

Integrating students' learning with professional practice through laboratory and workshop based teaching in undergraduate medicinal chemistry

LALEH VAHDAT*

Faculty of Pharmacy, University of Sydney, Australia

Abstract

Teaching medicinal chemistry in the second year of a pharmacy degree poses a special challenge as it requires teaching both fundamental chemistry and analytical techniques. It is generally felt that the current generation of students mostly lacks the basic knowledge and principle in analytical techniques. Yet, recent advances in analytical instrumentation, has created a false impression among the pharmacy students that fundamental pharmaceutical analytical knowledge & skills are no longer relevant to their pharmacy education. As a result, students' perception of the laboratory and workshop based teaching has been unfavourable. This paper assesses the factors influencing students' perceptions and outlines the processes of course design and improvement to change that perception. The study highlights the importance of the integration of academic teaching with the pharmacy profession, and the role of laboratory and workshop based teaching in improving the students' understanding of the course.

Keywords: *Laboratory teachings, improvement in teaching and learning, integrated teachings, students perception*

Introduction

There are a number of reports and reviews in literature on pharmacy education concerning pharmacy students' perception of the practice of pharmacy (Coffey, Barnett, Miller and Turberville-Vega, 2005; Marriott, Duncan, McNammara, 2007; Barnett and Matthews, 1997) and the need for embedded graduate qualities to meet with professional demands (Cisneros, Salisbury-Glennon, Anderson-Harper, 2002; Stupans, Angley, March, Soulsby, 2005). However, there is little published research on dealing with the challenges of integrating the basic core science subjects taught in pharmacy undergraduate courses, with the pharmacy profession. With pharmacy educators, there is a strong perception that whenever the students fail to see the relevance of a subject that they learn in their professional degree, their performance rate in that particular subject declines.

As the profession of pharmacy moves from its traditional dispensing role to a patient - centered clinical role, there is a need for a greater integration of pharmacy education with the modern professional practice. While some pharmacy schools around the world have established specific educational outcomes and learning objectives for their students to create a roadmap to the pharmaceutical care and pharmacy practice skills (Alsharif, Destache, Roche, 1999), many pharmacy students are facing disenchantment or disillusionment with their profession and academic learning in various stages of their studies (March, Gilbert, Roughead, Quintrell, 1999; Kritikos, Watt, Krass, Sainsbury, Bosnic-Anticevich, 2003).

In Sydney University, traditionally the students' perception of pharmacy teaching has been at the lower end of the scale in the allied health professions of the college of Health Sciences (SCEQ, 2007). There are now concerns from academic and clinicians that Australian Pharmacy students are reluctant to engage in Self Directed Learning (SDL) or pursue active learning strategies (Sainsbury, Smith, Chen,

*Correspondance: L. Vahdat, Department of Biotechnology, Chosun University, Gwangju, Republic of Korea. Tel: +82-62-230-6851. Fax: +82-62-233-6851. Email: lalehvahdat@gmail.com

Saini, Bosnic-Anticevich and Krass, 2006). Recent surveys from Sydney University's pharmacy students point to an attitude and approach to learning, by the majority of students, which is superficial in nature (Sainsbury, Smith, Chen, Saini, Bosnic-Anticevich and Krass, 2006).

Description

Students enrolled in the second year medicinal chemistry course, in the Faculty of Pharmacy in Sydney University, have often expressed their dissatisfaction with the heavy workload and ambiguity of laboratory teachings. This has led to an unfavourable students' perception of the course. The unsatisfactory perception of the medicinal chemistry students could be linked to their passive learning approach as reported elsewhere (Ruenitz, 1997; Roche and Zito, 1997). The general remedy sought by most academics and teaching professionals has been to move away from traditional lecture teaching approach to a students centered learning approach (Roche and Alsharif, 2002; Ruenitz, 1997; Roche and Zito, 1997). In recent times, computer and Problem Based Learning (PBL) have been projected as alternative effective learning tools. Therefore, many pharmacy schools have enthusiastically embraced these teaching methods. Others have tried to further rectify the situations by developing interest-enhancing teaching materials to keep medicinal chemistry subjects alive (Roche and Alsharif, 2002) for the students in pharmacy and other allied health professions.

