# COLLABORATIVE PROJECT–BASED LEARNING AND PROBLEM–BASED LEARNING IN HIGHER EDUCATION: A CONSIDERATION OF TUTOR AND STUDENT ROLES IN LEARNER-FOCUSED STRATEGIES

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## Introduction

The aim of this chapter is twofold. Firstly to support academic staff from a variety of subject disciplines in higher education in the clarification between two different learner focused strategies, namely collaborative project-based (CPBL) and problem-based learning (PBL). Secondly, to provide practical advice to them to assist in the making of informed decisions as to when which strategy is most appropriate to use to support learning. These decisions will be based on a sound understanding of each strategy and a consideration of when each is most appropriate to use in enhancing the learning of their students.

Section One explores what is meant by group learning. Students have knowledge, views and experiences to share that are valuable and worthy of consideration. Opening up our classes to the voices of our students is sending a very powerful message to them as it is through dialogue with others, articulation of viewpoints and identification of concerns that students are enabled to make sense of new information.

Definitions of the two learner-focused strategies will be provided in specific contexts within higher education. Collaborative project-based Learning will consider the learning afforded by the involvement of students in a collaborative group project. Problem-based learning will explore the importance of placing students in control of their own learning.

Section Two details each strategy under the key headings: the role of tutor and students.

## Group Learning

Lecturing is without doubt effective for transmitting information but if we wish to develop thinking skills, problem solving abilities and lifelong learning skills a more student-centered approach

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must be taken. This involves a change in the role of the lecturer from presenting information to students to facilitating and guiding learning. Palmer (1998) talks about preparing a learning space so that students can learn with and from each other and the there can be no doubting the potential of the group to learn from each other. According to Race (2001) *'learning from other people is the most instinctive and natural of all the learning contexts we experience'*. Group discussion allows students to attend more clearly to meaning as they interact with the language of the discipline and put into their own words the issues arising from a particular topic. It also gives students an opportunity to direct and take responsibility for their own learning. It has been argued that in higher education today students must be supported to develop specific expertise and knowledge in their chosen discipline and also facilitated to develop *'the skills necessary for employment and for life as a responsibility citizen'* (Fallows and Steve 2000). In a group learning context students are facilitated to develop key skills such as communication and teamwork. Students can only become proficient in a skill by practicing it and in a group learning context the students have to learn how to work within a group and listen and negotiate with others in order to resolve dilemmas or conflicts. These are important skills for students to develop as research indicates that employers worldwide want graduates who have well developed communication, teamwork and problem solving skills. The realization of this type of learning environment depends to a large extent on the skill of the tutor to lead and facilitate group discussion but many tutors find this task *'difficult to perform satisfactorily and too readily fall back in frustration on their reserve position of authority, expert and prime talker'* (Jaques 2000). Also, many students will want to be given the solutions to problems rather than taking responsibility for finding information and discussing it together and so there is a need for induction and tutor training and support; this will be discussed in more detail later in the chapter. There is a real potential to promote a deeper engagement with the subject matter and enhance the student experience by creating opportunities for group learning but this does require the tutor to focus more on the design and development of the learning experience and less on transmission of content. In further sections, we will look more closely at the role of tutor and students in project-based and problem-based learning. Firstly, we will define the terms, as each are each used to describe a range of instructional strategies. The breadth of their respective definitions, their conceptual similarity, and the use of the shorthand term PBL result in has previously resulted in some confusion in the literature.

## Definitions

Project-Based Learning is an individual or group activity that goes on over a period of time, resulting in a product, presentation, or performance. It typically has a time line and milestones, and other aspects of formative evaluation as the project proceeds. For the purposes of this chapter, we are considering the group activity involved in collaborative project-based learning.

Problem-based learning is both a curriculum and a process. The curriculum consists of carefully selected and designed problems that demand from the learner acquisition of critical knowledge, problem solving proficiency, self-directed learning strategies, and team participation skills. The process replicates the commonly used systemic approach to resolving problems or meeting challenges that are encountered in life and career.

