry course. Ninety six percent of the students were less than 25 years old. Furthermore, 65% of students scored a credit or better for their first year chemistry courses.

Given that students were unable to produce the normal practical portfolio, students were examined through formative questions on all 13 practicals. Two exam questions focused on the practicals; 82% of students achieved a minimum of 80%. In the previous year only 61% of students achieved a minimum of 80% for similar laboratory based questions with a slightly lower weighting (13% vs. 16% for 2009 vs. 2008 respectively; n=35).

Each activity was surveyed. Students consistently reported that they valued the opportunity to construct the knowledge through the student centred activities. Student feedback on performing the 'Marcel Marceau' videos included, "*This activity forced me to understand the techniques and chemical*

reactions well enough to teach others”, “*developed my team work skills*”, “*improved my communication skills*” and “*it made me feel great and really boosted my confidence as I did really think I wasn't very good at chemistry*”. Students cited drawbacks as “*their voice was squeaky on the video*” and “*nerves*”.

Students reported that they gained significantly from watching other students on video complete the practical activities that they were not able to perform themselves. All students reported watching all of the ‘Marcel Marceau’ video sessions (including the video they performed themselves) with 36% reporting a decreased feeling of intimidation in learning from their peers. A further 51% felt the videos clarified ‘new knowledge’, while 76% either agreed or strongly agreed that they were able to identify glassware, equipment and instrumental or ‘hands on’ technique. Eighty one percent of students indicated that they would have viewed the videos before their practical classes if they were available. Surprisingly, 68% of students said they would have viewed a video produced by students even if a video of the practical produced by academics was available. The reasons behind this included, “*The lecturers are too polite. They say ‘do this, don't do that’...but the students will use ‘real’ language such as ‘if you do this you will ‘stuff’ the prac and won't get results’. I tended to hear this!*”

Students also favourably reported increased levels of engagement with the practical when they were quizzed by their peers. They believed filming the practical three weeks after it had been preformed followed by an oral defence the subsequent week had facilitated better retention of knowledge and reflection.

The second strategy, teaching a key chemical concept and explaining it to a lay adult, was also enjoyed by the students. Seventy nine percent of students felt that they understood the concept better after explaining it to an adult. They reported the challenge of ‘peeling back the layers’ of complex concepts in order to explain them to individuals without a grasp of chemistry forced them to achieve a deeper level of learning for themselves. Student feedback also suggested this activity could be incorporated into future courses as they found it a highly effective strategy to gain a deeper understanding of complex concepts. All the lay adults either ‘agreed’ or ‘strongly agreed’ that they gained a clear understanding of the concept as taught to them by the students. The adults commonly reported that they enjoyed the activity, with one saying that they would ‘never look at everyday cooking processes in the same way again’.

DISCUSSION

In using an innovative PLTL curriculum design in which information was collaboratively constructed by the students by working together, appraising each other and gaining feedback from each other, students were able to gain the desired learning outcomes for the course despite 5 weeks of traditional practical classes not being available.

This is evidenced by the majority of students (82%) achieving a minimum of a distinction for the 2 laboratory based questions in the course exam. Both questions required students to demonstrate a deep learning and assimilation of key concepts conveyed in the practicals accessed. (Similar laboratory based questions were completed in the previous year with a much small number of students achieving 80%). Although this could be due to the larger class size in 2008 (35 vs 28 in 2008 and 2009 respectively), the improvement in results in the 2009 cohort is most likely to be due to the increased interaction with the material by the students and the level of deep learning achieved.

Analysis of student feedback of the ‘Marcel Marceau’ series of videos exercise indicated that students gained an understanding of the key concepts underpinning the practicals which they were unable to perform in the laboratory themselves. Furthermore, students gained skills in collaboration and team work, communication skills, critical enquiry and reflection. Boud et al. (1999) suggest that one of the reasons for this outcome was that PLTL strategies such as this provide students with an opportunity to plan and work together which required them to develop good collaborative skills with their fellow students. These strategies also provided increased opportunities for students to explore the context of the theoretical knowledge which underpinned the practical sessions. Students were then able to engage and reflect on the material independently when the lecturers are not directly involved in the creation of knowledge. Further, students gained a meaningful opportunity to communicate knowledge. Communicating knowledge does not normally occur to the same extent during conventional practical sessions. Additionally, the students’ articulation of their knowledge was critiqued by their peers, while

they had the opportunity to learn from adopting the reciprocal role (Boud et al., 1999). Increased course grades and improved attitudes and motivation to learning were consistent with research reported by Lloyd (2010) and Stewart et al. (2007).

Persky and Pollack (2009) point out that PLTL approaches are often more time consuming than other learning approaches and members of the group do not always 'do their part'. The Marcel Marceau activity was filmed during a timetabled 'laboratory class' with all students participating and the subsequent videos were viewed in students' own time in preparation for a subsequent class. Students did not report any dissatisfaction with being asked to view the videos outside of class time. On the contrary, the discussion board on the course homepage was filled with favourable and encouraging comments with respect to the videos.

Students generally reported a greater understanding of their chosen key chemical concept as a result of having to explain and teach it to a lay adult. As reported in the literature, students taking up the role of teacher required them to attain a much deeper understanding of the curriculum content. Students must be able to understand and then organise the content in such a way that it can be clearly communicated, and on this occasion, communicated not to a peer, but to an adult lacking underpinning knowledge of the topic (Goldschmid & Goldschmid, 1976; Lloyd, 2010; Nichols, 1994; Topping, 1996, 2005). Contemporary scientific literacy is dependant upon on capacity of communicators to understand and apply scientific concepts to everyday life (Burns, O'Connor & Stockmayer, 2003). In this exercise, students experienced an even greater cognitive demand, through being required to apply their chosen concept to an everyday process, and then teach rather than simply present information (Topping, 2005; Whitman, 1988).

The students had no prior warning that they would not be able to complete their practical course (due to the flood), the PLTL activities were implemented mid-course to replace the practical classes and the assessment activities for the course were changed from those outlined in the course information booklet. Where the students could have complained, they embraced these activities wholeheartedly. The students' enthusiasm, under the circumstances, made it easier for the lecturer as there were 5 strategies in total to replace to practical program. As opposed to the findings of Boud et al. (1999); Nichols (1994) and Cate and Dunning (2007), the demand on the lecturer was higher as each individual 'Marcel Marceau' video had to be downloaded from the recorder and uploaded to the course home page (Boud et al., 1999; Cate & Dunning, 2007; Nichols, 1994). In addition, the videos produced on the students' mobile phones and cameras were emailed to the lecturer in 9 different formats; IT support was required to download appropriate software to open these videos.

A further downside to the 'Marcel Marceau' videos was that some students were self conscious, nervous or distracted by the sound of their own voice which they perceived as squeaky. However, this appeared to be a minor distraction as 68% of the students indicated they would view the students videos even if there was a video of the practical available produced by academics.

Another potential limitation to the study is the nature of the student cohort. The majority of the students were under 25years old and were academically strong performers in Chemistry. There was no separate analysis of results for the 35% of students who scored less than a credit for their first year chemistry courses. Although the results of the current cohort were compared to those of the previous year, the exam questions in concurrent years were not identical and of different weighting. A more thorough analysis could be conducted with a control group within the same cohort of students. The study would also have to be completed with an older student cohort to gather data on the efficacy of these approaches with an older age group.

In conclusion, as a consequence of the unforeseen flood, PLTL approaches have been shown to deliver equally, if not better learning outcomes in terms of academic grades, and better outcomes in regard to student motivation and the development of team work and communication skills. Student feedback suggests that PLTL approaches could be incorporated into future courses.

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