

# A Critical Review of Problem Based Learning in Architectural Education

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*There is limited research and discussion on pedagogical approaches in architectural education, simply because it is considered as one of the “unimportant” areas that researchers “do not bother studying” (Teymur, 2001). Problem Based Learning has been known to provide competent graduates in other professional disciplines, and, consequently, there have been attempts to utilise the same pedagogical approach in architectural education where PBL is seen as a potential solution to the problems encountered in architectural education. This paper critically reviews PBL implementations at TU Delft Netherlands and Newcastle University, N.S.W. Australia and draws conclusions with particular respect to the teaching of architectural computing.*

**Keywords:** PBL; architecture; computing.

## Problem Based Learning in Architectural Education

There is only a limited literature available on the relevancy and effectiveness of PBL implementation in architectural education. PBL in architectural courses is usually confined to the studio itself and does not affect or interact with the teaching of other subjects in the curriculum (Maitland, 1997). The challenge becomes more severe when the goal is to simulate true-to-life design tasks across the course subjects of the whole curriculum (Westrik and de Graaff, 1994), but these descriptions are often limited to presenting the curriculum structure and the learning theory of an architectural version of the PBL pedagogical approach. In general terms, Boud and Felletti (1997) consider that discussions of PBL are mostly focused upon the aspects that are “more descriptive of process” rather than “analytical of either process or out-

come.” The exact questions of PBL relevancy, and how the PBL implementation is carried out in the most distinctive features of architectural education, its contents and its conventional teaching methods, have not been elaborated

A number of authors have reported experiences of using PBL in the teaching of architectural computing (Goldman and Zdepski, 1987; Kalisperis, 1996; Marx, 1998; Johnson, 2000; Rógemer and Russel, 2000; Wyeld et al, 2001; Silva, 2001; Delgado, 2005). However, most of them deal with specific teaching modules, which are applied within the boundaries of the design studio itself or try to integrate computing into an existing curriculum (Juroszek, 1999) rather than causing actual changes to its structure.

## An introduction to PBL

Problem-based learning is a practically oriented

pedagogical model, in which students develop their expertise on the content area under study by working with cases and problems that represent real life situations (authentic problems) (Savin-Baden, 2000). Barrows and Tamblyn (1980), the pioneers and developers of the model, define problem-based learning as: “the learning that results from the process of working towards the understanding or resolution of a problem. The problem is first encountered in the learning process, and it serves as a focus or stimulus for the application of problem-solving or reasoning skills, as well as for the search for or study of information or knowledge needed to understand the mechanisms responsible for the problem and how it might be resolved.”

The goal of learning is to acquire a pre-defined, integrated body of knowledge related to the problem(s), and this knowledge includes declarative knowledge (“what”), procedural knowledge (“how”) and contextual knowledge (“why, when and where”).

As Barrows and Tamblyn (1980) noted, the concept *problem solving* is a bit misleading. For many *problems* there is no solution or, alternatively, there are several solutions, and solving the basic problem is not essential. *Problems* are as a matter of fact quite close to *cases*. The difference is that a case is a description of a certain situation, which is used for training students to apply what they have learned from a textbook (Kunst and van Veen, 1986). Despite the differences of view, *problem* and *problem solving* are the commonly used concepts in this approach. It is important to notice that problems are not “exercises” or ready-made questions, as problems are sometimes thought in, for example, school mathematics teaching.

Learning by problem solving can be applied on two levels. Firstly, as an overall method of learning and as a distinctive, well-documented instructional approach (Bereiter and Scardamalia, 2000) applied especially in several areas of higher education, typically in medical education where it was first developed. In these approaches, all study of an academic

profession is constructed around problem solving. The educational organisation is then constructed to support the problem-solving approach and usually the educational settings are well designed and stable. Typically the problem solving process lasts some weeks (typically 6 weeks), and then it might include only one large problem. A problem has a large, cross-curriculum content, without an exact question but rather a set of several problems to be found, defined and solved. The process of solving the problems includes also group work, the division of labour for finding relevant information, the tutor, etc. Secondly, as a learning method for one content topic, sometimes connected with other teaching methods; in that case, problem-based learning is used only occasionally, and it is one alternative among other methods. The difference in these two approaches is mainly the educational setting, not the method of problem solving. When problem solving is used as one element of a course or a curriculum, a problem might be an independent *problem*, not a part of a larger group of problems. Still, it might consist of a cross-curriculum content area where the problems are complex, and the students’ task is to define their own problems and find the possible solutions. The process takes, however, less time and effort than in the first approach.