As defined in the literature, project-based learning and problem-based learning share several characteristics. Both are instructional strategies that are intended to engage students in authentic, "real world" tasks to enhance learning. Students are given open-ended projects or problems with more than one approach or answer, intended to simulate professional situations. Both learning approaches are defined as student-centered, and include the teacher in the role of facilitator or coach. Students engaged in project- or problem-based learning generally work in cooperative groups for extended periods of time, and are encouraged to seek out multiple sources of information. Often these approaches include an emphasis on authentic, performance-based assessment.

Despite these many similarities, project- and problem-based learning are not identical approaches. Project-based learning tends to be associated with engineering and science instruction.

Problem-based learning is also used in these disciplines, but has its origins in medical training and other professional preparation practices (Ryan and Koschmann 1994).

In practice, it is likely that the line between project- and problem-based learning is frequently blurred and that the two are used in combination and play complementary roles. Fundamentally, problem- and project-based learning have the same orientation: both are authentic, constructivist approaches to learning. The differences between the two approaches may lie in the subtle variations. There are at least two possible continua of variation in these type of learning approaches. One is the extent to which the end product is the organizing center of the project. On one end of this continuum, end products are elaborate and shape the production process, such as a CAD engineering piece which requires extensive planning and effort. On the other end, end products are simpler and more summative, such as a group's report on their research findings. The former example is best described as project-based learning, where the end product drives the planning, production, and evaluation process. The latter example, where the inquiry and research (rather than the end product) is the primary focus of the learning process, is a better example of problem-based learning.

A second continuum of variation is the extent to which a problem is the organizing centre of the project. On one end of this continuum are projects in which it is implicitly assumed that any number of problems will arise and students will require problem-solving skills to overcome them. On the other end of this continuum are projects that begin with a clearly stated problem or problems and require a set of conclusions or a solution in direct response, where the problematic situation is the organizing centre for the curriculum. Here again, the former example typifies project-based learning, where the latter is best described as problem-based learning.

## Clarification Between Strategies

Project-based learning typically begins with an end product or "artifact" in mind, the production of which requires specific content knowledge or skills and typically raises one or more problems which students must solve together. Projects vary widely in scope and time frame, and end products vary widely in level of technology used and sophistication. The collaborative project-based learning approach uses a production model: first, students define the purpose for creating the end product and identify their audience. They research their topic, design their product, and create a plan for project management. Students then begin the project, resolve problems and issues that arise in production, and finish their product. Students may use or present the product they have created, and ideally are given time to reflect on and evaluate their work (Blumenfeld et al. 1991). The entire process is meant to be authentic, mirroring real world production activities and utilizing students' own ideas and approaches to accomplish the tasks at hand. Though the end product is the driving force in collaborative project-based learning, it is the content knowledge and skills acquired during the production process that are important to the success of the approach.

Collaborative project-based learning adopts a multidisciplinary, project-based approach using real world problems to bringing together knowledge and skills. Designing the appropriate course materials provide the flexibility for a move away from transmission teaching in large lecture halls to a more student-centred teaching and learning environment. The term learning environment can be used to distinguish it from approaches based primarily on a sequence of questions, answers and feedback. A learning environment places greater emphasis on problem solving situations and mechanisms to assist the learner in their tasks and monitor learning.

Problem-based learning, as the name implies, begins with a problem for students to solve or learn more about. Often these problems are framed in a scenario or case study format. Problems are designed to be "ill-structured" and to imitate the complexity of real life cases. As with project-based learning, problem-based learning assignments vary widely in scope and sophistication. The approach uses an inquiry model: students are presented with a problem and they begin by organizing any previous knowledge on the subject, posing any additional questions, and identifying areas they need more information.

In acknowledgement of this existing blurring between the strategies, and in seeking clarification, we find it helpful to look at each strategy in terms of the role of the tutor and students.

## Role of the Tutor in CPBL

Collaborative project-based work is well established as a component of many courses in Arts, Social Sciences, Science, and Technology in higher education. The argument for the strategy principally rests upon the assumption that it is a means of developing a more active and motivated student-centred approach to learning.

A reason for introducing this form of learner-focus strategy is that students may have relatively little understanding of the real world examples that lecturers use in illustrating concepts in lectures.

