Pharmacy Education, January 2009; 9 (1): 1-5

Integrated learning: An EBL approach to pharmaceutical chemistry

MARY SATTENSTALL[1, 2] & SALLY FREEMAN[1*]

[1]*School of Pharmacy and Pharmaceutical Sciences, University of Manchester, Oxford Road, Manchester, M13 9PT, UK*

[2]*Centre for Excellence in Enquiry-Based Learning, University of Manchester, C24 Sackville Street Building, Sackville Street, Manchester, M60 1QD*

Abstract
This paper reports on the evaluation of an enquiry based learning (EBL) module in pharmaceutical chemistry which has been developed for first year pharmacy students. The module aims to encourage integration of knowledge within the multi-disciplinary pharmacy degree, leading to an appreciation of the importance that chemical properties have on the action of medicines. In teams, students selected a therapeutic area and medicines for its management. Following an introductory workshop, the teams completed an information retrieval and analysis exercise. Assessment included a poster or oral presentation, which confirmed, through questioning, that the teams appropriately applied chemical properties of their medicines to broadly rationalise their clinical efficacy. Evaluation by questionnaire showed that the students rated the module as being of relevance to pharmacy. Evaluation and peer assessment provided evidence of the development of key skills, and also showed that networking of teams of first year students from diverse backgrounds had social and academic benefits.

Keywords: *EBL, peer assessment, pharmaceutical chemistry, teamwork*

Introduction

Amongst healthcare professionals, pharmacists are the experts in medicines whose knowledge should include an understanding of pharmaceutical chemical properties. Some pharmacy students can often compartmentalise their knowledge and fail to apply this basic science to clinical situations. Some students believe that chemical knowledge is not relevant to their profession. Here, the aim is to motivate first year students by using an integrated enquiry based learning (EBL) team approach to demonstrate the relevance of pharmaceutical chemistry to the pharmacy graduate.

EBL is an active form of learning, driven by the students in a process of enquiry. EBL typically involves semi-structured exercises in teams, facilitated by a tutor. For a pharmacy graduate, teamwork and the appreciation of an individual's team contribution are essential, and EBL is considered to be an effective method to develop these skills (Glasper, 2001). Students' motivation is important as a lack of it leads to them becoming either disinterested or failing to participate in the activity (Kahn and O'Rourke, 2004; Edelson *et al*, 1999). EBL also enables the development of transferable skills, essential for a career where CPD is mandatory. Furthermore, the CPD model is supported by the EBL process, and Shaw and co-workers (2006) explain that they both involve the process of identifying knowledge gaps to drive learning.

Ravens and colleagues (2002) introduced a problem based learning (PBL) component into their first year curriculum entitled "Basics of drug therapy" and Kwan (2002) used PBL in medical pharmacology to enable scientific principles to be applied to clinically relevant situations. Here, an EBL approach has been introduced into the first year pharmaceutical chemistry module. It should be noted that many pharmacy graduates will complete project-based work

*Correspondence: School of Pharmacy and Pharmaceutical Sciences, University of Manchester Oxford Road, Manchester M13 9PT, UK. Tel: +44 161 275 2366. Fax: +44161 275 2396. Email: sally.freeman@manchester.ac.uk

in pharmaceutical chemistry, but the emphasis here is to promote integrated learning, as well as the concurrent acquisition of transferable skills and student networking.

Methods

A total of 185 first year pharmacy students completed an EBL exercise as part of their pharmaceutical chemistry module. The personal tutorial groups comprised between five and eight students who worked together from the start of the exercise to develop an effective team (Fink, 2004). Introductory workshops explaining the concept of EBL and the essential skills for team working were held. The workshops were interactive and involved completion of entertaining team exercises to network the group, and to provide information on the EBL exercise. The teams decided upon a structure with defined roles of chairperson and scribe. The teams selected a therapeutic area and medicines from the British National Formulary (BNF), which provided early exposure to this vital reference source.

During the EBL exercise two formal sessions were held with their personal tutor as facilitator. The facilitator's role was to provide guidance, but did not intervene unnecessarily in the process, so as to allow students to develop their own method of working (Rutter, 2002). Optional subject specialist question sessions in medicinal chemistry, pharmacy practice and drug distribution were offered to ensure that the teams had guidance to accessing appropriate literature etc. This eradicated the problem discussed in previous research, as to whether the facilitator should be an expert on the content of the EBL exercise (Shaw *et al*, 2006). The teams were free to arrange their other meetings in an environment which would promote participation of all team members.

