

Theory and Practice of Project-Based Learning in Built Environment Education: A CEBE Case Study on Innovative Design Project Work

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Abstract

This case study describes an MSc module in “Design Management” taught in the Department of Civil and Building Engineering at Loughborough University. Students in the module play various roles within a multidisciplinary design and construction team working on a fictional project. The design of buildings is markedly more multidisciplinary than other design domains, and often involves larger numbers of design and construction professionals. Therefore design management in the built environment deserves special attention. The case study begins with a summary of the pedagogical theories behind project-based learning, and makes an argument for adopting this instruction paradigm. The case study then describes teaching and assessment methods. The case study closes with benefits of the module as currently implemented (including feedback from formal module reviews and module surveys). Plans for future improvements include engaging industry professionals as mentors in the programme and making a construction extranet system available to students.

Keywords: Project-based Learning, Design Management, Role Play, Group Work

Introduction

This case study describes an MSc module in “Design Management” taught in the Department of Civil and Building Engineering at Loughborough University. The module was established in 2005, and was developed as a project-based module. Students in the module play various roles within a multidisciplinary design and construction team working on a fictional project. The design of buildings is markedly more multidisciplinary than other design domains, and often engages larger numbers of design and construction professionals. Therefore design management in the built environment deserves special attention. The case study begins with a summary of the pedagogical theories behind project-based learning, and makes an argument for adopting this instruction paradigm. The case study then describes teaching and assessment methods. The case study closes with benefits of the module as currently implemented, and describes plans for future improvements.

Project-Based Learning: What is it, why do it?

In project-based learning, all learning activities are anchored to a larger project or problem (Blumenfeld *et al.*, 1991). *Project*-based learning is closely related to *problem*-based learning (where learning is driven by challenging, open-ended problems) and the two terms are occasionally used interchangeably. Both concepts are based upon a constructivist model of human cognition (Savery and Duffy 1994) which contends that true knowledge lies in our interactions with the environment, rather than in detached or decontextualised “facts”. Project-based learning is further motivated by *activity theory* (Jonassen and Rohrer-Murphy, 1999). Activity theory places learning firmly in the perspective of contextual human praxis, and argues that conscious learning emerges from activity rather than as a precursor to it. When applied to education, activity theory helps educators to appreciate that the true focus of inquiry should be the everyday activity of persons acting in a setting.

Another important motivation for project-based learning is the emphasis it places on teamwork. The ability to work in a team is often cited as the most important skill employers look for in candidate employees. Teamwork in project-based learning can be understood through the concept of distributed cognition (Nardi, 1992). Distributed cognition is the study of knowledge propagation between different individuals and artefacts. This has important implications for designing a learning environment which trains students to work as professionals in a multidisciplinary team.

Teaching Methods

The “Design Management” module at Loughborough applies many pedagogical concepts of project-based learning. Students form design and construction teams of three or four. The teams are formed randomly by “picking names out of a hat”. This is intended to mirror real professional practice, where one rarely chooses individual friends to join one’s team. Although the module’s focus is on management rather than any specific discipline, care was taken in the team-forming process to ensure that each team had a mix of skills and expertise (by putting names in separate “hats” for architecture, construction, structures and building services). Learning is centred on the project on which the team works. A fictional project scenario was constructed where the teams are invited to bid for a design and build project to construct an “MSc Student Centre” at Loughborough. The scenario is designed to engage the students and inspire them to take ownership of the fictional project and the learning process.

The module is taught over one semester and comprises 11 weekly three-hour teaching sessions. The first hour of each session is dedicated to a lecture about the management of design and construction projects. Following the lecture, the remainder of the session is dedicated to meetings within each team and between the team and the fictional “client” of the project. The role of the client is played by the lecturer. The final teaching session is dedicated to student oral presentations where each team presents their bid proposal to the client.

Assessment Methods

The module is assessed using three items of coursework:

- **25%: briefing report.** A briefing report is set where each individual student plays the role of the project client and prepares a brief for the fictional MSc Student Centre. The British Standard BS 7832 (briefing checklist) is provided. Following the submission of the briefing coursework, the students are divided into teams and the design coursework is assigned using a standard previously-prepared project brief.
- **50%: design project.** Student teams are formed and students play the role of a design and construction team and prepare a proposal for the project.
- **25% reflective commentary.** Following the completion of the project, each student is asked to write a short reflective commentary on the briefing, design and construction process experienced during the module.

The briefing report and the reflective commentary are individual; the design project is assessed by team. Assessment of the design project is challenging due to the subjective and personal nature of design, particularly because the module's desired learning outcome is the ability to work in a multidisciplinary team. The project is assessed from the team's oral presentation during the last teaching session. The students are instructed to "sell themselves" as a team to the client: they must emphasise their management skills, their talent for working together, their integrated design approach, their interaction with the client, etc. They must also describe their process and rationale when describing their proposed design. The project is assessed not only based on the final designed *product* (i.e. the Student Centre building design), but also on their teamwork *process* described during the presentation.

In addition to the formal project assessment during the final project presentation, each student is asked to assess the team presentation for all teams except that to which the student belongs. This peer assessment is informal and is not counted in the formal module assessment. It is intended to motivate the students and is used to award an informal prize (a box of chocolates) to the highest-rated team immediately following the team presentations.

Assessed against the intended learning outcomes of ability to describe and manage the design process, and to produce design alternatives that meet all stakeholder requirements, students consistently attain high assessment in the module. In the two years that the module has been run, 100% of students passed and over 70% attained grades A or B.