While the relevance of the medicinal chemistry to the pharmacy profession is clearly obvious to an expert, it has not been the case to students. Since pharmacists are trained to think chemically about drugs and their therapeutic effects, the relevance of application of basic science, fundamental skills

and the knowledge needed in analytical chemistry and drug design techniques is less clear to students, making the task of evoking students' interest in the course, a demanding task.

In the Faculty of Pharmacy at Sydney University, the number of students enrolled on the second year of the pharmacy program is approximately 250. The unit of medicinal chemistry in the first semester of the second year of the pharmacy program focuses on the chemical and physical properties of drugs that can influence a number of factors such as analytical methods and drug action. The laboratory component in conjunction with the associated workshops constitutes an essential part of the course. It focuses on analytical techniques in drug analysis and design. Despite of lot of effort and the high cost of running these laboratories, students' feedback on laboratory teaching has been quite unfavourable.

This paper deals with the challenges faced and the approach taken to improve our second year pharmacy students' perception and degree of satisfaction with laboratory teachings of the medicinal chemistry subject in the second year pharmacy program. One major step forward in meeting this challenge was to align the laboratory teaching practice with the University's code of excellence in teaching and learning. The outcome has been a significant shift in students' perception of the unit over the past two years (2005-2006).

Educational Underpinning

The underlying guidelines from the Institute for Teaching and Learning, University of Sydney (ITL, Sydney University, 2007) that motivated this study are summarized in Table I.

Table I: Guidelines from Institute for Teaching and Learning, University of Sydney that motivated this study

Objectives	Methodology
1. Engaging students in learning	<p>Students are encouraged to undertake active learning</p> <p>Students are given the opportunities to test their new knowledge</p> <p>Students are given examples of how knowledge is applied</p> <p>Students interest is evoked and sustained</p> <p>Students are supported in the progressive assumption of responsibility for their own learning</p> <p>Students are encouraged to engage in dialogue and discussion amongst their fellow students and teachers at their convenience in a flexible manner inside or outside of class room thus creating a community of learners</p>
2. Contextualising students learning experience	<p>Students are given the context and rationale of their learning</p> <p>Students experience teaching methods which are appropriate to the context and goals of learning</p> <p>Students are engaged in the learning process by seeing the relevance of their learning in the context of their profession.</p>
3. Commitment to continuous improvement in teaching and learning practice	<p>Making sure that innovative practice in teaching and continuous improvement in learning is upheld</p> <p>Making sure that systematic feedback from the students is sought</p> <p>Making sure that the curriculum content is relevant and reflective of current changes in corpus of knowledge and the students needs.</p>

The existing laboratory and workshop content of the medicinal chemistry subject was carefully studied and revised using the university's guidelines on teaching and learning. In doing so attempts were focused on aligning them with the objectives of current unit of study in the medicinal chemistry taught to second year pharmacy students.

As a first step, the academics in charge of developing and teaching the course were consulted along with the technical staff responsible for facilitating the laboratory and workshop sessions to ascertain concerns and issues in relation to course delivery.

As a complementary step, a laboratory and workshop specific on-line survey was developed to gather students' feedback and assess their learning experience. The survey was conducted using an on-line questionnaire conducted on the WebCT (the university's educational technology and flexible teaching and learning tool). Students were asked to respond to each statement about the laboratory or workshop session using a 5 point Likert scale to indicate the extent to which they agree or disagree. The scale was based on the range of strongly agree (a) to strongly disagree (e) with the neutral being the mid-point. The degree of agreement was evaluated based on total percentage number of respondent who either strongly agreed or just agreed. Similarly, degree of disagreement was taken as the total percentage of respondents who either strongly disagreed or just disagreed. Students were asked to write their comment on any aspects that they strongly felt needed attention.

The response rates in 2005 and 2006 were 40% and 65% respectively. The first survey specifically on the laboratory and workshop component of medicinal chemistry was conducted in 2005 generated a pool material on the issues and concerns that students had with the components of the course. This survey shed light on the students' unfavourable perception of the course. The survey was conducted independently by the laboratory and workshop coordinator on WebCT giving students ample time to evaluate their learning experience in a considered way. As the survey conducted was anonymous students did not feel threatened to freely express their problems and issues with the course. Apart from the specific laboratory and workshop questions, the survey contained an open ended item requiring student written comments. This provided an excellent platform for the students to express their frustrations with the course.

