A HYBRID OF PROBLEM BASED LEARNING IN HIGHER LEVEL BIOCHEMISTRY : A FIRST EXPERIENCE

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Abstract

A hybrid style of Problem Based Learning (PBL) was trialed in an upper level biochemistry course in the Faculty of Science and Mathematics, Avondale College. While PBL is used frequently in a variety of professional and educational programs including disciplines such as nursing, medicine and engineering; its use in the biomedical science component of non-professional degrees such as a B.Sc. is limited. This paper will describe the first time experiences of both students and their lecturer during the presentation of Cellular Biochemistry, a 300 level course in the biomedical science strand of the B.Sc. degree. As a component of the assessment for this course, students maintained a learning journal. The lecturer also kept a learning journal, recording observations on students and reactions of the lecturer to the observed learning process. An analysis of such learning journals as well as recorded student interviews indicated that students could identify the development of skills associated with critical thinking, group conflict resolution, information access and retrieval, oral and written communication skills. It was also noted, that there was an overall increase in self-motivation and responsibility for learning by the students.

As a result of the evaluation process there arose a number of issues associated with the course's presentation. This paper will also look at the initiatives that were undertaken prior to the next presentation of this course. Of these issues the problems associated with the development and implementation of suitable assessment strategies was paramount to the success of the teaching initiative.

Introduction

Some time ago the authors sat down to explore the potential for the implementation of Problem Based Learning (PBL) into a Biology course. The implementation of the methodology of PBL was successful with the achievement of the, well documented, euphoria and problems (refer to the many articles on PBL implementation and evaluation (King, 1999). It was in the process of reflection that it became apparent that this project had only just touched on the potential of the methodology. It is from this perspective that we felt compelled to claim the implementation of only a hybrid form of PBL. In the evaluation and the development of strategies and approaches to address issues from the first adoption of the teaching approach we were better able to develop the changes necessary to bring it to a more accurate reflection of an exacting PBL methodology. In the following discussion, it is hoped the reader will see our progression towards a theoretically more accurate form of the

methodology as a process of development, which will entail ongoing development, implementation and evaluation.

Why Problem Based Learning?

Avondale College is a small tertiary institution located in a rural setting north-west of Sydney, Australia. A variety of courses are taught including science, nursing, business, education and theology. The context for this paper is the disciplinary fields of biochemistry and molecular biology. Educational strategies employed to the time of the implementation of PBL have been of the lecture delivery type with assessment items which included assignments, lab reports, tests, tutorial sheets and end of semester exams. A decision was made to change direction with both the method of delivery and the assessment strategies used to support the course. The change of direction resulted from the identification of a number of issues that were of concern. These issues included:

- some notable student disinterest in lectures,
- some students displayed poor performance in tests and examinations,
- students often did not appear to retain knowledge or information for long periods of time, especially over a period covering a year or more.

Further, it has been evidenced from an evaluation of student assessment tasks, students do not often develop an adequate synthesis of related concepts and fail to see how a particular topic fits into the "bigger picture" of their discipline.

From a lecturer's perspective, it is often difficult to select suitable lecture topics from the vast body of knowledge in a given discipline. On many occasions, course material presented only reflects the lecturer's area of interest and other important content tends to be omitted. As a consequence of such traditional teaching practices, students are at best passively involved in the learning process (Scott, 1997). These factors led to the trial of, what is claimed to be, a hybrid implementation of PBL in an upper level biochemistry course.

Implementing PBL

PBL is used successfully in a variety of professional and educational programs covering a wide range of disciplines from nursing (Andrews and Jones, 1996) to policing (Melville and Gartner, 1994). It has not been used widely in the biological sciences outside of the professional degrees, but can found to be implemented in some biological courses within professional degrees such as in the microbiology course of a veterinary program described by Green (1999). With change toward a PBL approach, instead of students being presented with structured formal lectures and tutorials, where information is disseminated by the lecturer and the degree of retention by the student assessed, a change is made to a learning environment where students are exposed to a series of problems for which solutions are

developed. The lecturer becomes a facilitator and the students become actively involved in the learning process.

Core Skills

Cowdroy and Mauffette (1999) discuss the benefits of PBL in science education, within disciplines that are not part of professional degrees. The authors note that historically, science has been driven by skills such as curiosity and critical inquiry and they observe that typical science educational processes concentrate on disseminating and learning conventional scientific procedures. The outcome of the process of learning such procedures invariably works against the development of creative intellectual thinking, upon which the very nature of scientific inquiry depends. Sternberg (1989) identifies the capacities of divergent creative thinking and critical enquiry as fundamental competencies to the progressive development of scientific capacities.