Future Developments

It is planned to engage industry partners to serve as mentors. Industry partnership has been implemented in other project-based programmes to great effect (Fruchter, 2003; Fruchter and Lewis 2003; Willmot, 2003). Industry professionals would mentor the students and act as consultants to whom the students could go with questions related to professional practice. It was not feasible to realize this during the first year that the module was taught at Loughborough. However, prior experience indicates that professionals are often eager to serve as active participants in educational programmes. A mentor would be engaged from each discipline involved in the design and construction of buildings. That mentor would be asked to contribute a short lecture, and then allow students to contact him/her with questions over the course of the design project.

Currently, team members communicate using the standard tools used by students, such as email, instant messaging and telephone. It is envisaged to make various construction-specific collaboration tools available to students.

Notably, a construction extranet system such as those used in real construction projects would be extremely useful to the students as they work on their projects (Wilkinson, 2005). As such extranet systems are becoming increasingly widespread, this improvement would better prepare students for professional practice.

Finally, it is hoped to partner with other higher education institutions, particularly an institution which teaches architecture, which is not offered by Loughborough University. This would strengthen the multidisciplinary collaboration skill imparted by the module. It could even be beneficial to partner with institutions from other countries. Again, this would better prepare students for practice in the construction industry, which increasingly entails collaboration with colleagues from different disciplines and cultures (Fruchter and Townsend 2003).

Increased industry involvement was partly implemented for the second generation of the module in 2006. A guest lecturer was invited from the Taylor Woodrow Technology Centre to speak about information and communication technologies for construction. In addition, the Loughborough University Estates Service was engaged in attending design reviews, giving feedback on proposals and providing information about the site. Negotiations are underway to grant the students access to an extranet system and to collaborate with other higher education institutions.

Transferring project-based frameworks between institutions

Project-based learning frameworks can be framed as three components:

- a project scenario
- collaboration tools
- a network of academic and industrial institutions as partners

The project scenario should motivate the students and inspire them to take ownership of the project. At Loughborough, the students were asked to design a university building that they themselves (as MSc students) would use. When transferring this framework elsewhere, this scenario will need modification to suit the institution and the students. Regarding tools, the toolset provided must include basic communication tools (email), as well as access to standard construction software applications such as CAD, estimating or construction planning. As discussed above, the third component (a network of partners) was not in place for the first year the module was offered at Loughborough. It should not be difficult to develop such a network of partners, but even without it, the module was extremely successful during its first year.

Perceived Benefits

Professional practice in the built environment sector entails working in multidisciplinary teams to a greater extent than ever before. Understanding the goals and constraints of other disciplines (and being able to communicate and collaborate with professionals from these disciplines) is essential to working well in real built environment projects. Such interdisciplinary teamwork skills cannot be acquired from traditional discipline-centric methods of instruction.

A second benefit of project-based instruction is that students are inspired to take ownership of the project and the learning process by constructing a project scenario with which they can identify. Most students are in the position of using university buildings in their everyday lives, and by assigning a project to design and construct a university building, they will be trained to relate to the end users of buildings even after they enter their chosen design/construction profession. This will make them better professionals. It also makes them better learners: they are motivated to learn in order to create better projects of which they can be proud in front of their peers. This is the intention behind incorporating informal peer review into the final presentation session. It addresses the problem of shallow, strategic learning where students learn the bare minimum needed to pass a course and gain a qualification.

Feedback on the Module

The “Design Management” module as described in this case study has been evaluated through the formal departmental protocol of module survey and module review. In the module survey, all registrants are asked to complete a machine-readable questionnaire soliciting opinions about module organisation, lectures, coursework, instructors and feedback returned on marked coursework. The “Design Management” module attained the second highest mean score (4.7/5 from 18 questionnaires) of all the modules surveyed in the department in 2005. Only the module on “Transport Policy” attained a higher score (4.9/5 from four questionnaires).

In the module review, an interview is held with two or three representative students who are asked to collect feedback from their fellow students in advance. In both forms of student feedback, the lectures offered were praised, but the students particularly benefited from the close interaction with the lecturer (playing the role of the client) during the mock client meetings. The project gave students the opportunity to apply the discipline expertise they learn from other modules in a real (or realistic) project context. This close interaction between lecturer and students makes this approach difficult

to implement for larger class sizes, but for class sizes of under about 40 students it is extremely beneficial.

The educational value of role-playing during the module was also recognized by the students. In the reflective commentary coursework item, one student wrote:

“By writing a detailed design brief [as clients] and preparing an outline proposal [as designers] we learned that sound management involves a proper understanding of the roles of the individuals being managed, and being able to see the project from multiple viewpoints.”

Another wrote:

“We learned that design management involves both technical integration (for example, through IT networks to facilitate data transfer) as well as social skills to ensure social cohesion, harmony and trust.”

Professor Patricia Carrillo is Professor of Strategic Management in Construction and Postgraduate Programme Director. She oversees the MSc programme of which the “Design Management” module is part. She writes,

“This module provided a new way of learning for our students and allowed them to exploit both individual and group skills. The group presentations were enthusiastic with each student keen to explain their group’s design. They praised the module extensively for bringing together the multidisciplinary teams and allowing them to be creative whilst considering the practical aspects of logistics, building layout, buildability, time and costs amongst others. The module is a real asset to the MSc portfolio.”

Other staff and students echoed these sentiments, reaffirming that project-based learning is extremely effective for guiding students through the complexities of managing building design.

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About the author

Peter Demian joined Loughborough University as a Lecturer in Construction Management in 2005. He developed and teaches the MSc module described in this case study. Before moving to Loughborough, he completed his PhD at Stanford University under the supervision of Dr Renate Fruchter, founding Director of the Project-Based Learning Lab at Stanford. At Stanford, Dr Demian served as Teaching Assistant for the “AEC Global Teamwork” course established in 1993 and offered in collaboration with universities worldwide. Before Stanford, he studied Structural Engineering at Cambridge University.