Although comments received for the first survey, were virtually all negative (Table II), it provided material for a thorough examination and evaluation of the existing course material, and redesigning the laboratory and workshop component.

The analysis of the first student survey in 2005 is as follows.

Laboratory Demonstrators

One key issue with students' unfavourable perception was reflected in their dissatisfaction with the demonstrators' teaching quality. Traditionally the lab/workshop classes had been taught by postgraduate students within the Faculty in conjunction with the teaching staff. However, over the years the number of undergraduate pharmacy intake by Sydney University has significantly increased. This has put undue pressure upon the teaching staff in discharge of their duties in

delivering course material to increasing number of students. Therefore, the delivery of laboratory and workshop teachings were heavily entrusted to the part time and casual demonstrators who were mostly inexperienced, unprepared and unmotivated. Some demonstrators came from outside the Faculty with various backgrounds in science, less than a perfect match for taking teaching responsibilities in medicinal pharmacy. Table II provides typical comments from students in 2005 survey. They illustrate the perception of students about the low quality of service provided by untrained laboratory demonstrators.

To improve the quality of laboratory demonstrators the Faculty required general training for all new demonstrators as a condition of part time employment. This general training, albeit helping casual teaching staff to create awareness about their basic teaching responsibilities, did little to address specific issues raised by the students with regards to delivery of medicinal chemistry. There was a clear need for extending the training to a more specific hands on approach. Therefore, the organizers for the unit of study committed themselves to compulsory hands on training for all the demonstrators / tutors teaching the course, for each specific exercise. The unit organizers also put in place a number of measures to improve the quality of delivery by the laboratory demonstrators. They were provided with various teaching aids, such as specific notes for each subject, demonstrators' manual containing instructions and guidelines on marking, providing feedback on students' reports and specific guidance for assisting students in the laboratory.

Course Integration

The second important issue raised by students was the non-alignment of lecture materials with laboratory and workshop components. Many students felt lost as they could not see the connection between the two parts of the course. They wanted a clearer articulation between the various components of the course. Typical students' comments (Table II, survey 2005) highlight this shortcoming.

Therefore, the laboratory and workshop materials were updated with clear cross referencing to the lecture materials where appropriate. The connection between the lecture and laboratory materials was also reinforced, providing additional notes and Self Directed Learning (SDL) materials. This approach to course development was analyzed in a recent study (Ingram, Sagoe, Sosabowski, Long and Moss, 2007) on students' perceptions of teaching materials. The study concludes that most students still prefer the traditional hand outs and teaching notes as their first choice of teaching aid.

Pre laboratory work and discussion sessions

Another issue that caused students' frustration was the pre laboratory work embedded in the laboratory notes, specifically, the level of assumed knowledge expected from the students. Often students were expected to know a lot of basic fundamental chemistry that they are not prepared for in the second year of their pharmacy program. However, the analysis of the student survey (Table II, survey 2005) revealed that students lacked the assumed knowledge in a laboratory session.

Although there is greater emphasis on the role of pharmacists in pharmaceutical care, the current generation of undergraduate pharmacy students seems to find it difficult to

grasp the relevance of pharmaceutical analysis embedded with basic analytical chemistry in their professional program. Therefore, with this in mind, the basic principles behind the exercise and workshop were reinforced in the form of SDL exercises that tied in with the designed exercise.

In the new design of the laboratory material, each exercise was associated with a set of revision quiz and assessment quiz component to test students learning or their preparation. The quizzes were specifically designed to engage students as they take charge of their own learning. To increase students' active participation in SDL process, they were asked to participate in online sessions by posting their questions relevant to SDL on the discussion site on the WebCT. It encouraged students to invite feedback from their fellow students (peer to peer learning) in tackling problems relating to all aspects of the course. The course Coordinator monitored the discussions and intervened whenever the discussion went off the track or when necessary to provide the correct version of response.