Specific tasks were set as motivational goals for the students to reach throughout the exercise and to introduce the students to the EBL process. Each of the described stages of the project had deadlines and this ensured that the teams had good time management, a transferable skill critical to their professional careers. Indeed, for EBL to be effective it requires students to be able to manage and organise their activities (Edelson *et al*, 1999). The first activity was to produce a brief report on their therapeutic area and the mode of action of the medicines. The team was then requested to comprise a list of key generic chemical properties with a statement to rationalise their importance to the efficacy of the medicines. The properties included drug structure, conformation, pKa, partition coefficient and Lipinski's rules, which were confirmed/prompted by the facilitator. The teams were then required to retrieve this chemical information on their medicines, using books and databases recommended by the pharmacy specialist librarian. The largest component of the project involved appreciating how the chemical properties of the medicines may be related to their pharmacological effects.

Results

The need for an assessment method which reflects the teaching approach is important (Norman *et al*, 2000). An exam on the EBL exercise would have been very restrictive and may have prevented students from engaging in their own lines of enquiry (Kahn and O'Rourke, 2004). Here the

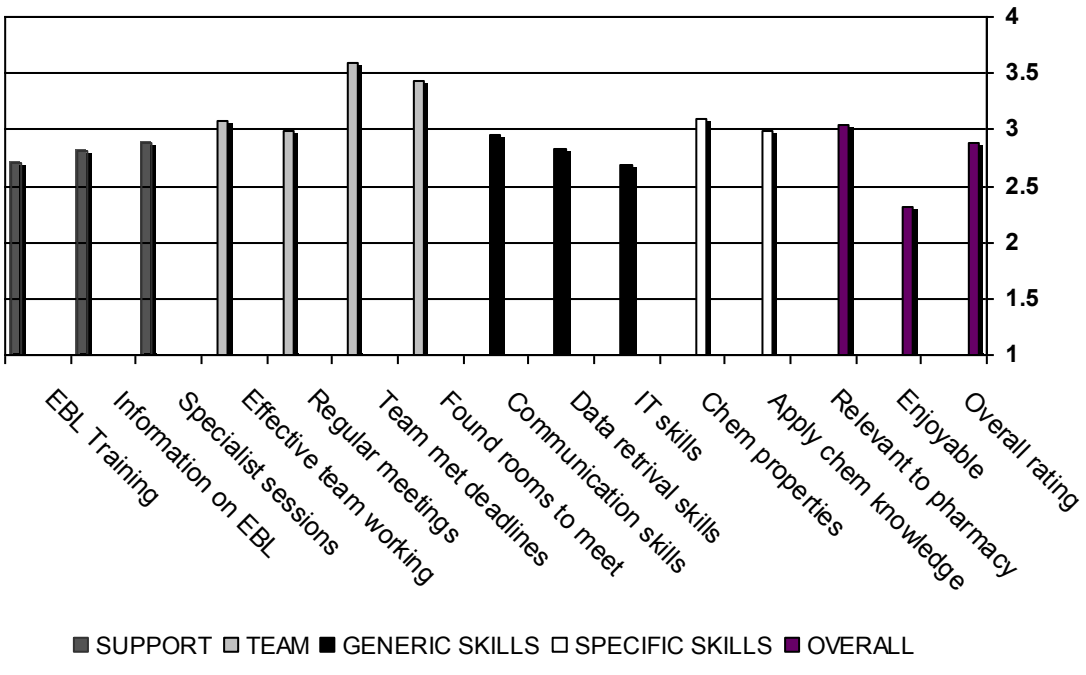

Figure 1. Results of student questionnaire.

Table I. A sample of positive student comments on the EBL exercise.

I believe this project should be carried on in the future as it is fun, informative and unique in its approach.
The EBL exercise enabled us to build on our teamwork skills and work together on a project that enabled us to learn information that is relevant to pharmacy.
….met deadlines and made great relationships with group members.
Winning the poster group actually gave me a sense of pride.
…it has had a very positive effect on me as it has improved my interpersonal skills.
The EBL exercise was really enjoyable….I feel that it is an effective method for learning.

assessment of EBL consisted of six structured components providing clear outputs: the initial e-mail communication of therapeutic area, medicines and group structure (5%), report on the therapeutic area (15%), list of generic chemical information (10%), poster (20%), final report (40%) and contribution to team (10%, peer assessment). All students passed with good grades (63-87.5%) with verbal and/or written formative feedback given to the teams at various stages.