A feature of PBL is the requirement of the student assuming greater responsibility for their own learning (Boud and Felleti, 1991). Instead of being passively involved, students are encouraged and supported in the development of the core skills of:

- critical thinking,
- problem evaluation,
- analysis of literature,
- assessment of established theories in the light of evidence,
- oral and written skills associated with the communication of problem analysis,
- and the ability to work as a member of a team.

In fact, the process of problem solving becomes preeminent to the content, meaning that selection of content material becomes less critical. This is because the process can be applied to a variety of problems in a variety of disciplines. Student self-evaluation and reflection on the learning process are also important aspects of PBL (Scott, 1997, 89). The development of these core skills better equip a graduate to become a life long learner.

Case Study

An upper biochemistry (300 level or third year) course, Cellular Biochemistry was chosen for the trial of the PBL educational strategy. The students had no prior experience in educational methodologies associated with PBL. The course focuses on the function and organisation of the cell, integrating earlier work in biochemistry, physiology and molecular biology. It contributes to the basic scientific knowledge acquired by a student studying the biological and health sciences. It also aims to develop an appreciation for the complexity of the cell and its processes, such as cellular differentiation, development and communication.

All students formed one group, a small class size of six, for the purposes of problem analysis. Group meeting minutes were recorded in a log with students taking turns as chairperson. The instructor sat in on all group meetings. The purpose of these meetings was to determine the limits of the problem, its investigation and assignment of tasks. Individuals reported completion of tasks to the meeting as small seminar presentations, which were followed by group discussion.

Students were supplied with a detailed course description, which included materials explaining the nature of PBL and outlining the type of core skills that might be developed as a result of approaching study in this methodology. Also included in the course materials were instructions for management of meetings, meeting log forms (see Appendix A), problem topics and a manual of research papers and references for each problem topic. Guidance was also provided for report writing as it was an expectation that students would write, edited and present a final group report.

The process that was followed by the group is similar to the PBL approach outlined by Williams and Williams (1994) where students started the process with problem identification and analysis. All aspects of the problem that need investigation were noted and students were encouraged in the use of concept map diagrams to help to clarify issues. The relevance of the problem to biochemistry and molecular biology was also considered, as was the significance and application of the problem outside of the sciences. Aspects of the problem were assigned to individual members of the group for further investigation who would then report back to the group at a regular series of meetings with discussion on how individual literature investigations inform the problem-solving process. Further literature investigations and discussions would continue until there was group consensus on the approach to the problem solution. The final stage of the process was the submission of a group written report.

Student Assessment

A significant part of the assessment was based on presentation of a final group problem report and to a lesser extent, on student learning journals (as described in Gibbs, 1995). The group problem report would provide evidence of critical thinking, problem evaluation and solution, research and evaluation of the literature. However other core skills such as communication, teamwork and conflict resolution could not be assessed using the final group report document.

As a measure to address the concern of lack of assessment of identified core skills the assessment procedures were modified with the commencement of the second cohort of students. The most notable changes were the introduction of peer and lecturer assessment. Such a procedure was designed to assess those core skills not evident in producing the group report. These core skills, as developed for this course included:

- participation in group meetings/discussions,
- degree of preparation for group meetings/discussions,
- communicates well with the group,
- makes positive contributions to group dynamics,
- and fulfils responsibilities allocated in the group log.

The course assessment was modified to include peer and lecturer assessment which was performed three times during the semester. Each student assessed themselves and the other students within their group on the defined criteria (see Appendix B). The nature of the assessment was strictly anonymous and copies of the assessment were returned to the student. Anonymity was maintained by distributing the assessment forms with the name of each student being assessed already entered on the form. No, identifiable, handwriting was required by the student doing the assessment, only circling a number in the assessment scale. The five key skills associated with PBL were assessed. The methodology developed to support students in the evaluation of both their own and their peers was informed by the methodologies proposed by Habshaw (in Gibbs, 1995) which involved:

- Detailed instruction and discussion of the process prior to implementation.
- Process should be trialed before full implementation.
- The topic chosen for study should be new to all students in the group as to remove any notion of advantage.
- There should be no free choice for individuals allowed within the topic, the outcomes should be specific.

