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The University of Manchester

Centre for Excellence in Enquiry-Based Learning

Project Case Study

Application of Chemical Knowledge to the Clinical Understanding of Medicines

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Abstract

An Enquiry-Based Learning (EBL) approach has been utilised in a first-year Pharmaceutical Chemistry module. The aim is to encourage Pharmacy students to take an integrated approach to their learning across the subject areas of the multi-disciplinary Pharmacy degree, and appreciate the pivotal role that chemistry plays in the understanding of drugs. Teams of Pharmacy students have selected a therapeutic area and three drugs for its treatment, completed an information retrieval and processing exercise and applied the knowledge of their chemical properties to appreciate clinical effectiveness. Assessment has included a report and a poster session, together with peer assessment. The EBL exercise has been evaluated using a questionnaire delivered to all students, which investigated the acquisition of chemistry knowledge and the development of generic skills.

Background

This report details the EBL component of the ‘Pharmaceutical Chemistry’ module, which is given as a core module to 185 first-year pharmacy students in their second semester. All students have an A level (or Access equivalent) in Chemistry, and they have completed a module titled ‘Basic Organic Chemistry’ in the first semester. In this module the chemical concepts relevant to medicines are explored.

Rationale

In the Faculty of Medical and Human Sciences EBL is well established in some disciplines, such as Medicine and Dentistry, but this pedagogic method has not been used in the earlier years of the Pharmacy course. Amongst healthcare professionals, pharmacists are the experts in medicines and should have a sound knowledge of all aspects of medicines, including their chemical structure, ionisation states of functional groups, pharmacology, drug stability, drug delivery and clinical application. Whereas all of these aspects are taught in the degree, the majority of students compartmentalise their knowledge and find it difficult to apply basic science to a clinical situation. An aim, therefore, is therefore to improve the students’ ability to apply knowledge across disciplines and to appreciate the pivotal role that chemical knowledge plays in the use of medicines. In addition, a perceived lack of relevance of Chemistry to their profession has led some students to become disengaged and unmotivated. Student responses, such as ‘We are pharmacists, why do we need all this chemistry?’, have prompted a desire to use a medicines-based approach for the teaching of ‘dull chemistry’.

EBL uses team work extensively, which is an essential skill in the practice of pharmacy. In addition, EBL promotes student-centred independent learning and also enables the development of transferable skills (e.g. database searching, IT, poster preparation, report writing), essential for a career where continuing professional development is compulsory.

The professional accreditation body, Royal Pharmaceutical Society of Great Britain (RPSGB), requires graduates to develop independent

learning skills, self-management, peer assessment, as well as team working, and this module encompasses all of these initiatives. In addition, RPSGB requires that students are able to position scientific knowledge and understanding into the context of pharmaceutical practice.

Approach

- The 185 first-year Pharmacy students were divided randomly into their 27 personal tutorial groups at the start of the academic year. These formed the EBL teams of six to eight students and typically comprised of a mix of home and international students, mature students and some students with pharmacy-related experience.
- In week 1, the teams were introduced to the concepts of EBL and the essential skills for good team working by interactive workshops facilitated by Karen O'Rourke at the Centre for Excellence in Enquiry-Based Learning (CEEBL).
- In week 2, the teams met their personal tutor, who acted as a facilitator in response to students' requests for help or guidance. The team chose a therapeutic area (examples included cancer, heart attacks, depression, psoriasis), together with three drugs from the British National Formulary (BNF) for these conditions. The diseases were allocated on a 'first come first served' basis, with a maximum of two groups for each therapeutic area. In addition to supporting the EBL process, the students had to decide on a team structure with defined roles and an action plan.
- The team then researched and wrote a short (three-page) report on their chosen therapeutic area (level of Pharmacology textbooks) and brief mode of action of the three drugs.
- The teams were given the brief to understand how the chemical properties of the three drugs may be linked to their clinical effectiveness. First the team compiled a generic list of chemical properties that they would like to obtain on their three medicines, with one sentence stating why this chemical property may influence its use as a medicine. Anticipated topics included drug structure, conformation, pKa, ionisation state, partition coefficient, potential sites of chemical instability and metabolism. The majority of the teams approached the medicinal chemistry specialist in timetabled sessions or by e-mail for guidance.
- Once the list of required chemical properties was identified, the group carried out database searching (an appropriate guide to the relevant databases was pre-prepared by the Pharmacy specialist librarian) to obtain detailed information on their three drugs.

- In week 6, the students attended a second EBL tutorial with their personal tutor. The team was guided to consider a number of questions which can be related to the chemical properties of the drug: does the compound require any special preparation by the pharmacist? Can the drug be taken orally? What sort of packaging does the medicine require? What storage conditions are required and why? What side-effects are there and can these be explained by the chemistry?
- Subject specialist question sessions in medicinal chemistry, pharmacy practice, microbiology and drug metabolism/drug disposition were timetabled for the teams to consult in weeks 3-7.
- In week 9, the teams prepared and presented posters on their therapeutic area/medicines, using CEEBL as a venue. Written guidance was provided on what to include on the poster and how to prepare it electronically. The posters were of an outstanding quality and small prizes were given to the four teams that were group winners.
- The teams wrote a report (20 sides) on their three drugs, along with library retrieval information and bibliography, for week 9. The reports were well presented, demonstrating competency in a range of software, i.e. chemistry drawing packages.

Assessment

Assessment of the EBL part of the Pharmaceutical Chemistry module had six components to encourage effective time management throughout the project and to ensure the students were working on the correct aspects. The assessed areas were the e-mail communication of the therapeutic area, drugs and group structure (5%), report on the therapeutic area (15%), list of generic chemical information to be acquired (10%), poster (20%), final report (40%) and evidence of contribution to team (10%, peer assessment). For the peer assessment each team member had the opportunity to comment on the role and input made by each team member. The comments were then converted into a mark by the module leader. All students passed with good grades (63-87.5%). Verbal feedback had been given by the facilitator at various stages to one student member of the team.