Role of Course Coordinator

In the proper management and delivery of the revised course, the role of the course coordinator cannot be underestimated. The course coordinator is responsible for the full integration of various components of the course in the context of the overall objective of the pharmacy program. Every aspect of the course needs careful and detailed planning and coordination. The leadership role of the coordinator, in the delivery of quality teaching is especially critical in the environment where the number of undergraduate students with diverse backgrounds is large, and similarly, the number of teaching staff involved in delivering the course is relatively large and diverse. The academics responsible for teaching the unit come from four to five subject areas. One major task of the coordinator is to maintain a cohesive flow of the required processes within the faculty that lead to best teaching practice. As a result the following policies implemented.

- The laboratory notes were updated with the objectives to convey contemporary analytical techniques and embedded drug actions and drug design exercises. Each laboratory/workshop exercise highlighted its relevance to the materials taught in lecture. The basic aim of each laboratory/workshop exercise was to complement students learning on what they have learned in lectures and to challenge the students to solve real problems. On the other hand each exercise was designed to be simple enough for most students to be able to complete during the allocated time.
- The survey results and the students' comments were shared with the rest of the academic staff and the technical staff in medicinal chemistry discipline. The students' feedback was utilized for further developments of the laboratory teachings.
- Additional experiments and workshops were designed to reinforce a greater correlation between lecture materials and laboratory component.
- On line SDL and quizzes were developed as complementary parts to each exercise, to enhance students learning by becoming active learners and engaging in their learning process.
- Academic staff teaching the course were consulted for taking a more active role in conducting some of the laboratory sessions relevant to the subjects they taught. This approach had the added benefit that their

postgraduate students were also involved in the laboratory demonstration activities.

- Regular communication and consultation with the technical staff responsible for the preparation of the laboratory/workshop. The collaboration was critical in ensuring good laboratory practice and effective outcomes.
- Specific hands on laboratory/workshop training for demonstrators were organized. Demonstrators training became a compulsory pre condition for the casual demonstrator employment.
- Specific demonstrators notes for each exercise were prepared with sample introductory talks and answers to laboratory/workshop questions.
- Specific guidance for demonstrators in terms of marking standard, providing feedback to the students on their reports, and the introductory presentations at the start of the session were provided in the demonstrator's manual to ensure consistency in marking and enhanced students learning process.
- Students were instructed to forward their questions related to any subject of the course on the discussion site on the WebCT. Peer to peer learning was facilitated through SDL and online discussion on the WebCT.

Evaluation

The aim of the evaluation was to seek student perceptions of the medicinal chemistry course and use them to improve the quality of the laboratory and workshop component. The evaluation tried to assess the following key aspects of student learning:

- evaluation of the students, of the degree to which their interest is evoked so that they are enthused in taking charge of their own learning;
- the relevance of the laboratory and workshop exercises with the materials taught within the unit of the study;
- if the students were given the opportunity to test their knowledge learned;
- the continuous improvement in teaching and learning;
- the usefulness of the laboratory and workshop materials and exercises in facilitating student learning;
- the standard of the support from casual teaching staff;
- the organization of the course materials;
- the systematic feedback from the students.

Both the surveys in 2005 and 2006 provided valuable insight into the challenges of effective laboratory teaching for pharmacy students. Even the response from students to the open ended comments section of the survey, a platform for students to vent their frustrations with the course, improved significantly (Table II), as many of the comments were either constructive or positive.

The survey demonstrated that the lack of proper coordination in delivering cohesive course materials and good teaching practices can significantly downgrade students' perception of the course, even if it is the most essential part of their pharmacy program. With more effective course coordination, consistency in course delivering through appropriate learning and teaching tools and implementing university's guidelines on effective teaching, significant improvement (Table III) in the students' satisfaction was achieved.