This process involved the evidence of each skill being ranked from 1 to 5 (1- never; 2- rarely; 3 – sometimes; 4 - most of the time; 5 – always fulfils task completely). A description of the ranking for each skill criteria was included on the assessment instrument, for example, criteria for the skill *"Participation in group meetings/discussions"* was described as*: "1. The student does not participate in and very rarely contributes to group discussions. If any contributions are made, they do not reflect a familiarity with the issues at hand and are not thoughtful nor constructive. 5. The student will always participate in and contribute to group discussions. The contributions always reflect a familiarity with the issues at hand and are always thoughtful and constructive."*

The lecturer performed the same anonymous assessment and this was also returned to each student. The first assessment of this type was not graded, the second and third assessments were worth 5% and 10% respectively.

Instructor Attitudes and Perceptions

Significant attitudes and perceptions of both students and the instructor were

observed during the implementation and development of this course. The following instructor perceptions were noted. There was a high degree of enthusiasm coupled with apprehension concerning the success of the introduction of PBL and student reactions that might result. There was considerable difficulty in "letting go" of the control of the learning process. It was not easy to sit and listen to student discussion and the temptation to take control in group meetings had to be resisted. There was concern over friction that may develop within the group, over members of the group who do not contribute as well as others and also watching the group enter into tangential discussions. There was a degree of anxiety associated with trialing a "non traditional" teaching method, the apparent reduction in course content and the method and equity of assessment. There was always an underlying concern that PBL may not benefit the students. However, it was rewarding to observe students taking responsibility for their own learning and observe the development of core skills associated with PBL.

Student Attitudes and Perceptions

Students also displayed enthusiastic excitement and were surprised by their freedom at being able to direct their own learning experiences. They were challenged by the amount of information available to them in journals, texts and on the Internet. They were also challenged by the problem solving exercises and significantly, the editorial procedure associated with the preparation of the group report.

It was noted that they appreciated being treated as a colleague instead of a student. There was a developing awareness of their own responsibility for learning, of self development coupled to the recognition that PBL is one of the best ways to extract, manage and apply information. Students enjoyed the experience of 'brainstorming' a problem rather than being lectured to. Students developed the perception that less reliance on the lecturer/teacher is acceptable. On an interesting note, an observation made on the basis of student learning journals, PBL seems to encourage the assessment of certain personal issues in the life of some students - even led to questions of "Who am I?" and "What I am doing?"

On a negative note, the following student perceptions were also observed. Students at first were unsure of boundaries, unsure of their report writing skills and expressed a certain amount of trepidation about the process. Some felt lost, confused and unsure of what to do. There was concern over assessment, group conflict (dealing with diverse ideas and the shallow effort of some students) and the temptation to procrastinate. Some concern was noted about reduced course content, minimal input from the lecturer and the fact, that to some this was just as hard as traditional learning.

Tangible Results

It was noted that during the course of the course, there was an observable increase in the core skills associated with PBL including critical thinking, information retrieval

and synthesis, communication skills, conflict resolution, report writing, etc. It was also observed that there was an increased general self confidence, a development in the ability to synthesize self acquired knowledge and the use of knowledge from other classes, eg: chemistry students with specialised knowledge were able to apply it in a different context.

Students also displayed an increased responsibility for the learning process and appreciation for the limits of the scientific process. Students were confident in their approach to other lecturers in related disciplines to gain specific information on a given problem. They were also able to recognise that skills acquired in PBL would be applicable to career pathways and/or a higher degree. In fact, some students were keen to take on research type courses and tackle other projects, while others expressed that they had noted improved learning in other courses. But there was an expression of frustration by some students when attending other classes following traditional teaching methods. This frustration manifested itself in an increased desire to ask questions (but not able to do so in a lecture situation). Also in an increased desire to know how a topic integrates into the "bigger picture" (which is not always explained in a lecture situation). Frustration was also evident in an increased student desire to follow a particular topic of interest in another course at greater depth (but not being able to do so in a traditional class).

Conclusion

In this paper has been documented the changes made to the assessment methods implemented to align the course's methodology more closely with the qualities of PBL. The changes have enhanced the students' achievement of the core skills identified in the paper. Students were able to identify the attainment of these skills through the evaluation of their own as well as others according to the developed criteria.