In conventional face-to-face teaching, the introduction of project-based methods entails recognizing that there will be less tutor control over the learning processes, that students must accept more responsibility for organizing their own learning experience, and that assessment is more complex because the piece of work that results from each student project will be unique. This variety is usually accommodated within the "conventional" learning framework by laying greater emphasis on providing opportunities for tutor supervision and guidance at appropriate stages during the course of the project. In a traditional setting of face-to-face teaching, frequent tutor/student contact means that adjusting the balance of supervision and guidance is a relatively flexible process. Knowledge of the project, built up by that tutor/student contact, can make assessment of it easier.

Biggs (1999:93) outlines the features of rich teaching and learning environments and emphasises that *'knowledge is constructed through learner activity and interaction'*. He goes on to point out that this kind of environment is created through a variety of teaching and learning activities directed by teachers, learners and peers because these each serve different purposes.

Collaborative project work often goes on for a considerable length of time, though the time span may range from a single afternoon to several years. Advantages of project-based learning include the encouragement of student initiative, self-directiveness, inventiveness, and independence. However, a project-based course demands from students a heightened level of self-confidence, motivation, and ability to organize their own work plans. A number of the issues are also present for the tutor: related to project time allocation, project scope delineation, and tutorial responsibility.

There may be extra involvement and time commitment that collaborative project-based work entails for tutors. This emerges from extra workload, on the extra resources that may need to be allocated to compensate for it, and on the more complex task of project assessment.

The tutor's role is very important at the design stage:

- Strong guidance is needed on how to tackle project work at the outset in order to reduce the likelihood of students attempting to undertake overly ambitious projects;
- Project specifications should be more detailed than they would be in "face-to-face" teaching;
- Careful piloting and testing of proposed projects should be undertaken in advance of the first presentation of the relevant course in order to establish reasonable estimates of time required for successful student completion;
- Sample projects should be provided to indicate to students the scope of project expected, in order to help students form a realistic picture of what they are expected to achieve;
- Course teams should be aware of the importance of a Project Guide (a document containing guidelines for undertaking the relevant project) and strive to make it as clear and as helpful as possible;
- It should be recognized that extra demands are made upon tutors both in terms of personal involvement and of time commitment in evaluating or assessing projects.

Collaborative project-based methods also imply more tutor involvement in terms of reassurance and guidance. Assessment will also be more demanding, and more resources may need to be allocated for assessment than would be required on "teacher-directed" courses (Crooks et al. 1976). They also need guidance on the extent to which they should allow students to follow an independent path and at which point they should intervene if a student's chosen direction seems to be going badly off-course. The flexibility of tutorial contact makes it easier to remedy the problem of students taking a "wrong" direction.

From an academic point of view, tutors also need to be clear about the rewards and penalties that students may incur by pursuing an unconventional solution to their project problem. They need to know the balance that the course aims to achieve between encouraging students to produce unique solutions and rewarding a successful arrival at the "end goal."

## The Role of the Student in CPBL

This is a student centred learning strategy and as such the role of the student must be considered. In the section which follows, we will outline and develop the important issues for students who are undertaking a project in higher education.

Throughout your studies at college you will be given a variety of opportunities to develop your skills as an independent learner and doing a project is a real example of this. A project takes you beyond what you already know about a topic and therefore requires research from a variety of sources including books, research papers and the world wide web. What you include in your project and how you present it will vary according to your discipline and the specific purpose of the project. However doing a collaborative project will require you to put into practice a range of important skills such as searching literature, collecting information from a wide variety of sources, analysing data and working as part of team. In addition skills of communication and time management will be important.

## Managing the Project

Doing a collaborative project requires that you identify key learning issues and take assume responsibility for your own learning as you undertake an extended piece of work and time management is a key area. Begin the project as soon as possible once you have the brief and plan your time to ensure that you make steady progress and build in regular project team meetings.

## Producing a successful project

A project brief can be daunting but it can help greatly if the task is broken down into a series of stages and then the group can logically work through each stage until your task is completed. A diagram of the main stages involved in doing a project is presented in Figure 1 below.