All 185 students were provided with an evaluation form for the EBL exercise, and 124 questionnaires were returned (65%). There were 15 questions on topics including team-working, generic skills, specific chemical skills and student support, for which the student was requested to score 1 (poor) to 4 (good). The data is shown in Figure 1, with a selection of positive comments in Table I and issues raised in Table II.

Discussion

As part of the EBL assessment, the teams presented high quality posters (2006) or oral presentations (2007) on their therapeutic area/medicines. Team members were confident when answering questions, demonstrating a good knowledge of pharmaceutical chemistry and an ability to relate this to the clinical effectiveness of the medicines. The teams also prepared comprehensive and well presented reports on the EBL exercise.

For the peer assessment component, each team member had the opportunity to comment on the role and input made by others. The comments were converted into marks by the module leader, ensuring that student effort was rewarded. Peer assessment has been identified as a "Top 5" key transferable skill required by graduate employers (Boud *et al*, 1999). Some problems have been reported with group assessment, such as a reluctance to participate and distrust in the marking abilities of their fellow students (Malcomson and Shaw, 2005). Furthermore Lejk and Wyville (2001) identified that groups may prearrange a marking scheme, however none of these issues were apparent in this study.

The student questionnaires (Figure 1) showed that the teams worked effectively (mean rating of 3.08) and were able to meet all deadlines (mean rating of 3.59). The lowest rating (mean rating of 2.32) was for the 'enjoyable' score, however this question was probably inappropriate: the students should have been asked to rate enjoyment relative to teaching by didactic methods. Indeed, medical students typically expressed more positive views when learning is *via* EBL compared with traditional methods (Dyke, 2001). An aspect rated highly was the increased knowledge of chemical properties (mean rating of 3.10). Furthermore the results of the survey yielded a good mean rating of 3.05 for relevance to pharmacy**,** making this a very positive aspect of the EBL exercise.

Students were also asked to provide comments on their experience of the EBL exercise, and a diverse selection of positive comments are shown in Table I. Students who enjoyed the EBL process felt that they benefited greatly from the experience and developed valuable interpersonal skills and friendships, assisting them in the challenging transition from school to university.

In addition, the students also raised a number of problems with the EBL exercise in 2005-6, solutions for which have been implemented in 2006-7 (Table II). One issue was team selection as it was felt that the personal tutorial groups (7-8) were too large. Fink (2004) suggest that a team of 4 can be optimal, although any smaller than this and the team working skills will be lost. In 2006-7, the personal tutorial groups were smaller.

Some of the negative comments were due to the minority presence of inactive team members. The conscientious students disliked inactive students receiving a similar mark to the rest of the team. Peer assessment was used as a mechanism to address this, however it was worth only 10% of the EBL exercise, which did little to either motivate weaker students or provide a wider spread of marks. Therefore, in 2006-7 each student was responsible for a medicine and the report was individually assessed (30%). In addition, the introductory information provided on team working in 2007 was strengthened with humorous analogies to good team working with monkeys and meerkats, and examples of poor team working skills with the lone wolf. It was raised that conflicts in the teams would inevitably arise, requiring swift resolution through negotiation, and that the challenges faced would be similar to those anticipated in the work place. In

Table II. Developments to the EBL exercise

Problem 2005-6	Solution 2006-7
Students lacked background knowledge.	Pharmaceutical chemistry lectures in semester 1, with EBL in semester 2.
Teams were too large.	Smaller personal tutorial groups.
Initial EBL training could be more relevant.	Information on EBL exercise included, and task started.
EBL was time consuming for 20% of module.	EBL exercise contributes 80% to module.
Medicinal chemistry specialist sessions were very busy.	Number and frequency increased.
Some students got a good mark for minimal effort.	Students were responsible for a report on an individual medicine.

2007, in contrast to 2006, the module leader did not have to intervene in resolving disputes within teams, perhaps because the students were better prepared to expect and resolve issues.

Students also commented that the initial EBL training in 2005-6 was too generic and should have been more related to their exercise. Zanolli and colleagues (2002) identified that training should focus upon group work on a related case. Therefore the introductory EBL workshop in 2006-7 covered more information relating to the pharmaceutical chemistry exercise, during which the teams commenced the activity with the organization of team structure, and selection of therapeutic area and medicines.