So a "hybrid" of PBL? Have the changes to the assessment processes allowed the removal of the quantifying term? The authors think not. Some looking at the course would identify that the structure and the methodology certainly does represent certain important characteristics associated with PBL type instructional techniques. The process of refinement is yet begun and the consideration of modification now turn to the issues of articulation within a PBL curriculum structure and the integration of the content and processes further. So a hybrid it shall remain, but because of the modification to the assessment to attain a better alignment of the assessment to the practices of PBL perhaps a purer form of the PBL genre has been attained.

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Appendix A

PROJECT MEETING LOG	
Meeting Date: **Time:**	
Team Members Present:	
Report on Carried Over Actions or Items	Member Reporting
PROJECT MEETING LOG	
Meeting Date: **Time:**	
New Actions	Member to Action

Appendix B

BI311 CELLULAR BIOCHEMISTRY

ASSESSMENT SHEET

Peer/Lecturer Assessment for: (Name of student will be printed here)

Please fill in the following assessment sheet using the key below:

- 1 never
- 2 rarely
- 3 sometimes
- 4 most of the time
- 5 always fulfils task completely

For the person under consideration circle the number that is most appropriate:

		Never				Always
1.	***Participation in group meetings/discussion.***	**1**	**2**	**3**	**4**	**5**
2.	***Degree of preparation for group meetings/discussions.***	**1**	**2**	**3**	**4**	**5**
3.	***Fulfils responsibilities allocated at group meetings.***	**1**	**2**	**3**	**4**	**5**
4.	***Communicates well with the group.***	**1**	**2**	**3**	**4**	**5**
5.	***Makes a positive contribution to group dynamics.***	**1**	**2**	**3**	**4**	**5**

Note:

A. Participation in group meetings/discussion:

1. The student does not participate in and very rarely contributes to group discussions. If any contributions are made, they do not reflect a familiarity with the issues at hand and are not thoughtful nor constructive.

3. The student will sometimes participate in and contribute to group discussions. The contributions sometimes reflect a familiarity with the issues at hand and are sometimes thoughtful and constructive.

5. The student will always participate in and contribute to group discussions. The contributions always reflect a familiarity with the issues at hand and are always thoughtful and constructive.

B. Degree of preparation for group meetings/discussions:

1. The student does not prepare for the group discussion, failing to read around the area for discussion in addition to their allotted task. They do not keep abreast of where the group is in terms of discussion and direction.

3. The student sometimes prepares for the group discussion by reading around the area for discussion in addition to their allotted task. They sometimes keep abreast of where the group is in terms of discussion and direction.

5. The student always prepares for the group discussion by reading around the area for discussion in addition to their allotted task. They always keep abreast of where the group is in terms of discussion and direction.

C. Fulfils responsibilities allocated at group meetings:

1. The student does not show any responsibly in fulfilling tasks assigned at group meetings and does not report on this activity at the next group meeting, or date assigned by the group.

3. The student sometimes shows responsibly in fulfilling tasks assigned at group meetings and reporting on this activity at the next group meeting, or date assigned by the group.

5. The student always shows responsibly in fulfilling tasks assigned at group meetings and reporting on this activity at the next group meeting, or date assigned by the group.

D. Communicates well with the group:

1. The student does not communicates their thoughts and ideas in a clear, concise scientific manner. (Communication can also take the form of diagrams, small presentations, handouts, use of the white board, OHP or other aids).

3. The student sometimes communicates their thoughts and ideas in a clear, concise scientific manner. (Communication can also take the form of diagrams, small presentations, handouts, use of the white board, OHP or other aids).

5. The student always communicates their thoughts and ideas in a clear, concise scientific manner. (Communication can also take the form of diagrams, small presentations, handouts, use of the white board, OHP or other aids).

E. Makes a positive contribution to the group dynamics:

1. The student does not contribute to the harmony of the group. They do not encourage an atmosphere of intelligent discussion where all points of view are heard. They may be argumentative or can overly sidetrack the group by injecting issues not directly relevant to the task in hand.

3. The student sometimes contributes to the harmony of the group. They sometimes encourage an atmosphere of intelligent discussion where all points of view are heard. They do not dominate the discussions, nor are they argumentative. They do not overly sidetrack the group by injecting issues not directly relevant to the task in hand.

5. The student always contributes to the harmony of the group. They always encourage an atmosphere of intelligent discussion where all points of view are heard. They do not dominate the discussions, nor are they argumentative. They never sidetrack the group by injecting issues not directly relevant to the task in hand.