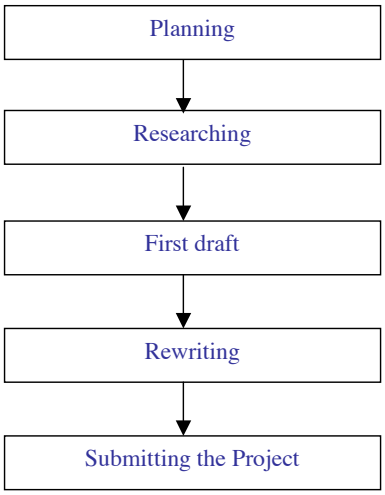


**Fig. 1:**

## Stage 1 — Planning

At this stage it is essential to make sure that you understand what the project requires. Read the brief carefully several times and write down initial thoughts and any questions that you might have. Then, at this stage, it will be essential to discuss the project brief with other students in your group but if you are unsure it is very important that you arrange to meet with the academic tutor involved with the project to avoid completing a task only to realise you misunderstood it. Once you have clarified the project brief you are now ready to begin researching.

## Stage 2 — Researching

This stage involves the group deciding on areas of responsibility for each individual. Then it will be necessary to locate relevant literature taking into account your aims and purposes, so that the information you gather is relevant. The amount of research will depend on the nature and length of the project and the time available to complete the work.

A large amount of information is available electronically and you will need to be able to use the library catalogues, databases and internet search engines. It is best to start with a visit to the library and librarians will give advice and guidance. It is very easy at this point to branch off in a variety of directions and spend a lot of time researching literature that is not directly relevant. In order to avoid this possibility it is good practice to keep in front of you the project title and this will support you to search through the literature using key words and thereby locate relevant material. Having located the literature it is important to take notes and record the main ideas gleamed from the text and think about how these relate to what you already know. It will be necessary to think critically and form conclusions based on a systematic evaluation of the available evidence.

Also take care to record your references sources correctly as failure to do this will mean that at a later stage you have to revisit all the literature consulted in order to check references and this can be very time consuming. It is expected in academic work that sources are correctly referenced and always avoid plagiarism, which is presenting somebody's work as your own without acknowledging it.

## Stage 3 — First Draft

Having located and evaluated the relevant information you can now move logically to the next stage, which is to write a first draft of your section of the project. All good writers produce a

draft, which they revise and edit to produce a final version. Once you begin to write you will find that you will begin to clarify your thinking. Try to get all your ideas down on paper first and you can reorganise later to ensure that there is logic to the draft and that your writing is clear and coherent and meets academic expectations. You must be very careful to reference the work of other people so as there is no plagiarism in the finished work. In producing a collaborative project, there will be a need to decide as a group how best to synthesise the individual elements into a coherent whole. A number of approaches can be taken to this but it will be essential that the final document is logical and consistent.

There is a common formula for writing an assignment at college level that may appear simplistic but does provide a good structure for a project:

- Introduction: Provide the reader with a clear outline of what you are going to do in the project and relate it to the project title.
- Main Body: Draw on relevant material and present your arguments in a structured way.
- Conclusion: Bring everything together so that there is a sense of completion. This involves summarising the main points, making recommendations and highlighting issues for further investigation.

## Stage 4 — Rewriting

It is important to understand that all writing involves rewriting and that even the most gifted writers will revisit work and edit and revise. Pay attention to the following as you make annotations and amendments:

- The document clearly adheres to the project brief
- The objectives are achieved and there are no gaps in the work
- There is a logical flow to the document
- Formal academic language is used
- The conclusions are clear to the reader
- The document is clear and well presented and adheres to the conventions laid down in the assignment brief.

## Role of the Tutor in PBL

As the amount of direct instruction is reduced in problem based learning, students assume greater responsibility for their own learning (Bridges and Hallinger 1991). The tutor's role becomes one of subject matter expert, resource guide, and facilitator of learning in the group. This arrangement promotes group processing of information rather than an imparting of information by tutors (Vernon and Blake 1993). The tutor's role is to encourage student participation, provide appropriate information to keep students on track, avoid negative feedback, and assume the role of fellow learner (Aspy et al. 1993). In essence, tutors should be more concerned with the process of learning of students than with the content of their learning. To do this properly requires many skills from the tutor, most of them in the field of social-pedagogy.