Students stated that they found the EBL process difficult, because they lacked background knowledge regarding the topic. Romero and colleagues (2004) teach pharmaceutics to pharmacy students using elements of EBL. They found that most effective learning occurs when EBL was complemented by lectures on key topics. Therefore in 2006-7 traditional teaching methods (12 lectures on pharmaceutical chemistry) were given in Semester 1, prior to the EBL exercise in Semester 2.

An issue raised by the students was that the EBL module was time consuming, contributing to only 20% of the module in 2005-6. In 2006-7 the EBL component was 80% of the final module mark, which addressed this concern.

In conclusion, the introduction of EBL into the pharmaceutical chemistry module of the first year of the pharmacy degree has been successful**.** Students identified that EBL encouraged them to initiate their own learning and it provided an ideal mechanism to promote integration and establish the link of pharmaceutical chemistry to a clinical context. The students also practised several key skills, including team working, IT, presentation, interpersonal and time management skills, all essential for a career in pharmacy. In addition, the professional accreditation body, RPSGB, requires graduates to develop independent learning skills, self-management and peer assessment which this module encompasses (RPSGB, 2002).

Acknowledgements

Support from William Hutchins, Peter Khan, Karen O'Rourke, Norman Powell, Ruth Silman, Elizabeth Theaker and academic staff and students in the School of Pharmacy is appreciated, as is a project grant from CEEBL.

References

Boud, D., Cohen, R., & Sampson, J. (1999). Peer learning and assessment. *Assessment & Evaluation in Higher Education*, 24, 413-426.

Dyke, P., Jamrozik, K., & Plant, A. J. (2001). A randomized trial of a problem-based learning approach for teaching epidemiology. *Academic Medicine*, 76(4), 373-379.

Edelson, D. C., Gordin, D. N., & Pea, R. D. (1999). Addressing the challenges of enquiry based learning through technology and curriculum design. *Journal of the Learning Sciences,* 8, 391-450.

Fink, L. D. (2004). Beyond Small Groups: Harnessing the extraordinary power of learning teams. In: Michalsen, L., Knight, A., Fink, D. Team based learning: A transformative use of small groups, Sterling USA, Stylus publishing.

Glasper, E. A. (2001). Child health nurses` perceptions of enquiry based learning. *British Journal of Nursing,* 10(20), 1343-1349.

Kahn, P., & O'Rourke, K. (2004) *Guide to Curriculum Design: Enquiry-Based Learning.* CEEBL, University of Manchester, www.campus.manchester.ac.uk/ceebl/resources/

Kwan, C-Y. (2002). Problem-based learning and teaching of medical pharmacology. *Nauyn-Schmiedeberg`s Archives of Pharmacology*, 366(1) 10-17.

Lejk, M., & Wyville, M. (2002). Peer assessment of contributions to a group project: Student attitudes to holistic and category based approaches. *Assessment & Evaluation in Higher Education*, 27, 569-577.

Malcomson, C., & Shaw, J. (2005). The use of self- and peer-contribution assessments within final year pharmaceutics assignment. *Pharmacy Education*, 5, 169-174.

Ravens, U., Nitsch, I., Hagg, C., & Dobromir, D. (2002). What is a good tutorial from the students' point of view? Evaluation of tutorials in a newly established PBL block course "Basics of drug therapy". *Nauyn -Schmiedeberg`s Archives of Pharmacology*, 366 (1), 69-76.

Romero, R.M., Eriksen, S.P., & Haworth, I.S. (2004). A decade of teaching pharmaceutics using case studies and problem based learning. *American Journal of Pharmaceutical Education*, 68 (2), 1-7.

RPSGB. (2002). Report on responses to RPSGB consultation document “Future Pharmacists”.

Rutter, P, (2002). Monash Pharmacy Practice Symposium. New approaches to teaching and learning. *The Pharmaceutical Journal*, 269, 583.

Shaw, S., Lacey, J., Leighton, B., & Warner, B. (2006). How problem-based learning supports continuing professional development. *The Pharmaceutical Journal*, 277, 254-255.

Zanolli, M. B., Boshuizen, H. P. A., & De Grave, W. S. (2002). Students' and tutors' perceptions of problems in PBL tutorial groups at a Brazilian Medical School. *Education for Health*, 15(2), 189-201.