Table 2: Typical comments from the students in 2006 and 2007 surveys

Key issues	Typical Students comments from Survey 2005	Typical Students comments from Survey 2006
Laboratory Demonstrators	<p><i>"I believe that the lab component could have helped support the rest of the course if the tutors had been better. I found all my tutors had very little idea of the theory and the concepts and were of very little help."</i></p> <p><i>"The labs were totally useless because the demonstrators had no idea and lacked communication skills, if they were more informed themselves and more capable of explaining things would be better also the time allocated to do the amount of work was limiting."</i></p> <p><i>"We had a few different demonstrators throughout the semester and many of them were not prepared for the labs ie. unable to answer some of our questions."</i></p> <p><i>"I feel that should the tutors have had more knowledge on the tutorials they would have had the confidence to better communicate the work to us and we could have benefited from the practical a lot more."</i></p>	<p><i>"All the demonstrators we had were great, always extremely helpful"</i></p> <p><i>"The demonstrators varied immensely with some being very helpful and others very poor."</i></p> <p><i>"demonstrators need to be more technically sound and theoretically knowledgeable."</i></p> <p><i>"Most demonstrators were helpful in explaining what the experiment is aimed to show."</i></p>
Course Integration	<p><i>"Overall the content is good, but it would be better if the labs complemented the lectures better."</i></p> <p><i>"Each lab needs a clear introductory talk to establish how the lab work fits in with the course content."</i></p> <p><i>"Sometimes I had a problem seeing the relevance of the lab material to the lectures. I think it would have been good if there was a more direct link."</i></p> <p><i>"a stronger overlap with lecture material might make labs more interesting for students"</i></p>	<p><i>"I love the practicals, it's so helpful "</i></p> <p><i>"More tutorials would be useful"</i></p> <p><i>"I did like though that some of the exercises were coupled to other exercises such as exercise 1 with exercise 4 and exercise 6 with exercise 6T because it allowed me to better understand things. Also, I liked the mixture of pracs with workshops, because it mixed up theory with application."</i></p> <p><i>"Thank you"</i></p> <p><i>"some of the pracs were rather rushed and it would have helped more if the lectures were more tied into the prac classes and some more examples made available for study eg. Calculations".</i></p> <p><i>"Overall, a useful learning experience."</i></p>
Pre laboratory work and Discussion Sessions	<p><i>"lots of the prework was hard and it would have helped if demos went through it at the start of the lab."</i></p> <p><i>"Also i felt the level of assumed knowledge for the prework and practical was too high and I know I would have gained a lot more from pre-work should have the very basics been outlined."</i></p> <p><i>"there were not enough information or examples given for us to be able to do those questions and most of the time the demonstrators either did not know how to do the questions or lacked the capacity to explain how to do the questions to us."</i></p>	<p><i>"Perhaps some form of postwork should be introduced, a concept I found valuable in first year chemistry. Rather than forgetting about the entire exercise following its completion"</i></p> <p><i>"a lot of the material we are expected to know in the laboratory is not covered in enough detail in the lectures".</i></p> <p><i>"there needs to be extra material or places where students can get that extra help .Thank you for all your effort though!"</i></p> <p><i>"I would have liked to see examples on how to USE formulas and EXTRAPOLATE the correct information. A lot of the time we were just given the formula and we were expected to know what information correlates to whichever part of the formula."</i></p>

The results from 2006 survey were encouraging (Table II and Figure 1). Students perception of the whole laboratory / workshop component had markedly improved, to the extent that 54% of the respondents agreed that the laboratory /

workshop component was interesting. However, twenty five percent of respondents disagreed. This was a significant improvement from 2005 survey where only 32 % of the respondent agreed and 49% disagreed.