Evaluation

All 185 students were provided with an evaluation form for the EBL exercise, and 124 questionnaires were returned (65%). There were 15

questions on a range of topics, including team-working, generic skills, specific chemical skills and student support, for which the student was requested to score 4 (GOOD) to 1 (POOR), the data for which is presented in Figure 1. The data shows that the teams worked effectively and were able to meet all deadlines. As a cohort, the students thought that their chemistry-specific skills and generic skills had improved, and most importantly they rated the EBL exercise as relevant to pharmacy. The provided information and the organisation of the EBL exercise were adequate. The lowest rating (2.32) was for the 'enjoyable' score; however, it was probably an inappropriate question as the students had not been asked to rate enjoyment relative to, for example, a lecture-only style of teaching. In addition, some teams raised issues regarding weaker team members (See Table 1), which made the exercise more stressful for some students.

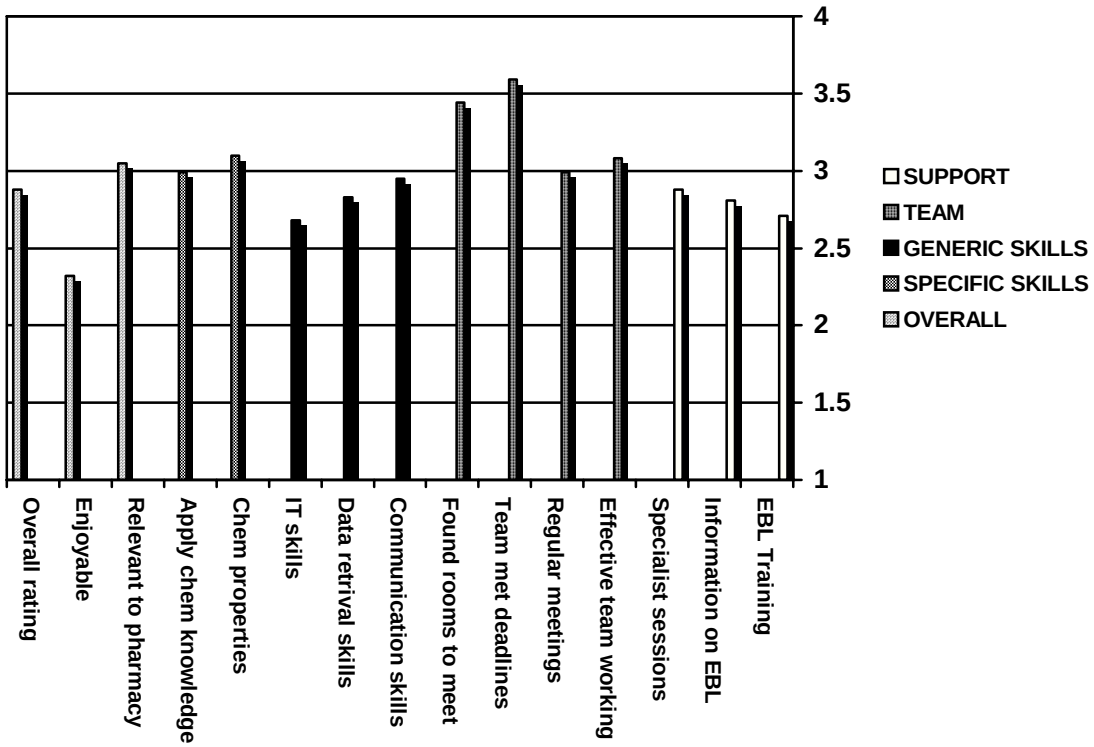

Figure 1 Results of student questionnaire.

In addition, the students were invited to give written comments. A sample of positive and negative comments is quoted in Table 1.

Positive Comments	Negative comments
I believe this project should be carried on in the future as it is fun, informative and unique in its approach.	I hate teamwork. EBL was never going to be my favourite.
The EBL exercise enabled us to build on our team-work skills and work together on a project that enabled us to learn information that is relevant to Pharmacy.	Some members of the EBL group have done no work, so the rest of us struggled to compensate for their lack of effort.
….met deadlines and made great relationships with group members.	I did not expect to encounter unmotivated and selfish people at this level of education.
Winning the poster group actually gave me a sense of pride.	The EBL exercise was unsuccessful due to the selection of the teams.
…it has had a very positive effect on me as it has improved my interpersonal skills.	Group size [7] made it difficult for us all to work together effectively.
The EBL exercise was really enjoyable….I feel that it is an effective method for learning.	It may have been useful if we had covered relevant materials in lectures prior to the tasks set.

Table 1 A sample of student comments on the EBL exercise.

Further Development

The evaluation, in particular the written feedback, raised a number of issues that needed to be addressed, which are summarised in Table 2.

Problem	Proposed solution
Students lacked background knowledge.	Lectures will be in Semester 1, with EBL in Semester 2.
Teams were pre-assigned and too large.	Personal tutor group will form two teams of 3 to 4 students, divided by student selection.
Initial EBL training could be more relevant.	Specific information on the exercise will be included.
EBL exercise was time consuming considering it was weighted for only 20% of module.	EBL exercise will contribute 80% to module.
Medicinal Chemistry specialist sessions were chaotic.	Number and frequency will be increased.
Some students got a good mark for no effort.	Each student will be responsible for a drug (personalised learning).

Table 2 Proposed developments to the EBL exercise

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