Fundamentally, the tutor is an educator who leads a task-oriented group to successfully achieve the outcomes of a teaching programme. In doing this, the tutor has to fulfil several responsibilities and is accountable to the teaching programme for the satisfactory completion of them. These responsibilities require abilities and skills relevant to the principles and practice of problem-based learning, group dynamics, the assessment of student learning, the use of learning resources and managerial skills.

The role of the tutor is very different from the usual teacher's role. Rather than being a "content expert" who provides the facts, the tutor is a facilitator, responsible for guiding students to identify the key issues in each problem and to find ways to learn those areas in appropriate breadth and depth. Tutors in a problem based learning curriculum need to alter their traditional teaching methods of lectures, discussions, and asking students to memorize materials for tests. As such, tutors focus their attention on questioning student logic and beliefs, providing hints to correct erroneous student reasoning, providing resources for student research, and keeping students on task. Because this role will be new to some teachers, they may have concern moving away from their past practice.

Considerable debate has occurred in higher education about the merits and demerits of tutors being selected for their content expertise. The early literature on PBL tutoring, exemplified by Barrows (1988), has emphasized the need for tutors to possess "*facilitatory teaching skills during a small group learning process*", these skills being the major determinant of the quality of the PBL learning process.

Other studies of tutor roles and behaviours by Schmidt et al. (1993), Schmidt and Moust (1995), have found that subject matter expertise of tutors enhanced both student learning and the learning process. With respect to tutor behaviours, Schmidt et al. (1993) found that subject matter expert tutors were able to employ more effective process facilitative behaviours such as asking stimulating questions, offering counter examples or seeking clarification, and that these behaviours were related to achievement, the latter referring to written test scores. Schmidt and Moust conclude that to be effective, tutors must possess both facilitatory teaching skills and content expertise, with content expertise a pre-condition to effectively perform the behaviours suggested by Barrows (1988).

Although students have much more responsibility in PBL than in most conventional approaches to teaching, the tutor is not just a passive observer. He or she must be active and directive about the learning process to assure that the group stays on target and makes reasonable choices on what issues are key to study. Teachers also have considerable influence on what is learned by selecting the problems in the first place, and by creating tutor guides and specific outcomes for each phase of the curriculum.

## Role of Students in PBL

As problem-based learning is a student-centred process, it is the responsibility of the individual student to participate fully, not only for his or her own learning, but also to aid the learning of others in the group. Although a significant proportion of time is spent alone in the library or at the computer, the full benefits of PBL cannot be realized in isolation.

In PBL, students devise a plan for gathering more information, then do the necessary research and reconvene to share and summarize their new knowledge in the group. Students may present their conclusions, and there may or may not be an end product. Again, students ideally have adequate time for reflection and self-evaluation (Duch 1995; Delisle 1997; Hoffman and Ritchie 1997; Stepien and Gallagher 1993). All problem-based learning approaches rely on a problem as their driving forces, but may focus on the solution to varying degrees. Some problem-based approaches intend for students to clearly define the problem, develop hypotheses, gather information, and arrive at clearly stated solutions (Allen 1998). Others design the problems as learning-embedded cases which may have no solution but are meant to engage students in learning and information gathering (Wang 1998).

An unanticipated issue with problem based learning is the traditional assumptions of the student. Most students have spent their previous years assuming their teacher was the main disseminator of knowledge. Due to this orientation towards the subject-matter expertise of their tutor and the traditional memorization of facts required of students, many students appear to have lost the ability to "simply wonder about something" (Reithlingshoefer 1992). This is especially seen in first year students who often express difficulties with self directed learning (Schmidt et al. 1992).

Although students generally prefer problem based learning courses, and their ability to solve real-life problems appears to increase over traditional instruction, there are issues to be aware of in moving towards this type of learning. Contributing to this divergence is the time requirement placed upon academic staff to assess student learning (Delafuente et al. 1994), prepare course materials, and allow students to complete the reduction in coverage of course material.

Students all seek approval from their tutors. They need guidance and role models whom they can respect and trust. It is essential for tutors to be honest with students. Even though effective tutors avoid the 'expert' role, they can have a powerful impact on students. Figure 2 depicts the possible levels of independence that students can achieve in a PBL group, where the tutor adopts differing roles.