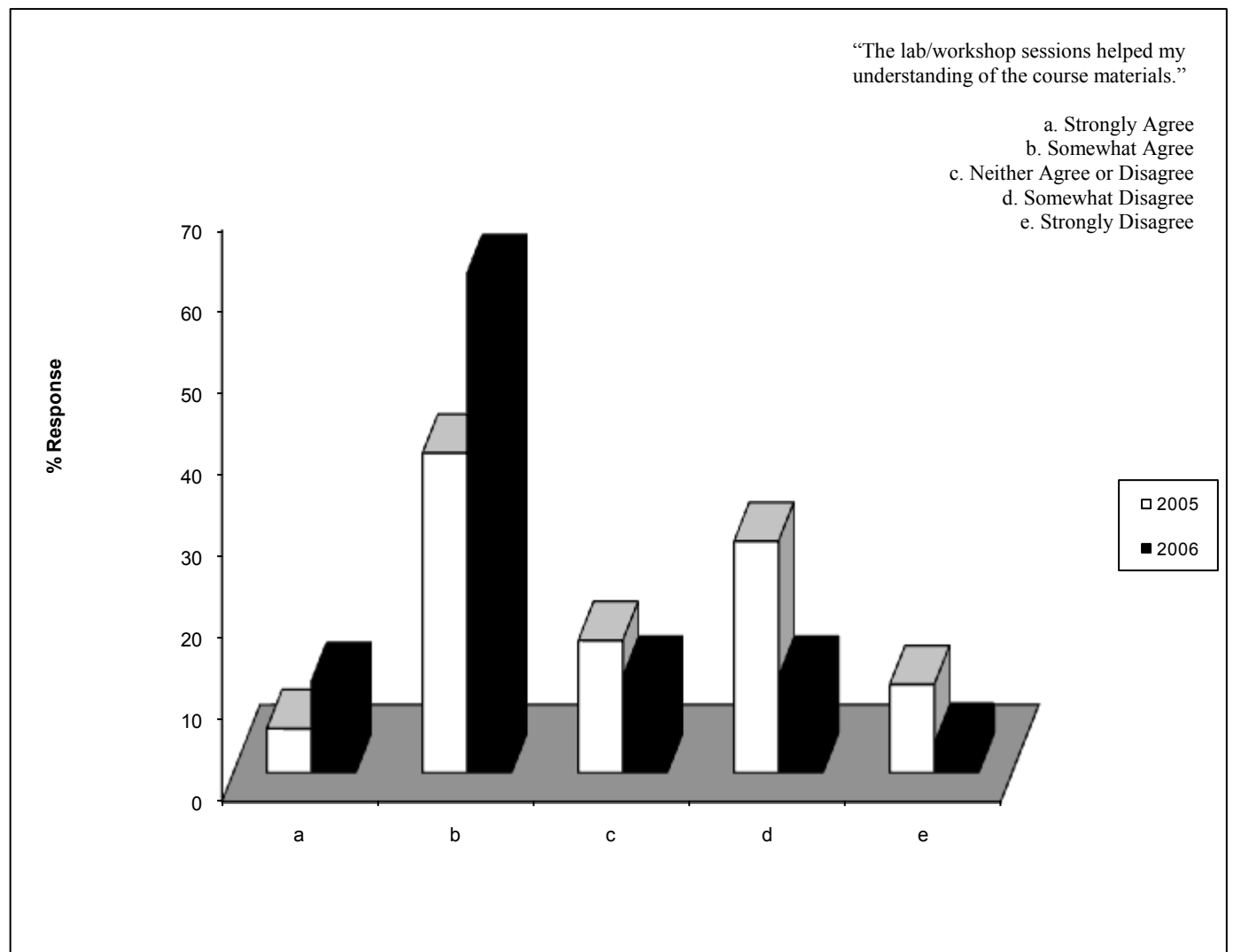
Table 3: Comparison in the key areas of students' satisfaction.

Survey Questions	% Respondents agreed			% Respondents disagreed		
	2005	2006	Difference	2005	2006	Difference
The lab/workshop component was interesting	32	54	+22	49	25	-24
Lab/workshop helped my understanding of the course material	44	72	+28	39	15	-14
The pre laboratory work helped me to prepare for each session	39	69	+30	39	12	-27
The quizzes were valuable complementary study tool	-	69	-	-	11	-
Received adequate assistance from the demonstrators	17	42	+25	73	36	-37

Another significant improvement observed was in the area of usefulness of the laboratory workshop component to the students learning in understanding the unit of the study (Figure 1). Over 72% of respondent in the 2006 survey felt that the course has complemented their learning of the unit of the study, and 15% disagreed. The corresponding numbers from the survey in 2005 were 44% and 49% respectively.

The performance of the demonstrators, where the score of student satisfaction was very poor in the 2005 survey, also showed an encouraging improvement too. Table I presents the relative improvement achieved in 2006 in key areas of students' dissatisfaction when it is compared to survey 2005. The quiz component added in survey 2006 as complementary study tool, clearly has gained significant students satisfaction.

Figure 1: Comparison of students' responses to a survey question in 2005 and 2006.



The clear improvements in course indicators were the obvious results of the changes that took place in the course design and delivery. The discussion sessions on the WebCT were valuable as well.

Nevertheless, there still remains some level of student dissatisfaction with the course. However, as the trends indicate constant coordination and monitoring of various teaching activities relating to the course in accordance with the university's goal of excellence in teaching practice is critical, and can greatly improve students learning experience and in turn their perception.