Savin-Baden (2000) defines three essential conditions for problem-based learning:

1. It concentrates on constructing a curriculum based on problems, to support a broad, cross-curriculum approach, and to support learning of cognitive skills instead of specific contents.
2. It is supported by a tutor’s guidance, work in small groups, and active learning.
3. The outcomes are the development of skills and motivation, and the ability for life-long learning.

The outcomes of problem-based learning are anticipated to be:

1. the increasing expertise in the content area;
2. problem solving skills and the ability to solve new and challenging problems;
3. good metacognitive skills, like an ability for self-

- reflection;
4. higher order cognitive skills, like decision making, critical and creative thinking;
  5. the ability to combine declarative and procedural knowledge.

### **PBL at the Technical University Delft**

The Faculty of Architecture at the Technical University of Delft emphasizes integration of design and engineering. The faculty is one of the largest ones at Delft University with about 2,400 students and over 450 staff members. Before the innovation of the educational system, the curriculum basically consisted of a series of design projects complemented by discipline courses and skill exercises. Students could choose from over 1000 different courses and projects. There were large differences in the quality of different projects, integration with other parts of the curriculum often failed and the programmes were almost impossible to manage. In 1990 a new curriculum was implemented, employing the principles of Problem-Based Learning. The PBL curriculum consisted of a series of thematic blocks. During a period of eight weeks (one block), a theme was highlighted. Theoretical study, learning to design, and acquiring skills (such as presentation techniques) were all integrated within the theme. The program of each block was documented by means of a so-called block-book, containing problems, design assignments, and a time schedule for exercises and lectures. The teachers monitoring the groups of 16 students had a double role. Whilst the group were analyzing PBL problems, they acted as facilitators. The supervision of design follows the apprenticeship model of studio teaching. Since, both students and teachers prefer design to more theoretical study activities, the integration of different elements in the thematic blocks was handicapped (de Graaff & Cowdroy, 1997). A series of evaluation studies indicated that students clearly felt design is the most important part of their study and they are most critical in relation to the design teaching. Together with other theoretical disci-

plines, the humanities tended to be neglected.

### **PBL in Architecture (University of Newcastle, Australia)**

At the University of Newcastle, Australia, the Department of Architecture found that their structured lectures and design studio session were lacking in integration. A complete PBL structure was then implemented for the entire 5-year programme. In Year 1, a series of problems lasting four weeks each are given to students. In Years 2–4, students deal with one major problem lasting the whole year and shorter problems of varying length. In Year 5, students get to select their own problem and deal with it the whole year. Throughout the 5-year programme, seminars and short lectures are held between problems. These seminars and short lectures are driven by the problems. With a learning issue on hand, each student would want to learn more about the various subjects in order to solve the problems. Hence, students are found to be more attentive and motivated to learn.

### **Evaluation**

Although the PBL implementation in the Faculty of Architecture, TUDelft, seemed to offer an improvement in architectural education, the faculty later abandoned the PBL pedagogical approach. The current programme consists of BSc and Master Programmes following the “Bologna” structure without specific PBL characteristics. In fact, the faculty published a book in 2002 entitled “Ways to Study and Research Urban, Architectural and Technical Design” which describes eight scholarly methods of design, providing readers with “perspectives on innovating architectural thought” (de Jong and de Voordt, 2002). This book brought back design studio to be the focus of the architectural curriculum in the Faculty of Architecture, and was written without reference to the PBL pedagogical approach that had been previously implemented in the faculty.

From the evaluation carried out by Abdullah (2006), the implementation of PBL in the Faculty of Architecture at TUDelft could not be considered as successful, mainly because the adoption of PBL was not carefully refined to suit architectural thinking, and the scale of the faculty was too large to undertake such a reformation in its curriculum and organizational structures. However, the faculty was successful, in terms of using the label of PBL in its curriculum, in ensuring its survival in TUDelft.

In contrast, the Faculty of Architecture at the University of Newcastle, N.S.W., Australia carefully adapted the PBL pedagogical framework simply by enhancing the importance of the design studio in architectural education, and strengthening the integration of subjects in the architectural curriculum. In addition, the scale of the Faculty of Architecture, at the University of Newcastle, was considered small, compared to the TUDelft. The appropriate adaptation of PBL and the small scale of the faculty contributed to the unanimous acceptance in the faculty, of the attempt at reformation brought about by the implementation of PBL.