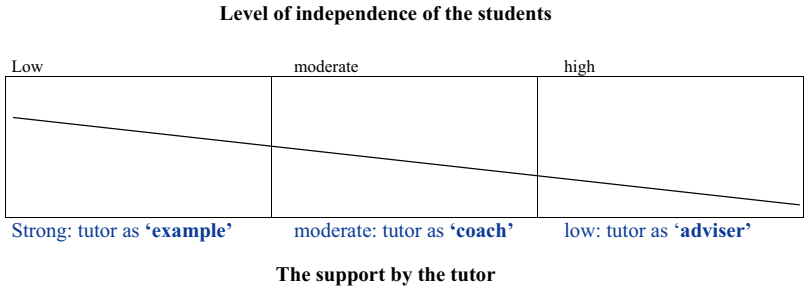


**Fig. 2:**

## Induction Process

Arguably, induction to both strategies is very important for both students and staff. Student induction must have a group work session, and include more support for those without group work experience. Through a series of team-building and problem-solving group activities, students need to become exposed to the problem-based and project-based way of thinking in an enjoyable way.

Considering problem-based learning, before students go into the curriculum proper, a PBL Orientation is essential to prepare students for PBL and enables them to make full use of the PBL process for life-long learning. Such an orientation can cover the following:

- Knowing and using PBL;
- Guest speakers from graduates on their views of PBL;
- Guest speakers from clients/employers on their views of the type of employees that they are looking for and their experience with students who learnt via PBL approach;
- Coping with change;
- PBL Small Group Tutorial Process;
- Assessment for PBL;
- Concept mapping.

Within the orientation, a specific focus on teamwork is vital, in particular, it can include problem-challenging and self-esteem games alongside how effective feedback in group situations is going to be constructed and conveyed.

## Academic achievement

Few academics doubt the ability of students prepared in problem based learning to exhibit strong reasoning and team building skills. Concern has been raised, however, over the breadth of content covered. As the focus of problem based learning centres on a specific problem, academic achievement scores often favour traditional teaching methods when standardized tests are used, but favour neither method when non-standardized forms of assessment are employed (Vernon and Blake 1993). These measures include problem-solving ability, interpersonal skills, peer-tutor relationships, the ability to reason, and self-motivated learning. In contrast, traditional instruction is judged better in the coverage of science content areas (Albanese and Mitchell 1993; Vernon and Blake 1993) and in evaluating students' knowledge content. Although problem based learning tends to reduce initial levels of learning, it can improve long-term retention (Farnsworth 1994).

## Resources

A continuing challenge for CPBL and PBL groups is "How much detail is enough?" Students should be encouraged to bring books and previous class notes and use them in the tutorial, if necessary, to clarify concepts and terminology. To obtain additional information, the tutor may direct students to a specific resource (journal article, book, expert, web site etc.). It is important for students to avoid wasting time tracking down an obscure reference. However, on the other hand, it is important for them to develop skill in finding good information and taking responsibility for the self-evaluation and development of personal study skills.

Generally, there is not a specific list of references developed for each problem considered. Part of the overall learning experience implicit in CPBL and PBL is the development of skills that will facilitate access to learning resources throughout students' future professional career.

Tutors should encourage students to discuss matters of interest pertaining to specific problems with their peers and with more senior students. Similarly, by virtue of the multidisciplinary nature of many of the learning issues that will evolve from individual problems, it is important to guide them towards discussions with professionals in the field.

In CPBL and PBL, resources need to be allocated to take specific factors into account. More generous tutorial support needs to be allocated than is provided for "traditional" courses. Additional tutor time needed to assess a final project report and for double marking of that report needs also to be included.

## Conclusion

It could be argued that the skill of the twenty first century graduate will be to articulate the right questions and to understand where and how they can search for knowledge, not remember the answers. Thus the importance for lecturers in higher education to adopt teaching strategies which cultivate and develop in students the processes of thinking, learning how to learn, problem solving and team-working, within a context of self-directed learning. We believe that well designed collaborative project-based and problem-based learning strategies have the potential to support the development of academic knowledge and skills and combine these in a way that enhances the student learning experience.

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