Future challenges of the Laboratory Teachings

Despite advances in on line teaching and moving away from traditional face to face teaching practices, laboratory teaching remains to be an essential part of the pharmacy professional education that needs hands on teaching techniques. Possibly the most crucial factor in the continuation of laboratory teaching in the long term will be the cost factor. With much more stringent Occupational Health and Safety (OHS) requirements, the cost of running the labs has increased significantly. This will, no doubt, impact on the course design and delivery and could limit the nature and number of the laboratory sessions conducted in each unit of study.

Conclusion

This paper presents the challenges of effective integration of laboratory teachings with the pharmacy profession. The study evaluated the various factors influencing the unfavourable perception of the students about the teaching in medicinal chemistry and outlined the processes in course design and delivery to change this perception. A two-year pilot trial of the course design methodology based on the university's teaching and learning practice in a marked improvement on students' general perception of the laboratory teaching.

Acknowledgments

The author wishes to acknowledge the assistance of Dr Colin Duke in course design and delivery. The second year undergraduate pharmacy students are greatly acknowledged for their participation in the surveys.

References

- Alsharif, N. Z., Destache, C. J., Roche, V. F. (1999). Teaching medicinal chemistry to meet outcome objectives for pharmacy students. *American Journal of Pharmaceutical Education*, 63, 34-60
- Barnett, C. W., and Matthews, H. W. (1997). Students evaluation of classroom teaching: A study of pharmacy faculty attitudes and effects on instructional practices. *American Journal of Pharmaceutical Education*. 61, 345-350
- Cisneros, R. M, Salisbury-Glennon, J. D., Anderson-Harper, H. M.(2002). Status of problem-based learning research in pharmacy education: A call for future research. *American Journal of pharmaceutical Education*. 66, 19-26
- Coffey, C. W., Barnett, C. W., Miller, S. W., Turberville-Vega, V.(2005). Students attitude about Service-learning:

- A longitudinal Study. *Journal of Pharmacy Teaching*, 12 (2), 51-68
- Ingram, M. J., Sagoe, L. A., Sosabowski, M. H., Long, A. J., Moss G. P. (2007). Pharmacy student perceptions of educational media tools. *Pharmacy Education* , 7(1), 77-82
- ITL (Institute for Teaching and Learning), University of Sydney. <http://www.itl.usyd.edu.au>
- Kritikos, V., Watt, H.M.G., Krass, I., Sainsbury, E. and Bosnic-Anticevich, S.Z. (2003). Pharmacy students' perceptions of their profession relative to other health care professions. *Int J Pharm Pract*, 11, 121-129
- March, G., Gilbert, A., Roughead, E., Quintrell, N. (1999). Developing and evaluating a model for pharmaceutical care in Australian community Pharmacies. *Int J Pharm Pract*, 7, 220-9
- Marriott, J. L., Duncan, G. J., McNamara, K. P. (2007). Barriers to Pharmacist participation in continuing education in Australia. *Pharmacy Education* ,7(1), 11-17
- Roche, V. F. and Zito, S. W. (1997). Computerized medicinal chemistry case studies. *American Journal of Pharmaceutical education*, 61, 447-452
- Roche, V. F. and Alsharif, N. Z. (2002). Staying alive: Advancing medicinal chemistry by enhancing students responsibility for learning. *American Journal of Pharmaceutical education*, 66, 319-328
- Ruenitz, P. C. (1997). Promoting In-class student involvement in Medicinal Chemistry. *American Journal of Pharmaceutical Education*., 6, 302-306
- Sainsbury, E., Smith, L., Chen, T., Saini, B., Bosnic-Anticevich, S. and Krass, I. (2006). Australian undergraduate pharmacy students' approaches to learning. *Pharmacy Education*,6(3), 215
- SCEQ (Students Course Experience Questionnaire), University of Sydney Website. <http://www.itl.usyd.edu.au/SCEQ>
- Stupans, L., Angley, M. T., March, G., Soulsby, N. (2005). Graduate qualities: Exploring problem solving in the applied pharmacotherapeutics curriculum at the university of South Australia. *Pharmacy Education*, 5(3), 261-265