The TUDelft implementation suffered from philosophically adopting the PBL approach used in the Faculty of Medicine at the University of Maastricht version of PBL. This methodology defined problems as cases, which required the diagnostic search of cause and result, rather than treating architectural design projects as the “problems” to trigger the learning process. The treatment of architectural problems in the same way as medical cases failed to tackle the complexity of architectural thinking, where a wide range of integration among various architectural disciplines was required, because cases only touch a small percentage of the possible fields. For example, one problem used in environmental design asked students to consider the problem of a bathroom mirror being covered in condensation. This did not fulfil the needs of developing design skills, but rather only stipulated that students had to analyse the reasons why and how condensation on the mirror occurred. Treating the case of a condensed mirror as a “prob-

lem” in architectural PBL was considered as diagnosing a constructional problem of an architectural object, or a building. In the conventional architectural curriculum, knowledge related to such a case would only be disseminated in a lecture on environmental design, because the scope of its architectural application was too small, compared to the complexity of architectural disciplines. Therefore, taking this type of constructional case as an architectural problem in the implementation of PBL, compared to clinical cases in medical schools, was perceived by most academics in the faculty as irrelevant to the holistic nature of architecture.. The use of analogical thinking in the treatment of cases as problems in architectural PBL, as implemented in the Faculty of Architecture, TUDelft, was considered as too didactic and too mechanical in architectural studies, which explained why it raised persistent resistance to the PBL implementation among academics in the faculty.

Furthermore, there was an attempt to re-invent the cases used in the architectural PBL, using architectural design precedents or building typologies. In the conventional architectural education, cases were generally known as the precedents of design, which were constantly used as references for developing architectural designs. Similar to treating constructional cases as problems, the attempt at using building typologies as problems in the architectural version of PBL had a limited scope for architectural learning and simultaneously discarded the needs of developing comprehensive design and professional skills. Especially with the separation of group discussion sessions and design exercises, design precedents did not contribute to a large extent to the integration of knowledge in architectural studies.

In comparison, the adaptation of PBL in the Faculty of Architecture at the University of Newcastle, took into consideration the complexity of architectural thinking, where architectural design projects were developed as the “problems” from which students generated reasons and solutions. Depending on the context and scope of the architectural study areas, the use of architectural design projects, as stim-

uli for learning in the architecture version of PBL, did not jeopardize the conventional importance of the design studio. Instead, it enhanced the importance of the design studio by strengthening the integrative quality of the architectural discipline. Thus, this situation of treating architectural design projects as problems made the adaptation of PBL pedagogical approach in the faculty more acceptable than had been experienced in TUDelft.

The initial problem of lack of refinement in the architecture PBL version implemented in the Faculty of Architecture at TUDelft was rooted in the manner in which an impromptu decision to adopt the Maastricht version of PBL was made within a six months period. Since the decision was made ad hoc, mainly for the survival of the Faculty, the management of the Faculty took the drastic approach of making a top down decision, without consensus from the lower level members of the faculty, who would eventually have to carry out the implementation. As such, the implementation was perceived as enforcement rather than cooperation. Most of the low level staff in the Faculty did not have much influence on the decision making, and were not involved in the design and planning of the proposed undertaking of PBL. Instead, consultation on the proposed PBL implementation was primarily received from educational specialists, who were considered as outsiders and whose knowledge of the nature of architectural thinking was in doubt. Most of the academic staff perceived that the absence of architectural input, except for the types of cases used, in the design of PBL led to the faulty and misinterpreted adoption of the Maastricht version of PBL. Thus, the persistent resistance from the faculty members towards the implementation of PBL in the Faculty of Architecture at TUDelft contributed to the unsuccessful outcome of the implementation.

## General conclusions

1. The decision to introduce PBL should be discussed amongst not only the decision makers, but also the architectural academic staff who would be involved in the implementation process.
2. The design of an architectural version of PBL should be done with advice and references not exclusively from the general educational specialists who are experts in PBL pedagogical approach, but also from architectural teaching staff who have a better knowledge of architectural education
3. In terms of curriculum design, the nature and types of problems to be used as the triggers for learning in architectural PBL pedagogical approach should be thoroughly researched and developed, for relevancy, before the commencement of the PBL implementation. As different disciplines have different definitions or constitution of problems, the proposed architectural problems to be used in an architectural PBL approach should be based on both educational and professional architectural contexts, and take into consideration how architects think.
4. Issues of relevancy should also be confronted in terms of what suitable PBL mechanisms may be included in the proposed architectural PBL approach. Relevancy of PBL mechanism, such as its learning process and techniques, to architectural studies and disciplines must be analysed at the planning stages to ensure its suitability to architectural education. For example, PBL group discussion alone is not enough to generate integration in architectural studies, but the experiential “learning by doing” feature of the conventional methods of architectural teaching should also be incorporated to ensure that the provision of design skills development is available in the proposed system.
5. In terms of curriculum structure, the design studio should be used as the arena for integrating architectural knowledge. Having separated venues and time allocations for PBL group discussion and design studio, as had been practiced in the Faculty of Architecture at TUDelft, does

not contribute to the comprehensive integration of knowledge. Since architectural education requires both the accumulation of architectural knowledge and the development of various skills among students, too much emphasis on group discussion may jeopardize the development of various professional skills required for architectural students.

6. The proposed PBL educational approach to be implemented in architectural education should have appropriate provision of flexibility, as compared to the pure version of PBL pedagogical approach, so that it suits architectural education. For example, a strict ban on the use of lectures as one of the learning techniques should be waived so that any architectural knowledge that could not be disseminated via group discussion, such as history, could also be incorporated in PBL. In addition, free hand drawing class that requires the development of skill via “learning by doing” could be taught successfully if PBL does not over-emphasise upon group discussion. Flexibility on the assessment methods should also be provided to give weight to the conventional architectural method of assessing design product as part of a PBL mechanism. The provision of flexibility in the architectural version of PBL may produce an architectural curriculum that transforms in an evolutionary manner rather than revolutionary, or as an adaptation, not direct adoption of the PBL pedagogical approach.
7. In terms of the issues of managing change, a proper monitoring system of the PBL implementation process should be designed and carried out by an elected committee, because having a monitoring system can ensure the PBL implementation remains always on track. Methods of managing the implementation should be researched during the planning stages, while the PBL curriculum structure is designed.
8. Although the importance of the design studio should be maintained in the proposed architectural version of PBL, the long-held practice

of autonomy among design mentors should be abolished. Academic staff should not be given the absolute freedom to manage and conduct their studios individually, but co-operation among several design facilitators should be incorporated.

9. The design of an architectural version of PBL should include the provision of staff induction, training, and development to promote understanding, acceptance and commitment among the academic staff towards the implementation. Academic staff should master methods of delivering knowledge in PBL before the implementation even starts, so that the proper role of facilitators can be practiced in the learning process. Consequently, facilitators who fully understand the philosophy of PBL pedagogical approach will be able to help students to conduct their own learning processes. Otherwise, insufficient concern with staff induction, training, and development in the designed of PBL implementation may result in confusion of PBL philosophy, both among academic staff and students.

### **Specific points of relevance to the teaching of architectural computing**

#### **Complexity of the problem**

The problem should be sufficiently complex to not only engage the students’ interest but also bear some relationship to real world circumstances. Simply finding out how to operate a particular piece of software may be seen as a parallel to the bathroom mirror example. Suitable projects should relate to design studio work and not be seen as separate activities away from the main focus. One example might be the modeling and representation of precedents related to the current studio project.

#### **Open-endedness of problem**

The task should be open to multiple interpretations. In architectural computing this might encompass the selection of alternative software packages or

forms of representation.

### **Duration of assignment**

The assignment should be of sufficient duration to allow students to meaningfully engage with the problem. As indicated previously six weeks appears to be an optimum duration.

### **Degree of collaboration amongst students**

Teamwork and sharing of information leads to an enhanced learning experience.

### **Explicit incorporation of reflection**

Reflection on learning outcomes and skills gained is of particular importance. Students acquire important “generic skills” in these classes and it is worth reflecting on these skills and documenting them in “Personal Development Portfolios”.

### **Variety of skills required**

The project should allow for the development of a range of skills. Examples might include the mixing of scanned and manipulated traditional media with computer generated media or photo-montaging CAD images onto scanned photographs. Presentations may use hardcopy media or projected images.

### **Diversity of media**

CAD modeling and imaging may be taught alongside traditional manual drawing and modeling.

### **Use of precedents**

The selection of suitable precedents is crucial. One of the key considerations is the availability of sufficiently detailed and accurate source material to work with.

### **Collaborative development of problem definitions**

The project is more meaningful if the participants have been involved in the collaborative definition of the problem formulation.

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